

Adherence to the Mediterranean dietary pattern among workers: a systematic review

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Abstract

Purpose – This paper aims to carry out a systematic review based on the preferred reporting items for systematic reviews and meta-analyses (PRISMA) guidelines to assess the adherence to the Mediterranean dietary pattern (MDP) in workers.

Design/methodology/approach – Three electronic databases were searched up to March 2022. The population was restricted to adults, workers in any professional area, without special diets and no specific health conditions. Their adherence to the MDP was assessed by any a priori method/instrument. Two reviewers independently applied the eligibility criteria and performed the data extraction from each study included. In case of disagreement, a third reviewer was consulted.

Findings – Of the 590 studies found, 46 were included. Most of the studies were carried out in Europe, between the years 2019 and 2022 and were cross-sectional studies. The minimum sample size was 38, and the maximum was 1,74,638 participants. Most studies included both males and females; six included only females and nine only males. The three most prevalent types of workers under study were health professionals, factory workers and firefighters. The most used method for assessing adherence to the MDP was the Mediterranean diet score. Overall, workers showed low or moderate adherence to the MDP.

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Erratum: It has come to the attention of the publisher that the article, Leão, P., Rei, M. and Rodrigues, S. (2024), “Adherence to the Mediterranean dietary pattern among workers: a systematic review”, *Nutrition & Food Science*, Vol. 54 No. 6, pp. 1106-1130. <https://doi.org/10.1108/NFS-11-2023-0252>, did not include the full affiliation details for each of the co-authors. This error was introduced during the production process. The affiliations have been corrected in the online version of the article. The publisher sincerely apologises for the error and any inconvenience caused.

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Originality/value – This systematic review conducted to assess the adherence to the MDP in workers displays an urgent need to improve diet quality in the workplaces.

Keywords Mediterranean diet, Diet quality, Occupational health, Systematic review, Workers

Paper type Literature review

Introduction

Occupational health gains special relevance when it is verified that workers represent half of the world's population and are the main contributors to economic and social development (WHO, 2017; WHO, 2013; WHO, 2006). Moreover, the majority of the population is at working ages, spending a large part of their day at work (WHO, 2017). Therefore, in 2010, the World Health Organization (WHO) carried out a systematic review of concepts associated with a healthy workplace, as well as practices to improve health in the workplace. This work gave rise to the definition of a "healthy work environment," which is considered as "one in which workers and managers collaborate to a continuous improvement process aimed at protecting and promoting the health, safety and well-being of all workers and the sustainability of the work environment" (WHO and Burton, 2010).

As early as 2003, the WHO stated that productivity at work can increase by 20% with adequate nutrition (WHO, 2010). Two years later, in 2005, the International Labor Organization verified that the availability of healthy food to employees can benefit absenteeism, showing, once again, the important connection between eating habits and work (Wanjek, 2005). Adequate food, in quantity and quality, increases health, and thus performance, productivity and efficiency in the functions performed by employees and, consequently, reduces absenteeism, decreasing costs for the employer (Fitzgerald *et al.*, 2018).

Individuals have recently changed their eating habits due to changes in their lifestyles (Nitzke and Freeland-Graves, 2007; Popkin *et al.*, 2012). The current fast pace of life causes changes in the eating habits, forcing people to eat outside of their homes due to distance between their workplace and their home, lack of time, daily routine and high workload (Jabs and Devine, 2006; Möser, 2010; Smith *et al.*, 2013). Thus, the dietary patterns of workers can be influenced by the social context in which they live and also work, becoming important to understand the quality of diet among a population group as relevant to society as this (Devine *et al.*, 2003). The Mediterranean dietary pattern (MDP) has been considered one of the healthiest and sustainable dietary patterns. It is characterized by the dominance of plant origin products such as vegetables, fruit, cereals, nuts, legumes and olive oil as the main source of fat; moderate consumption of fish, white meats, eggs and dairy products; moderate consumption of wine at main meals, with water being the main drink and reduced consumption of red meat, meat products and sugar (Davis *et al.*, 2015).

However, several studies point out to a gradual departure from the countries of the Mediterranean region from this food model. Among other factors, the globalization of the food market and the region's integration into the European space are considered potential causes for the deviations from this pattern and changes in eating habits (da Silva *et al.*, 2009; Vilarnau *et al.*, 2019). In addition, the protective effect of this dietary pattern comes from the biological interactions of the various nutrients and behaviors in relation to its associated lifestyle: physical exercise, adequate time for meals and rest periods (Huhn *et al.*, 2015). However, working and social conditions, nowadays, modify the food routine, providing multiple meals often composed of processed and convenience foods, with lower nutritional quality (Murakami and Livingstone, 2016).

We hypothesized that workers need to improve diet quality. In this alignment, this study aimed to carry out a systematic review to assess the adherence to the MDP in workers. The guiding question of the review process was: "What is the workers' adherence to the MDP?"

The population was restricted to adults (over 18 years old), workers in any professional area, without special diets and no specific health conditions. Their adherence to the MDP had to be assessed by any *a priori* method/instrument.

Methods

Study design

This systematic review was based on the preferred reporting items for systematic reviews and meta-analyses (PRISMA) guidelines (Page *et al.*, 2021); however, it was not registered. Reference management software, CADIMA (www.cadima.info/), was used to gather, store and organize the references, including the elimination of duplicates.

Search strategy

Studies that assessed the adherence to the MDP in workers were searched in PubMed, Scopus and Web of Science databases, until March 2022. In PubMed, the final search results were identified by using the following expression: (((“adherence”[All Fields] OR “compliance”[All Fields] OR “adequacy”[All Fields] OR “score”[All Fields] OR “instrument”[All Fields] OR “metric”[All Fields] OR “assessment”[All Fields] OR “measure”[All Fields] OR “measurement”[All Fields] OR “abstracting and indexing”[MeSH Terms]) AND (“Mediterranean Diet”[All Fields] OR “diet, mediterranean”[MeSH Terms] OR “Mediterranean Food Pattern”[All Fields])) AND (“Worker”[All Fields] OR “employee”[All Fields] OR “personnel”[All Fields] OR “staff”[All Fields] OR “occupational groups” [MeSH Terms])). In Scopus and the Web of Science, the following expression was used: (((“adherence” OR “compliance” OR “adequacy” OR “adoption” OR “index” OR “indexes” OR “indice” OR “indices” OR “scale” OR “scales” OR “score” OR “scores” OR “metric” OR “metrics” OR “indicator” OR “indicators” OR “instrument” OR “instruments” OR “measure” OR “measures” OR “measurement” OR “measurements” OR “assessment” OR “assessments” OR “assess”) AND (“mediterranean food pattern” OR “mediterranean food patterns” OR “mediterranean diet” OR “mediterranean diets” OR “mediterranean diet pattern” OR “mediterranean diet patterns” OR “mediterranean dietary pattern” OR “mediterranean dietary patterns”)) AND (“worker” OR “workers” OR “employee” OR “employees” OR “personnel” OR “staff” OR “occupation” OR “occupational groups”)).

