Mediterranean diet adherence and sleep pattern: a systematic review of observational studies

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Abstract

Background and aims Despite a huge body of evidence on the linkage between dietary intakes and pattern of sleeping, the findings are controversial. The current study aimed to summarize earlier findings on the association between adherence to Mediterranean diet (MD) and pattern of sleeping.

Methods This study performed based on PRISMA guideline. Systematically search was applied in PubMed, Scopus and Google Scholar to find out relevant publications appeared up to February 2023. No restrictions on language and time of publication were applied. Duplicate citations were removed. We included observational studies which assessed MD as the main exposure and kind of sleep disorders as the main outcome.

Results A total of 20 observational studies included. Out of these studies, two were cohort studies and 18 had a cross-sectional design. A total of 21,714 participants included. Usual dietary intakes were assessed using a validated Food Frequency Questionnaire, and a diet history questionnaire. Some studies did not report methods of measuring habitual dietary intakes. Adherence to MD was evaluated by KIDMED questionnaire, PREMED, alternate Mediterranean (aMed) questionnaire, MEDAS questionnaire, MedDietScore, MEDI-LITE score, modified Mediterranean Diet Score (mMDS), Mediterranean food pattern (MFP) and modified Mediterranean diet score (mMED). Pattern of sleeping was examined as sleep quality, sleep duration, sleep latency, sleep efficacy, sleepiness, sleep disturbance, taking a nap and some other sleep disorders.

Conclusion In conclusion, findings of published studies highlighted the importance of consumption of MD for better sleep quality.

Keywords Mediterranean diet, Sleep pattern, Sleep disorders, Sleep quality, Sleep hygiene, Sleep disturbance, Sleep, Dietary pattern

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Intruduction

Sleep is an important physiological function to repair and clear tissue and brain [1]. World Health Organization expressed that 27% of the world's population su er from sleep disorders [2, 3]. Other sleep disorders include sleep-disordered breathing (SDB), parasomnias, narcolepsy, and restless leg syndrome [4]. As a common health problem in modern society, sleep disorder have a high incidence in the elderly population, which seriously a ect the quality of life and physical and mental health [5].

ere is a high prevalence of sleep disturbance worldwide as 7.8% of adults had severe sleep problems in the general population [6]. e prevalence of sleep disorder in older Iranian adults was reported as 48.9% [7]. Medical conditions, depression, anxiety, or cognitive dysfunction can occur along with sleep disorders [8]. ese disorders can increase the risk of stroke [9, 10], migraine [11], neurodevelopmental disorders [12] and irritable bowel syndrome [13]. Despite the role of several factors in sleep quality, including age, sex, body weight and depression [14], dietary factors have received great attention recently. Consumption of fruit, vegetables, dairy products and various vitamins and minerals have been previously studied in this regard [15]. However, limited data are available abut theses speci c dietary patterns. e Mediterranean diet (MD) is a diet based on high consumption of green leafy vegetables, fruits, sh, healthy fats mainly olive oil, legumes, whole grains, nuts and seeds, moderate intake of dairy products and wine consumption as well as low consumption of processed foods, confectionery and red meat [16, 17]. is diet is low in saturated fat and high in vegetable oils, which observed in Greece and Southern Italy during the 1960s [2]. e MD consists of antioxidants, anti-in ammatory micronutrients and n-3 fatty acids and is characterized by a high intake of monounsaturated fat and ber [18].

e association between MD and various health-related outcomes has been previously studied [19]. For instance, some documents have shown that the high adherence to the MD can be associated with a lower incidence of chronic diseases and lower aging impairment [20] and frailty [21]. MD also can a ect against platelet aggregation [22] and mental disorders including cognitive decline and cancer [23]. In fact, weight loss programs based on the MD, can decrease the lean tissue losses [24]. MD bene cial e ects seem to be exerted in both populations of Mediterranean and non-Mediterranean areas [23].

Adherence to the Mediterranean diet has also been studied in relation to sleep patterns; however, ndings were con icting. For example, in a cohort study on the US women aged 20–76 y, adherence to the Mediterranean diet was associated with better sleep quality, higher sleep e ciency, and lower sleep disorders [25].

In contrast, van Egmond et al. in a study on 970 Swedish older men failed to see any signi cant association between adherence to the MD and self-reported sleep initiation and sleep maintenance problems [26]. Despite having several studies in this eld, no systematic review has been conducted on the relationship between MD and sleep disorders. Overall, given the presence of con icting results on the association between MD and sleep disorders, there is a need for a systematic review summarizing all available ndings in this eld. Considering above, we performed the current study to systematically review all available studies regard to the relationship between MD and sleep pattern.