Eligibility criteria

Studies were restricted to those with a sample aged over 18 years, written in English, Portuguese or Spanish, and carried out only in humans. Studies evaluating the adherence to the MDP in workers were included, covering different types of professions and shifts, and using any *a priori* method/instrument for the MDP assessment. As exclusion criteria, the following were defined: population with special diets and/or any specific health conditions, and studies not using *a priori* methods for MDP assessment. No study design was imposed on the search, but all reviews, abstracts-only, books, conference papers and opinion/editorial articles were excluded. Moreover, authors were contacted whenever the study was unavailable. However, in the absence of a response from the authors, up to 1 month after contact, two studies were excluded.

Study selection and data extraction

Two reviewers independently applied the eligibility criteria – first by reading the titles and the abstracts, and then by reading the full-text – and selected the studies of interest for inclusion in this systematic review. In case of disagreement, a third reviewer was consulted.

Data from each study included in this systematic review was extracted independently by two reviewers and encompasses information about: author; year of publication; country; study design; sample size and characterization; type of workers; type of *a priori* method/instrument used to assess the adherence to the MDP and level of adherence to the MDP. In case of disagreement, a third reviewer was also consulted.

Results

As shown in the flow diagram (Figure 1), the search found 590 records (154 from PubMed, 189 from Scopus and 247 from Web of Science). Duplicates ($n = 166$) were removed and 424 titles and abstracts were screened, resulting in 289 excluded records. After full-text analysis of the remaining 135 records, 89 were excluded. The main reasons for exclusion were: i) the sample included adults unemployed or with specific health conditions ($n = 68$), ii) the MDP adherence was assessed without *a priori* methods ($n = 11$), iii) the record was considered gray literature or inaccessible ($n = 5$), iv) the article was written in Italian ($n = 2$) and v) other reasons such as low adherence to the MDP as inclusion criteria ($n = 3$). At the end, 46 studies were included in this systematic review. Data extraction is summarized in Tables 1 and 2, where studies are ordered by type of workers (with repeated samples) and subgroups of workers (others within the same area): health professionals > factory workers > firefighters > militaries > office/company employees > university staff and other workers, and then in decreasing order of publication year.

Studies characterization

Forty six studies included were developed in 12 different countries, the majority being carried out in Europe ($n = 27$), in the USA ($n = 17$) and only two outside Europe and not belonging to the USA. Additionally, 21 studies were published between 2019 and 2022, 11 studies between 2016 and 2018, ten between 2012 and 2015 and only four studies before 2011. Regarding the type of study, most studies included were cross-sectional studies ($n = 31$), followed by cohort studies ($n = 12$), randomized controlled trials ($n = 2$) and nonrandomized uncontrolled trials ($n = 1$). (Tables 1 and 2)

The studies included had samples of varying sizes, ranging from 38 (Rapisarda *et al.*, 2021) to 1,74,638 participants (Hu *et al.*, 2015), with cohorts like the Health Professionals Follow-up Study, the Nurses' Health Study, the Nurses' Health Study II and the Aragon Workers' Health Cohort Study having the larger numbers of participants. (Tables 1 and 2)

Workers characterization

Most studies evaluated male and female workers ($n = 31$), but some evaluated only males ($n = 9$) and others only females ($n = 6$). The participants' age ranged from 18 to 75 years. One of the studies (Sentenach-Carbo *et al.*, 2019) did not perform the characterization of the sample in terms of sex and age. Regarding the type of profession, most studies included health professionals ($n = 17$) followed by factory workers ($n = 7$) and firefighters ($n = 6$). Office/company employees ($n = 5$), university employees ($n = 4$), military ($n = 3$), taxi drivers ($n = 1$) and nightlife workers ($n = 1$) were also considered. In two studies (Pavičić Žeželj *et al.*, 2019; Hulsegge *et al.*, 2016), a clear description of the type of profession was not presented (Tables 1 and 2).

In the Health Professionals Follow-up Study, the Nurses' Health Study and the Nurses' Health Study II, the participants' age ranged between 25 and 55 years for females and 40–75 years for males. The percentage of males ranged from 36.9% to 37.4%; however, two of these studies evaluated only males (Wirth *et al.*, 2018; Kenfield *et al.*, 2014) and four evaluated only

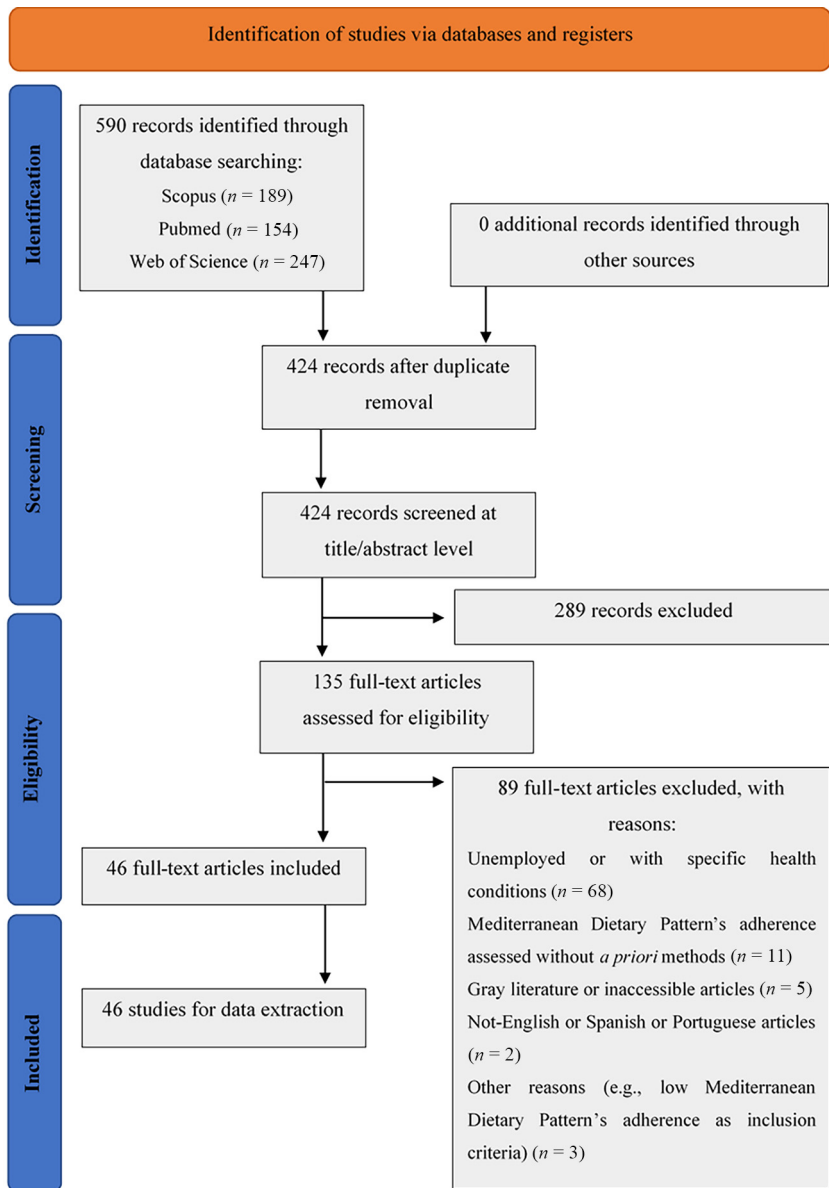


Figure 1. Flow diagram depicting the study selection process – adherence to the Mediterranean dietary pattern in workers: a systematic review

Source: Authors own creation

First author, et al. (year)	Country	Study type	Sample	Type of workers	A priori method used	Adherence to the MDP
<i>Health professionals</i> Petimar et al. (2018)	United States	Cohort	1,24,707 adults (37.4% males, range: 40–75 years among males and range: 30–55 years among females)	Healthcare professionals (Nurses' Health Study and Health Professionals Follow-up Study)	Alternate Mediterranean diet (aMED) score [range: from 0 to 9]	Males Q1: $m \pm SD = 1.5 \pm 0.6$, $n = 8,726$ Q5: $m \pm SD = 7.4 \pm 0.6$, $n = 6,818$ Females Q1: $m \pm SD = 1.5 \pm 0.6$, $n = 18,592$ Q5: $m \pm SD = 6.6 \pm 0.7$, $n = 16,213$
Wang et al. (2018)	United States	Cohort	14,046 adults (37.1% males, range: 40–75 years among males, and range: 30–55 years among females)	Healthcare professionals (Nurses' Health Study and Health Professionals Follow-up Study)	Alternate Mediterranean diet (aMED) score [range: from 0 to 9]	Males T1: $m \pm SD = 5.2 \pm 1.8$, $n = 1,842$ T2: $m \pm SD = 4.3 \pm 1.9$, $n = 1,599$ T3: $m \pm SD = 3.4 \pm 1.7$, $n = 1,777$ Females T1: $m \pm SD = 5.1 \pm 1.6$, $n = 3,189$ T2: $m \pm SD = 4.2 \pm 1.8$, $n = 2,308$ T3: $m \pm SD = 3.2 \pm 1.7$, $n = 3,331$
Sotos-Prieto et al. (2015a)	United States	Cohort	79,538 adults (36.9% males, range: 40–75 years among males, and range: 30–55 years among females)	Healthcare professionals (Nurses' Health Study and Health Professionals Follow-up Study)	Alternate Mediterranean diet (aMED) score [range: from 0 to 9]	Males Q1: $m \pm SD = 5.6 \pm 1.6$, $n = 5,945$ Q3: $m \pm SD = 4.2 \pm 1.9$, $n = 7,074$ Q5: $m \pm SD = 3.0 \pm 1.6$, $n = 5,176$

(continued)

Table 1. Data extraction summary of the included studies on healthcare workers – adherence to the MDP among workers: a systematic review

First author, et al. (year)	Country	Study type	Sample	Type of workers	A priori method used	Adherence to the MDP
Barbhaiya et al. (2021)	United States	Cohort	1,73,122 female adults (range: 25–55 years)	Healthcare professionals (Nurses' Health Study and Nurses' Health StudyII)	Alternative Mediterranean diet (aMED) score [range: from 0 to 9]	Females
						Q1: $m \pm SD = 5.4 \pm 1.5$, $n = 9,576$
						Q3: $m \pm SD = 4.0 \pm 1.8$, $n = 11,673$
						Q5: $m \pm SD = 2.7 \pm 1.6$, $n = 9,742$
						Nurses' Health Study ($n = 79,568$) T1: $n = 18,930$ T2: $n = 30,801$ T3: $n = 29,837$
Hu et al. (2015)	United States	Cohort	1,74,638 female adults (range: 25–55 years)	Healthcare professionals (Nurses' Health Study and Nurses' Health StudyII)	Alternate Mediterranean diet (aMED) score [range: from 0 to 9]	Nurses' Health Study II ($n = 93,554$) T1: $n = 37,128$ T2: $n = 17,638$ T3: $n = 38,788$
						Nurses' Health Study ($n = 83,245$) Q1: range = 0–2, $n = 19,140$ Q2: range = 3, $n = 17,279$ Q3: range = 4–5, $n = 32,501$ Q4: range = 6–9, $n = 14,325$
						Nurses' Health Study II ($n = 91,393$) Q1: range = 1–2, $n = 19,071$ Q2: range = 3–4, $n = 33,881$

(continued)

First author, et al. (year)	Country	Study type	Sample	Type of workers	A priori method used	Adherence to the MDP
Hirko et al. (2016)	United States	Cohort	1,00,643 female adults (range: 30–55 years)	Healthcare professionals (Nurses' Health Study)	Alternate Mediterranean diet (aMED) score [range: from 0 to 9]	Q3: range = 5, <i>n</i> = 16,375 Q4: range = 6–9, <i>n</i> = 22,066 Q1: range = 0.0–2.6 Q2: range = 2.7–3.5 Q3: range = 3.6–4.4 Q4: range = 4.5–5.4 Q5: range = 5.5–9.0
Jung et al. (2016)	United States	Cohort (but with a nested case-control analysis)	1,688 female adults (range: 30–55 years)	Healthcare professionals (Nurses' Health Study)	Alternate Mediterranean diet (aMED) score [range: no information]	Q1: median = 20, <i>n</i> = 366 Q2: median = 23, <i>n</i> = 327 Q3: median = 26, <i>n</i> = 381 Q4: median = 28, <i>n</i> = 381 Q5: median = 32, <i>n</i> = 566
Wirth et al. (2018)	United States	Cohort	43,635 male adults (range: 40–75 years)	Healthcare professionals (Health Professionals Follow-up Study)	Alternate Mediterranean diet (aMED) score [range: from 0 to 9]	Q1: range = 0.0–2.0 Q2: range = 3.0–3.0 Q3: range = 4.0–5.0 Q4: range = 5.0–6.0 Q5: range = 6.0–9.0
Kenfield et al. (2014)	United States	Cohort (but with a case-only survival analysis)	51,529 male adults (range: 40–75 years)	Healthcare professionals (Health Professionals Follow-up Study)	Mediterranean diet score (MDS) [range: from 0 to 9]	At baseline (in 1986) Low adherence (0–3 points): 36.8% Moderate adherence (4–5 points): 34.0% High adherence (6–9 points): 29.2%
Béjar Prado and Mesa Rodríguez (2022)	Spain	Cross-sectional	44 adults (47.7% males; mean age of 47.7 ± 11.8 years)	Healthcare professionals from hospital emergency services	2 indicators: (1) Global adherence indicator, expresses the average of items within the recommendations, ranging from 0 to 15;	(1) Global adherence indicator: <i>m</i> ± <i>SD</i> = 6.0 ± 2.2 (2) Global adherence indicator ≥ 8 points: <i>n</i> = 9 (20.5%)