Methods

Search strategy

is study performed based on PRISMA, protocol for reporting systematic reviews. We performed a comprehensive literature search in the online databases of PubMed, Scopus and Google Scholar up to January 2024.

e key words which used for this search were as follows: "Mediterranean Diets" OR "diet" OR "Mediterranean dietary pattern" OR "Feeding Behavior" OR "dietary adherence" OR "dietary score" OR "Mediterranean score OR "MD score" OR "food pattern" OR "dietary habit" OR "Mediterranean dietary score" OR "Mediterranean" OR "dietary pattern" accompanied by "Sleep Disorders" or "insomnia" or "Sleep Wake Disorders" or "Sleep Disorders, Circadian Rhythm" or "Sleep" or "Sleep Deprivation" or "Sleep quality" or "Sleep disturbance" or "Sleep quality index" or "Sleep duration" or "Sleep impairment". All keywords were based on MeSH and non-MeSH terms. All references of selected articles were also reviewed to nd relevant missing publications.

Selection

No restrictions on language and time of publications were applied. Duplicate citations were removed. Observational studies assessing the association between adherence to MD and sleep pattern were included in this systematic review. We included studies with the following criteria: (1) observational studies with prospective, case-control or cross-sectional design; (2) studies that considered adherence to MD as the main exposure; (3) those that had examined every kind of sleep disorders as the main outcome or as one of the outcomes. We excluded letters, comments, short communications, reviews, meta-analyses, ecological studies, and animal studies. A ow diagram of the study selection is shown in Fig. 1.

Data abstraction

Required data from each eligible study were extracted by two independent investigators, and any disagreements were reconciled by discussion. e following

Table 1 Characteristics of included studies on the association between consumption of Mediterranean diet and pattern of sleeping

Author	Gender	Study Design	Country	Age	Outcome Assessment	Exposure Assessment	Sample Size	Study Quality	Outcome	Result
Zuraikat et al. 2020	female 100%	Cohort	USA	20–76 y	PSQI [a]	FFQ [b] /aMed score	432	Fair quality	Sleep onset latency Sleep efficiency Sleep disturbances	lower sleep onset latency no association lower sleep disturbances
Godos et al. 2019	female 58.5%, male 41.5%	cross sectional	Italy	over 18 y	PSQI	FFQ/Medi-lite score	1936	Good quality	Sleep quality Sleep latency Sleep duration Habitual sleep efficacy Sleep disturbances Day time dysfunction Self-rated sleep quality need medication to sleep	higher sleep quality Lower sleep latency Lower shorter sleep duration lower low sleep efficacy no association lower day dysfunction Higher sleep quality no association
van Egmond et al. 2019	females 53%, male 47%	cross sectional	Sweden	71 ± 1	questionnaires	food record/mMDS	970	Good quality	Sleep Initiating problems Sleep maintenance problems	no association no association
Mamalaki et al. 2018	female 59.2%, male 40.8%	cross sectional	Greece	65 y	questionnaires	FFQ / MedDietScore	1639	Good quality	Sleep duration Sleep quality	no association lower trouble falling sleep, higher sleep adequacy
Flor-Alemany et al. 2020	female 100%	cross sectional	Spain	32.9 ± 4.6	PSQI	FFQ /MFP [c]	150	Fair quality	Sleep quality	higher sleep quality during both the 16th and 34th
Campanini et al. 2017	female 51.4%, male 48.5%	Cohort	Spain	60 y	questionnaires/ESS [d]	questionnaires/MEDAS [e]	1596	Fair quality	indicator of Sleep quality Sleep duration	higher sleep quality lower change in sleep duration
Castro-Diehl et al. 2018	female 53.6%, male 46.4%	cross sectional	USA	45–84	WHIIRS [f]/Actigraphy	FFQ /aMed score	2068	Good quality	Insomnia Sleep duration	Lower insomnia by no change vs. decrease in a Med score more likely to sleep 6–7 h/ night (vs. <6 h/night)
Ferranti et al. 2016	female 54.6%, male 45.5%	cross sectional	Italy	11-14y	questionnaires/PDSS [g]	FFQ /KIDMED	1586	Good quality	sleep quality sleep quantity	higher total sleep time, week day sleep time Lower insomnia
Adelantado-Renau et al. 2018	girl 48%, boys 52%	cross sectional	Spain	14-18y	PSQI/Wrist-worn accelerometer	KIDMED [h]	269	Fair quality	Sleep quality Sleep duration	Higher sleep quality no association
Muscogiuri et al. 2020	females71.5%/ male 28.5%	Cross sectional	Italy	51.8 ± 15.7 y	PSQI	PREDIMED	172	Fair quality	Sleep quality	Higher sleep quality
Boralta et al. 2020	females 50%, males 50%	Cross sectional	Spain	12–17 y	questionnaire	KIDMED	761	Good quality	Sleep duration	More sleep duration