(continued)

First author, et al. (year)	Country	Study type	Sample	Type of workers	A priori method used	Adherence to the MDP
Rapisarda et al. (2021)	Italy	Cohort	38 adults (45% males; mean age of 48.5 ± 7.4 years among males, and mean age of 49.3 ± 7.9 years among females)	Healthcare workers at an emergency hospital	and (2) Global adherence indicator ≥ 8, expresses the percentage of participants who comply with recommendations in eight or more items PREDIMED questionnaire [range: from 0 to 14]	At baseline Males: m ± SD = 4.6 ± 2.3 Females: m ± SD = 4.8 ± 1.9
González-Sosa et al. (2021)	Spain	Cross-sectional	922 adults (28% males; mean age of 42.6 ± 11.4 years; range: 20–69 years)	Healthcare personnel	Mediterranean diet adherence score (MEDAS) [range: from 0 to 14] PREDIMED-PLUS questionnaire [range: from 0 to 17]	Low adherence (0–8 points); n = 358 (38.8%) Good adherence (9–14 points); n = 564 (61.2%) Overall: m ± SD = 7.2 ± 2.6
Leyva-Vela et al. (2021)	Spain	Cross-sectional	240 female adults (mean age of 37 ± 10 years)	Nurses and nursing assistants	Mediterranean diet score (MDS) [range: from 0 to 9]	Low adherence (0–2 points); n = 126 (14.2%) Moderate adherence (3–5 points); n = 504 (56.6%) High adherence (6–9 points); n = 260 (29.2%)
Carlos et al. (2020)	Spain	Cohort	890 adults (51.9% males; mean age of 51.7 ± 9.4 years; range: 19–65 years)	Doctors	PREDIMED questionnaire [range: from 0 to 14]	Very low adherence (0–5 points); 12% Low adherence (6–7 points); 33% Medium adherence (8–11 points)
Sentenach-Carbo et al. (2019)	Spain	Cross-sectional	422 adults (no sample characterization)	Primary care physicians		

(continued)

First author, et al. (year)	Country	Study type	Sample	Type of workers	A priori method used	Adherence to the MDP
Eleuteri et al. (2018)	Italy	Cross-sectional	117 adults (37.6% males; mean age of 54.0 ± 6.4; range: 40–64 years)	Primary caregivers of people with Alzheimer sdisease or dementia	Mediterranean diet score (MDS) [range: from 0 to 55]	points): 52% High adherence (12–14 points): 3% Overall: m ± SD = 31.7 ± 5.2
Tountas et al. (2007)	Greece	Cross-sectional	262 adults (38.5%; mean age of 38.3 years)	Hospital employees, namely administrative, auxiliary and technical personnel, medical doctors and nurses	Diet score [range: no information]	Males: m ± SD = 34.7 ± 4.0 Females: m ± SD = 34.1 ± 3.8

Notes: MDP = Mediterranean dietary pattern; m = mean score; SD = standard deviation; n = absolute frequency
Source: Authors' own creation

Table 1.

Table 2.
Data extraction
summary of the
included studies on
nonhealthcare
workers – adherence
to the MDP among
workers: a
systematic review

First author, <i>et al.</i> (year)	Country	Study type	Sample	Type of workers	<i>A priori</i> method used	Adherence to the MDP
<i>Factory workers</i>						
Uzhovaet al. (2018)	Spain	Cross-sectional	1,798 male adults (range: 40–55 years)	Workers at an automobile assembly plant (from Aragon Workers' Health Cohort Study)	Alternate Mediterranean diet (aMED) score [range: from 0 to 9]	No plaque in femorals: m ± SD = 4.4 ± 1.7 No plaque in carotids: m ± SD = 4.2 ± 1.7 No coronary artery calcification: m ± SD = 4.3 ± 1.7 Overall: m ± SD = 4.2 ± 1.7 Males: m ± SD = 4.2 ± 1.7 Females: m ± SD = 4.2 ± 1.7 Overall: m ± SD = 11.3 ± 2.6
Mateo-Gallego <i>et al.</i> (2017)	Spain	Cross-sectional	2,588 adults (94.9% males; mean age of 51.3 ± 3.9 years; range: 40–60 years)	Workers at an automobile assembly plant (from Aragon Workers' Health Cohort Study)	Alternative Mediterranean diet (aMED) score [range: from 0 to 9]	Males: m ± SD = 4.2 ± 1.7 Females: m ± SD = 4.2 ± 1.7 Overall: m ± SD = 11.3 ± 2.6
Sotos-Prieto <i>et al.</i> (2015b)	Spain	Cross-sectional	988 adults (range: 40–55 years)	Workers at an automobile assembly plant (from Aragon Workers' Health Cohort Study)	Mediterranean lifestyle index (MEDLIFE) [range: from 0 to 28]	Overall: m ± SD = 11.3 ± 2.6
Kendel Jovanović <i>et al.</i> (2020)	Croatia	Cross-sectional	366 adults (51.6% males; 63.9% with <40 years; 36.1% with ≥ 40 years)	Employees at the oil and gas company	Mediterranean diet score (MDS) [range: from 0 to 9]	Low adherence (0–3 points); n = 150 (41.0%) Moderate adherence (4–5 points); n = 144 (39.3%) High adherence (6–9 points); n = 72 (19.7%) Males: m ± SD = 13.1 ± 2.8 Females: m ± SD = 14.5 ± 2.5
Pavičić Žežej <i>et al.</i> (2018)	Croatia	Cross-sectional	366 adults (51.6% males; mean age of 37.2 ± 8.6 years)	Employees at the oil and gas company	Mediterranean lifestyle index (MEDLIFE) [range: from 0 to 28]	Females: m ± SD = 14.5 ± 2.5
Kanauchi and Kanauchi (2015)	Japan	Cross-sectional	433 male adults (mean age of 45.3 ± 7.0 years; range: 30–62 years)	Workers at an electronic products factory	Mediterranean-style diet (MED) score [range: from 0 to 11]	Nonhypertension: m ± SD = 5.2 ± 1.5
Leighton <i>et al.</i> (2009)	Chile	Nonrandomized uncontrolled trial	145 adults (88.7% males; mean age of 39 years)	Workers of a metalmechanic company servicing the mining industry	Mediterranean diet score (MDS) [range: from 0 to 14]	At baseline Overall: m ± SD = 4.8 ± 1.4

(continued)

First author, <i>et al.</i> (year)	Country	Study type	Sample	Type of workers	<i>A priori</i> method used	Adherence to the MDP
<i>Firefighters</i> Romero Cabrera <i>et al.</i> (2021)	United States	Cross-sectional	258 adults (94% males; mean age of 48.8 ± 7.6 years)	Firefighters (from feeding America's bravest cluster-randomized controlled trial)	Modified Mediterranean diet score (mMDS) [range: from 0 to 51]	Overall: m ± SD = 24.3 ± 6.2
Romanidou <i>et al.</i> (2020)	United States	Cross-sectional	460 adults (94.4% males; mean age of 46.7 ± 8.3 years)	Firefighters (from feeding America's bravest cluster-randomized controlled trial)	Modified Mediterranean diet score (mMDS) [range: from 0 to 51]	Overall: m ± SD = 21.9 ± 6.7
Sotos-Prieto <i>et al.</i> (2020)	United States	Randomized Controlled trial	48 adults (intervention group: 91.7% males and mean age of 47.5% ± 6.7 years; control group: 95.8% males and mean age of 47.6 ± 8.6 years)	Firefighters (from feeding America's bravest cluster-randomized controlled trial)	Modified Mediterranean diet Score (mMDS) [range: from 0 to 51] PREDIMED questionnaire (at time point 1)	mMDS (at time point 1) Control Group: m ± SD = 26.1 ± 2.1 PREDIMED questionnaire (at time point 1) Control Group: m ± SD = 6.6 ± 2.1
Sotos-Prieto <i>et al.</i> (2019)	United States	Randomized Controlled trial	420 adults (94.7% males; mean age of 48.4 ± 8.3 years)	Firefighters (from feeding America's bravest cluster-randomized controlled trial)	Modified Mediterranean diet score (mMDS) [range: from 0 to 51]	At baseline Overall: m ± SD = 24.1 ± 5.7
Lan <i>et al.</i> (2020)	United States	Cross-sectional	92 adults (96.8% males; mean age of 25.6 ± 5.1 years)	Firefighters (from fire recruit health study)	PREDIMED questionnaire [range: from 0 to 14]	High adherence (9–14 points); n = 24 (26.2%) Low adherence (0–8 points); n = 68 (73.9%)
Yang <i>et al.</i> (2014)	United States	Cross-sectional	780 male adults (range: > 18 years)	Firefighters (from a North American cohort)	Modified Mediterranean diet score (mMDS) [range: from 0 to 42]	Overall: m ± SD = 21.3 ± 5.6
<i>Militaries</i> Mullie <i>et al.</i> (2013)	Belgium	Cross-sectional	1,852 male adults (range: 20–59 years)	Military men	Mediterranean diet score (MDS) [range: from 0 to 9]	Low adherence (0–3 points); n = 694 (38.3%) Moderate adherence (4–6 points); n = 803 (52.5%)

(continued)

First author, et al. (year)	Country	Study type	Sample	Type of workers	<i>A priori</i> method used	Adherence to the MDP
Mullie et al. (2011)	Belgium	Cross-sectional	1,852 male adults (range: 20–59 years)	Military men	Mediterranean diet score (MDS) [range: from 0 to 9]	High (7–9 points); $n = 108$ (9.2%) Low adherence (0–3 points); $n = 694$ (38.3%) Moderate adherence (4–6 points); $n = 803$ (52.5%) High adherence (7–9 points); $n = 108$ (9.2%) Q1: range = 0–2, $n = 344$ Q3: range = 4, $n = 379$ Q5: range = 6–9, $n = 406$
Mullie et al. (2010)	Belgium	Cross-sectional	1,852 male adults (range: 20–59 years)	Military men	Mediterranean diet score (MDS) [range: from 0 to 9]	At baseline (before pandemic) Non-Mediterranean diet followers (0–8 points): $n = 135$ (45.5%) Mediterranean diet followers (≥ 9 points): $n = 162$ (54.5%) Healthcare workers: $m \pm SD = 35.8 \pm 4.7$ Nonhealthcare workers: $m \pm SD = 34.1 \pm 3.7$
<i>Office/company employees</i> Franco et al. (2021)	Spain	Cohort	297 adults (50.2% males; mean age of 42.8 ± 7.8 years; range: 24–63 years)	Office employees participating in a health promotion program	PREDIMED questionnaire	Low adherence (0–7 points); 29.3% High adherence (8–13 points); 71.2%
Di Lorenzo et al. (2021)	Italy	Cross-sectional	147 female adults (mean age of 46.0 ± 8.9 years among healthcare workers, and mean age of 44.0 ± 10.0 years among nonhealthcare workers)	Female employees of public companies	Mediterranean diet score (MDS) [range: from 0 to 55]	
Calderón García et al. (2021)	Spain	Cross-sectional	634 adults (67.7% males; median age of 41.3 years among males, and median age of 40.2 years among females)	Workers of a company	Modified PREDIMED questionnaire [range: from 0 to 13]	

(continued)