Table 1 (continued)

Author	Gender	Study Design	Country	Age	Outcome Assessment	Exposure Assessment	Sample Size	Study Quality	Outcome	Result
Rosi et al. 2020	females 46%, males 54%	Cross sectional	Italy	11–14 y	questionnaires/PDSS	KIDMED	409	Good quality	Sleep duration / Sleep quality / daytime sleepiness	adequate sleep duration / higher sleep quality / Lower sleepiness
ÖZCAN1 et al. 2021	females 31%, males 69%	Cross sectional	Turkey	19–65 y	PSQI	MEDAS/quesstionnaries	1053	Good quality	Sleep quality	higher sleep quality
Zaidalkilani et al. 2021	female	Cross sectional	Jordan	36 ± 10 y	AIS	Questionnarie/ PREDIMED	917	Good quality	Insomnia	Lower insomnia
Gupta et al. 2021	female 26%, male 74%	Cross sectional	Costa Rican		questionnaires	FFQ /aMed score	2169	Good quality	Sleep duration / inconsistent between weekday-weekend sleep / take nap	Adequate sleep duration / no association / no association
Bakırhan et al. 2022	females 63%, males 37%	Cross sectional	Turkey	19–64 y	PSQI	MEDAS	250	Good quality	Sleep quality	higher sleep quality
Naja et al. 2022	Females 81.5%, males 18.5%	Cross sectional	Emirates	22 y	PSQI	KIDMED	503	Good quality	Sleep quality / sleep latency / sleep disturbance / Sleep medication / Sleep duration / daytime dysfunction / Sleep e cacy	better subjective sleep quality / less sleep latency / less sleep disturbance / No association / No association / less daytime dysfunction / No association
Yaghtin et val. 2022	female	Cross sectional	Iran	12–18 y	ISI [j]	FFQ/mMED [k]	733	Good quality	Insomnia	Lower insomnia

assessment of adherence to Mediterranean diet and outcome assessment.

Demographic information of included studies
Study design
Totally, out of 20 included studies, two were cohort studies [25, 27] and eighteen had cross-sectional design [26, 28–36].   e duration of follow up for two cohort studies ranged from one year to 2.8 years [25, 27].

Participant characteristics
Included studies consisted 21,714 participants. Sample sizes across studies varied from 150 [31] to 3254 people [37]. Participants aged over 11 years old. All studies were on both gender, except for four articles that were performed on women [25, 31, 38, 39]. Five studies were on older adults (60–84 y) [26, 27, 29, 33, 37] and seven on young adolescents (11–15 y) [28–30, 35

food pattern (MFP) which was a validated questionnaire [31].

Outcome assessment

Sleep quality and quantity were separately considered as primary outcomes. In general, eleven studies assessed sleep quality [27, 28, 31–35, 37, 42–44], ten studies considered sleep duration [27–29, 32, 33, 35, 36, 40, 41, 44], three studies investigated sleepiness [30, 33, 35], four studies investigated sleep disturbances [25, 31, 32, 44], three studies examined taking nap [30, 33, 36] and three studies examined sleep efficacy and sleep latency [25, 32, 44]. All other sleep disorders that were assessed in two other studies were need medication to sleep [32, 44], day time dysfunction [32, 44], sleep initiating problems [26], sleep maintenance problems [26], not quiet sleep, awaken short of breath or with a headache, feel drowsy or sleepy during the day, trouble falling asleep, awaken during sleep and have trouble falling asleep, trouble staying awake during the day, snore during sleep, snoring and sleep adequacy [33], insomnia [29, 38, 39], inconsistent between weekday-weekend sleep [36] bed time and wake time on weekday and weekend, total sleep time, weekdays sleep time and weekend sleep time [30]. To examine sleep disorders, Pittsburgh Sleep Quality Index (PSQI), a 19 items validated questionnaire, was used by nine studies [25, 28, 31, 32, 34, 37, 43, 44], Women's Health Insomnia Rating Scale (WHIIRS) and a five-items validated questionnaire, was used in the study of Castro-Diehl et al. [29]. Iranian version of the Insomnia Severity Index (ISI) and Athens Insomnia Scale (AIS(was used to assess insomnia in two studies [38, 39]. A validated self-report questionnaires and pediatric daytime sleepiness scale (PDSS) was used by two studies [30, 35]. An Epworth Sleepiness Scale (ESS), an eight items validated questionnaire, was used in the study of Campanini et al. [27] Some other questionnaires were used in the other eight remaining studies [26, 27, 30, 33, 35, 36, 40, 41]. Actigraphy [29] and Wrist-worn accelerometer [28] were used for sleep duration assessment in just two studies, which allowed for evaluation of sleep phenotype.