First author, <i>et al.</i> (year)	Country	Study type	Sample	Type of workers	<i>A priori</i> method used	Adherence to the MDP
Alvarez-Fernández <i>et al.</i> (2021)	Spain	Cross-sectional	1,609 adults (60.0% males; mean age of 48.0 ± 8.3 years among local government workers, and mean age of 41.1 ± 10.2 years among workers at risk of social exclusion)	Working population from the city hall	Mediterranean diet Adherence screener (MEDAS) [range: from 0 to 14]	Overall: m ± SD = 7.7 ± 2.0 High adherence (≥9 points): n = 565 (35.1%)
Papadaki <i>et al.</i> (2015)	United Kingdom	Cross-sectional	590 adults (27.5% males; mean age of 43.8 ± 11.1 years; range: 18–65 years)	Employees in business and professional services companies and local government branches	Mediterranean dietscore (MDS) [range: from 0 to 55]	Overall: m ± SD = 33.8 ± 5.4 Low adherence (0–20 points): n = 3 (0.5%) Moderate adherence (21–35 points): n = 356 (60.6%) High adherence (36–55 points): n = 228 (38.8%)
University staff Virolet <i>et al.</i> (2021)	Portugal	Cross-sectional	102 adults (48% males; mean age of 47 years; range: 24–69 years)	Workers of a public university (from iMC SALT randomized controlled trial)	Alternative Mediterranean diet (aMED) score [range: from 0 to 9]	Low-to-moderate adherence (0–5 points): n = 73 (73.5%) High adherence (6–9 points): n = 27 (26.5%)
Caparello <i>et al.</i> (2020)	Italy	Cross-sectional	340 adults (45.9% males; mean age of 46.8 ± 10.6 years; range: 24–67 years)	University staff	Mediterranean diet Adherence screener (MEDAS) [range: from 0 to 14]	Overall: m ± SD = 7.3 ± 1.9 Males: m ± SD = 7.4 ± 2.0 Females: m ± SD = 7.3 ± 1.8
Bellissimo <i>et al.</i> (2020)	United States	Cross-sectional	693 adults (35% males; mean age of 48.9 ± 11.5 years)	Metropolitan university and health care system employees	Mediterranean diet score (MDS) [range: from 0 to 9]	Lean group: m ± SD = 4.6 ± 0.2

(continued)

Mediterranean dietary pattern

Table 2.

First author, et al. (year)	Country	Study type	Sample	Type of workers	<i>A priori</i> method used	Adherence to the MDP
Ferranti et al. (2013)	United States	Cross-sectional	640 adults (32.3% males; mean age of 48.0 ± 11.2 years)	Employees of the university and academic health center	Mediterranean diet score (MDS) [range: from 0 to 9]	Overall: m ± SD = 4.4 ± 1.8
<i>Other workers</i> Martin et al. (2016)	Ireland	Cross-sectional	41 male adults (mean age of 56.7 ± 9.8 years; range: 35–72 years)	Taxi drivers	Modified Mediterranean diet score (mMDS) [range: from 0 to 10]	Overall: m ± SD = 4.6 ± 2.2
Moreno Linares et al. (2015)	Spain	Cross-sectional	144 adults (61.1% males; mean age of 26.9 ± 4.7 years; range: 18–44 years)	People working in nightlife	Mediterranean diet score (MDS) [range: from 0 to 9]	Overall high adherence: 12.5%
Pavičić Žeželj et al. (2019)	Croatia	Cross-sectional	400 adults (68% males; median age of 36 years)	Full-time workers	Mediterranean diet score (MDS) [range: from 0 to 9]	Overall: median = 6, IQR = 2
Hulsegge et al. (2016)	Amsterdam	Cross-sectional	7,856 adults (30% males; mean age of 47 years; range: 20–70 years)	EPIC-MORGEN and EPIC-PROSPECT cohorts participants	Mediterranean diet score (MDS) [range: from 0 to 9]	Day workers: median = 5, IQR = 4–6 Shift workers: median = 5, IQR = 4–6

Notes: MDP = Mediterranean dietary pattern; m = mean score; SD = standard deviation; IQR = interquartile range; n = absolute frequency

Source: Authors' own creation

females (Barbhaiya *et al.*, 2021; Hirko *et al.*, 2016; Hu *et al.*, 2015; Jung *et al.*, 2016). In the remaining studies that included health professionals, the participants' mean age ranged from 37.0 to 51.7 years, the percentage of males ranged from 28.0% to 51.9%, and two of these studies included only females (Leyva-Vela *et al.*, 2021; Di Lorenzo *et al.*, 2021) (Table 1).

In studies with factory workers, three included participants from the Aragon Workers' Health Cohort Study (Uzhova *et al.*, 2018; Mateo-Gallego *et al.*, 2017; Sotos-Prieto *et al.*, 2015b). The lowest mean age of the factory workers was 37.2 years, and the highest was 45.3 years. The percentage of males ranged from 51.6% to 88.7%, with one study being conducted only in males (Kanauchi and Kanauchi, 2015) (Table 2).

In studies with firefighters, four included participants from the Feeding America's Bravest cluster-randomized controlled trial (Romero Cabrera *et al.*, 2021; Romanidou *et al.*, 2020; Sotos-Prieto *et al.*, 2020; Sotos-Prieto *et al.*, 2019). The minimum percentage of males among the firefighters was 94.0%, and the lowest and the highest mean age was 46.7 and 48.8 years, respectively (Table 2).

Of the studies that included office/company employees, one included only females (Di Lorenzo *et al.*, 2021) and, in the remaining ones, the percentage of males ranged from 27.5% to 67.6%. The mean age of these workers ranged from 41.1 to 46.0 years. Among studies with university employees, the maximum percentage of males was 48.0%, and the participants' mean age ranged between 46.8 and 48.9 years (Table 2).

In studies with a sample composed by militaries, the individuals' age ranged from 20 to 60 years, and the percentage of males was higher than 90% in all studies. In the Taxi Drivers' Study, the participants were all males with a mean age of 56.7 years. Finally, in the Nightlife Workers' Study, 61.1% of the participants were males, and their mean age was 26.9 years (Table 2).

Methods/instruments used to assess adherence to the Mediterranean dietary pattern

The Mediterranean diet score (MDS) was the *a priori* method most used to assess adherence to the MDP ($n = 15$), followed by the alternate Mediterranean diet (aMED) ($n = 11$). Other studies used the prevention with Mediterranean diet (PREDIMED) questionnaire, including PREDIMED-PLUS and a modified PREDIMED questionnaire ($n = 7$), the modified Mediterranean diet score (mMDS) ($n = 6$), the Mediterranean diet adherence screener (MEDAS) ($n = 3$), the Mediterranean lifestyle index (MEDLIFE) ($n = 2$) and the Mediterranean-style diet score (MED-Score) ($n = 1$). One of the studies used a diet score (Tountas *et al.*, 2007), and another used a Global adherence indicator (Béjar Prado and Mesa Rodríguez, 2022). (Tables 1 and 2)

Adherence to the Mediterranean dietary pattern

Health professionals (Table 1): The adherence to the MDP among the cohort participants in the Nurses' Health Study, the Nurses' Health Study II and the Health Professionals Follow-up Study was assessed by the aMED (score range from 0 to 9) (Petimar *et al.*, 2018; Wang *et al.*, 2018; Sotos-Prieto *et al.*, 2015a; Barbhaiya *et al.*, 2021; Hirko *et al.*, 2016; Hu *et al.*, 2015; Jung *et al.*, 2016; Wirth *et al.*, 2018), with the exception of one study where the authors used the MDS (score range from 0 to 9) (Kenfield *et al.*, 2014). According to this last study, 70.8% of the male health professionals had low to moderate adherence to the MDP (at baseline, in 1986). Moreover, the other authors organized these health professionals by quintiles, quartiles or terciles, according to their aMED score value. Through the analysis of the quintile/quartile/tercile that included the midpoint of this score (as representative of a "moderate" adherence to the MDP), it was possible to notice a general tendency to have less quintiles/quartiles/terciles with aMED score value higher than this midpoint (in other words, less health professionals with moderate to high adherence to the MDP) (Wang *et al.*, 2018; Sotos-Prieto *et al.*, 2015a; Hirko *et al.*, 2016; Hu *et al.*, 2015; Wirth *et al.*, 2018).

The other studies with health professionals used the PREDIMED questionnaire (score range from 0 to 14) (Rapisarda *et al.*, 2021; Sentenach-Carbo *et al.*, 2019), the PREDIMED-PLUS questionnaire (score range from 0 to 17) (Leyva-Vela *et al.*, 2021), the MEDAS (score range from 0 to 14) (González-Sosa *et al.*, 2021), the MDS (score range from 0 to 9 in one study, and score range from 0 to 55 in other two studies) (Carlos *et al.*, 2020; Eleuteri *et al.*, 2018; Di Lorenzo *et al.*, 2021), a Diet Score (no score range information) (Tountas *et al.*, 2007) and a Global adherence indicator (score range from 0 to 15) (Béjar Prado and Mesa Rodríguez, 2022). Overall, both male and female healthcare workers had low to moderate adherence to MDP (mean score of 4.6 ± 2.3 among males and mean score of 4.8 ± 1.9 among females, according to the PREDIMED questionnaire (Rapisarda *et al.*, 2021); only 3% of the primary care physicians with high adherence, also according to the PREDIMED questionnaire (Sentenach-Carbo *et al.*, 2019); mean score of 7.2 ± 2.6 among nurses and nursing assistants, according to the PREDIMED-PLUS questionnaire (Leyva-Vela *et al.*, 2021); 70.8% of doctors with low to moderate adherence, according to MDS (Carlos *et al.*, 2020); mean score of 31.7 ± 5.2 among primary caregivers (Eleuteri *et al.*, 2018) and mean score of 35.8 ± 4.7 (Di Lorenzo *et al.*, 2021) also according to MDS; mean score of 6.0 ± 2.2 , according to a Global adherence indicator (Béjar Prado and Mesa Rodríguez, 2022)). However, in one study using MEDAS, 61.2% of the healthcare personnel had good adherence to this healthy dietary pattern (González-Sosa *et al.*, 2021).

Factory workers (Table 2): The adherence to the MDP among workers at an automobile assembly plant (from the Aragon Workers' Health Cohort Study) was assessed by the aMED (score range from 0 to 9) (Mateo-Gallego *et al.*, 2017; Uzhova *et al.*, 2018) and the MEDLIFE (score range from 0 to 28) (Sotos-Prieto *et al.*, 2015b). Overall, these workers had moderate adherence to the MDP, according to both methods (mean score of 4.2 ± 1.7 , according to the aMED; mean score of 11.3 ± 2.6 , according to the MEDLIFE).

Among workers at an oil and gas company, the authors used the MDS (score range from 0 to 9) (Kendel Jovanović *et al.*, 2020) and the MEDLIFE (score range from 0 to 28) (Pavičić Žeželj *et al.*, 2018). According to the MDS, 80.3% of the workers had low or moderate adherence to the MDP, and according to the MEDLIFE both males and females had moderate adherence to this dietary pattern (mean score of 13.1 ± 3.8 among males; mean score of 14.5 ± 2.5 among females).

Additionally, in workers from other factories/industry branches, the adherence to the MDP was assessed by the MDS (score range from 0 to 14) (Leighton *et al.*, 2009) and the MED-Score (score range from 0 to 11) (Kanauchi and Kanauchi, 2015), disclosing also low (mean score of 4.8 ± 1.4 , according to the MDS) and moderate (mean score of 5.2 ± 1.5 , according to the MED-Score) adherence to this dietary pattern.

Firefighters and militaries (Table 2): The adherence to the MDP among firefighters from the Feeding America's Bravest cluster-randomized controlled trial was assessed by the mMDS (score range from 0 to 51) (Romero Cabrera *et al.*, 2021; Romanidou *et al.*, 2020; Sotos-Prieto *et al.*, 2019; Sotos-Prieto *et al.*, 2020), except in one study where the authors also used the PREDIMED questionnaire (score range from 0 to 14) (Sotos-Prieto *et al.*, 2020). These firefighters had moderate adherence to the MDP (mean score of 24.1 ± 5.7 , at baseline, according to mMDS). This review also included two other studies with firefighters using the PREDIMED questionnaire (score range from 0 to 14) (Lan *et al.*, 2020) and the mMDS (score range from 0 to 42) (Yang *et al.*, 2014). By the different methods, a low to moderate adherence to the MDP was noticeable (73.9% of the firefighters with low adherence, according to the PREDIMED questionnaire; mean score of 21.3 ± 5.6 , according to the mMDS).

Among military personnel, the authors assessed the adherence to the MDP with the MDS (score range from 0 to 9) (Mullie *et al.*, 2011; Mullie *et al.*, 2010; Mullie *et al.*, 2013), disclosing low to moderate adherence to this dietary pattern among 90.8% of these workers.

Office/company employees and other workers (Table 2): Studies with samples of employees from companies/offices/local government assessed adherence to the MDP with the MDS (score range from 0 to 55) (Di Lorenzo *et al.*, 2021; Papadaki *et al.*, 2015), the PREDIMED questionnaire and a modified version (score range from 0 to 13) (Franco *et al.*, 2021; Calderón García *et al.*, 2021), and the MEDAS (score range from 0 to 14) (Álvarez-Fernández *et al.*, 2021). According to the MDS, this working population had moderate to high adherence to the MDP [mean score of 33.8 ± 5.4 (Papadaki *et al.*, 2015); mean score of 34.1 ± 3.7 among nonhealthcare workers (Di Lorenzo *et al.*, 2021)]. With the PREDIMED questionnaires, the majority of these workers also followed this healthy dietary pattern (high adherence among 54.5% of the sample (Franco *et al.*, 2021); high adherence among 71.2% (Calderón García *et al.*, 2021)). However, according to MEDAS score, only 35.1% of these workers had a high adherence to the MDP (Álvarez-Fernández *et al.*, 2021).