The association between MD and sleep disorders

Sleep disorders in relation to the adherence to the Mediterranean diet were investigated in different studies as follow:

Sleep quality

Sleep quality was reported in the most included studies. Mamalaki et al. [33] assessed sleep quality by examining following items: daytime sleepiness, sleep adequacy, sleep disturbance, trouble falling asleep, take naps, feel drowsy or sleepy during the day, trouble staying awake during the day, snoring, snore during sleep, awaken during sleep and

have trouble falling asleep and awaken short of breath or with a headache. Ferranti et al. [30] reported the association of a component of sleep quality with MD and did not consider total sleep quality. Eleven studies that evaluated the association of MD with sleep quality reported a greater adherence to the MD in association with a better sleep quality [37, 42–44].

Sleep duration

Seven publications assessed MD in relation to sleep duration. Six studies reported a significant association between adherence to MD and sleep duration [27, 32, 35, 36, 40, 41]. While three studies reported no significant association between MD and duration of sleep [28, 33, 44]. Castro-Diehl et al. [29] compared moderate-high aMed score to a low aMed score across different categories of objectively measured sleep duration (<6 h/night, 6–7 h/night, 7–8 h/night and >8 h/night). They reached no significant association in total; however, participants with a moderate-high aMed score were more likely to sleep 6–7 h/night than those who had a low aMed score.

Sleep latency

Sleep latency was examined in three studies [25, 32, 44]. All of them had reported adherence to the MD was associated with a lower sleep latency.

Sleep efficacy

Based on three studies that assessed adherence to MD in relation to sleep efficacy, two of them reported no significant association [25, 44] and the other found a lower occurrence of low sleep efficacy by a greater adherence to MD [32].

Sleepiness

All three studies [30, 33, 35] that evaluated adherence to MD and sleepiness by PDSS [35] and self-report questionnaires [30, 33] reported an inverse association between sleepiness and MD.

Sleep disturbances

Four studies considered sleep disturbances as the outcome of interest. Zuraitkat et al. [25] and Naja et al. [44] found an inverse association between consumption of MD and sleep disturbances among women, however, no significant association was seen between sleep disturbances and MD in Godos et al. [32] and Mamalaki et al. [33] studies.

Taking a nap

All three studies that evaluated the association between adherence to MD and taking a nap reported no statistically significant associations [30, 33, 36].

Other sleep disorders

In addition to the disorders mentioned above, some other sleep disturbances were also examined in some studies. Needing medications to sleep and self-rated sleep quality [32] as well as sleep initiating problems and sleep maintenance problems [26] were also assessed in any other investigation. In general, only self-rated sleep quality was

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assessment of included studies indicated that out of 12 studies, only seven studies had a high quality and the ve remaining studies had a high risk or a very high risk of bias, which might further limits the reliability of ndings in earlier studies in this regard.

In conclusion, most ndings of published studies highlight the importance of consumption of MD for better sleep quality. Given the di erent forms of sleep pattern examined in the earlier studies, future large-scale, international, multicenter, population-based, epidemiological studies with samples from di erent areas like as other countries worldwide, urban, rural and island regions, are essential for more reliable conclusions. Clinical intervention studies to examine the e ect of consumption of MD on sleep quality are needed. More animal studies can provide a better view of the mechanisms mediating the association between MD and sleep features. In addition, objective neurophysiological tools for sleep assessment (for example actigraphy, polysomnography) are suggested to widely use in feature studies. Moreover, other studies could examine the e ects of meal timing and frequency, in the relation of the MD and sleep quality and quantity. Face-to-face interviews with validated questionnaire such as PSQI is recommended in future studies to reduce recall bias and to increase the validity of the responses. By further studies have been done on these desired variables, meta-analysis would be allowed to be performed.

 erefore we can obtain more accurate information and make stronger recommendations for dietary pattern and sleep hygiene.

Declarations

Ethics approval and consent to participate
Not applicable.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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