In studies with university staff the authors used the MDS (score range from 0 to 9) (Bellissimo *et al.*, 2020; Ferranti *et al.*, 2013), the MEDAS (score range from 0 to 14) (Caparello *et al.*, 2020) and the aMED (score range from 0 to 9) (Viroli *et al.*, 2021) as methods to assess adherence to the MDP. These types of workers had low to moderate adherence (mean score of 4.4 ± 1.8 and 4.6 ± 0.2 , according to the MDS (Bellissimo *et al.*, 2020; Ferranti *et al.*, 2013); mean score of 7.3 ± 1.9 , according to the MEDAS (Caparello *et al.*, 2020) and 73.5% of the sample with low to moderate adherence, according to the aMED (Viroli *et al.*, 2021).

Among taxi drivers (Martin *et al.*, 2016) and nightlife workers (Moreno Linares *et al.*, 2015), the adherence to the MDP was assessed by the MDS and a modified version (score range from 0 to 10), showing low to moderate adherence (mean score of 4.3 ± 2.2 among taxi drivers; low to moderate adherence in 87.5% of the nightlife workers). Finally, a study with full-time workers (Pavičić Žeželj *et al.*, 2019) and another with day workers and shift workers (Hulsegge *et al.*, 2016) also disclosed moderate adherence to the MDP, using the MDS (score range from 0 to 9).

Discussion

This systematic review on workers' adherence to the MDP displays an urgent need to improve adherence to this healthy dietary pattern among adults at working ages, as early hypothesized. Very few of the 46 included studies showed a high adherence to the MDP among workers (González-Sosa *et al.*, 2021; Franco *et al.*, 2021; Calderón García *et al.*, 2021; Hulsegge *et al.*, 2016), with office/company employees showing greater adherence than other type of workers.

Overall, this population group showed low or moderate adherence to this healthy dietary pattern, despite workers from European countries tending to show better adherence than workers from non-European countries. These results are in agreement with other studies that evaluated the MDP adherence in the general population and that confirm a decreasing adherence to this healthy dietary pattern, in recent years in several countries (Bonaccio *et al.*, 2014; Trichopoulou, 2004; Garcia-Closas *et al.*, 2006; Dernini, 2006; Lopes *et al.*, 2018). Moreover, a recent systematic review of the MDP adherence in adults from Mediterranean countries, concluded that the Mediterranean populations have a low to moderate adherence to the MDP, such as the results found in this systematic review in workers (Obeid *et al.*, 2022).

Our results also show a greater adherence to this dietary pattern among office/company employees, such as office workers of an insurance and health services company, of local government agencies, commercial services and employees of public companies. Although

not evaluated in the present study, the combination of a higher education level (many times required in such jobs) and nonrotating/shift work may be related to the greater adherence to this healthy dietary pattern. Among the general population, the higher the education level, the higher the level of adherence to the MDP can be (Mendonça *et al.*, 2022; Velhinho and Perelman, 2021). Furthermore, shift work has also been associated with greater difficulty in having healthy eating habits (Souza *et al.*, 2019), so it may be more difficult for shift workers to adhere to the MDP.

This systematic review shows that the adherence to the MDP was assessed by several different *a priori* methods. Even in the same type of workers or in the same cohort participants, authors opted to use different methods to summarize the complexity of the MDP throughout a score – that result from the combination of different components that characterize the MDP principles (Bach *et al.*, 2006). However, the MDP principles do not have always well-defined criteria that allow a clear and objective decision of which components should be included in these scores (Bach *et al.*, 2006) – thus, different instruments can assess different aspects of the MDP.

Additionally, authors applied these instruments in different populations from those where the score was originally designed, others used adaptations or different cutoff points from the original ones – common practices in studies that use *a priori* methods (Bach *et al.*, 2006). Some authors presented their results as continuous variables, others as categorical variables, others by gender, body mass index or other sub-groups, showing that there is still a lack of standardization in the results presentation. For example, Sotos-Prieto *et al.* (2020) used two different scores to assess MDP adherence among the same sample of firefighters and presented both scores as a continuous variable, allowing us to conclude about the similarity of the results obtained (through the use of the midpoint of each score as “moderate” adherence); while Lan *et al.* (2020) also used two different scores in the same sample but presented them as categorical variables with different cutoff points and classifications – one of the scores is classified as low (0–8 points) vs high (9–14 points) adherence, and the other is classified as low (0–2 points) vs medium (3–4 points) vs high (5–7 points) adherence. In addition, some studies did not aim to assess MDP but its association with other health outcomes. Some studies have sought to associate dietary scores with certain diseases such as incidence of colorectal cancer (Petimar *et al.*, 2018), risk of systemic lupus erythematosus (Barbhaiya *et al.*, 2021) and markers of oxidative stress (Jung *et al.*, 2016). Thus, although calculated, they did not present enough information for a clear conclusion about adherence to the MDP.

Finally, some authors do not present enough information about the instrument used. For example, in the studies of Tountas *et al.* (2007) and Jung *et al.* (2016), there is an absence or poor description of the range of values of the final score used to assess MDP adherence. All these methodological constraints were a major limitation for the comparison and summary of the systematic review’s results. Other limitations of this study were: the language restriction, leading to the exclusion of papers not published in English, Portuguese or Spanish; the lack of registering the systematic review protocol in databases like PROSPERO which, even though is not mandatory, enhances transparency and mitigates the risk of duplication and the absence of the quality assessment of the included studies which might allow more informed conclusions about the body of literature being reviewed, but it can also be resource-intensive and there are debates within the scientific community about the necessity and reliability of certain quality assessment tools.

Nevertheless, this systematic review has several strengths: it followed the PRISMA guidelines; it used several databases and the eligibility criteria application as well as the data extraction from each study included was performed by independent investigators. We also

used stringent inclusion criteria to ensure the relevance and appropriateness of the included studies to our research question, despite the absence of quality assessment of the included studies. Moreover, to the best of our knowledge, this is the first study carrying out a systematic review to review and report information on adherence to the MDP in workers.

Future research should be focused in creating a uniform classification system for the scores used to assess adherence to the MDP and also in understanding the determinant factors associated to adherence to this dietary pattern in different workers and workplaces. Practical initiatives such as workplace wellness programs and offering healthier food options should be encouraged as they can play a pivotal role in promoting diet quality, namely the MDP, among workers, thereby enhancing overall health and productivity of this population group and ultimately leading to broader public health benefits, including the reduction of diet-related chronic diseases and the establishment of healthier societal norms around food.

Conclusion

This is the first article that reviewed the available scientific literature on adherence to MDP in workers, and the vast majority of the included studies reported low or moderate adherence. Therefore, there is an urgent need to promote appropriate policies and health promotion actions in the workplaces to improve diet quality among this huge population group that is of high social and economic relevance.

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