



Review Article

Work-Related Musculoskeletal Disorders in Iranian Dentists: A Systematic Review and Meta-analysis



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ABSTRACT

Background: Work-related musculoskeletal disorders are the most important problems among professions particularly, dentists. This study was conducted to determine the prevalence of musculoskeletal disorders in various parts of the body in Iranian dentists by using systematic review and meta-analysis. **Methods:** This systematic review and meta-analysis was based on preferred reporting items for systematic reviews and meta-analyses (PRISMA) guidelines and searching in national databases such as SID, Magiran, Irandoc, IranMedex, and Medlib, and international databases such as MedLine, Web of Sciences, Scopus, PubMed, ScienceDirect, Cochrane, Embase, Springer, Wiley Online Library, Ebsco, CEBM, and Google Scholar search engine which were published by January 1, 2017. Researched keywords were in Persian and their standard English equivalents were in accordance with their MeSH. The obtained documents were analyzed using Comprehensive Meta-analysis version 2.

Results: According to 23 studies through 2,531 Iranian dentists which took part in this study, prevalence of skeletal disorders in Iranian dentists has been 17.6% [confidence interval (CI) 95%:11.7–25.5] in knees, 33.2% (CI 95%:24.1–43.8) in shoulders, 33.4% (CI 95%: 26.8–40.8) in the thorax, 51.9% (CI 95%:46.7–57.2) in necks, 33.7% (CI 95%:28.2–39.6) in wrists/hands, 12.9% (CI 95%:7.7–20.6) in elbows, 37.3% (CI 95%: 31.5–43.5) in lower back, 11.9% (CI 95%:8.7–16.1) in thighs, 12.9% (CI 95%:3.8–36) in the foot, and 10.5% (CI 95%:7–15.4) in legs.

Conclusion: Considering the high prevalence of musculoskeletal disorders in Iranian dentists, ergonomics should be included as a lesson in preclinic and also, reeducation courses for ergonomics basics should be executed for graduate dentists.

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1. Introduction

Musculoskeletal disorders are among the most important work-related problems throughout the world. Unsuitable positions during work, genetic predisposition, aging, and mental pressure could be named as effective factors in increased incidence of these damages [1–3]. Musculoskeletal disorders include injuries in muscles, joints, cartilage, nerves, ligaments, and the vertebral column are increasing in developing countries [4].

The National Institute for Occupational Safety and Health (NIOSH) has classified musculoskeletal disorders as the second most common disease resulting from work, with respiratory diseases being the first [5]. According to the statement of the World Health Organization (WHO), musculoskeletal disorders are

considered as work-related when working activities and conditions significantly induce and exacerbate them [6]. The occurrence of these complaints leads into negative social, financial, and political consequences. According to a recent report by the United States (US) Census Bureau (Federal agency), 40% of the compensation of musculoskeletal disorders related to work injuries, and costs ~\$45–54 million. Nearly 48% of all diseases caused by work are work-related musculoskeletal disorders WMSDs [7,8]. According to the studies performed in the US, 65% of all the new disease cases in the work environment are musculoskeletal disorders [9]. Prevalence and incidence of these musculoskeletal injuries are higher in developing countries [10,11]. Based on a report of the work health center in Iran's Ministry of Health, ~36% of working people in the country have an unsuitable body position while working [12].

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The dentistry profession also may cause some specific skeletal disorders like other jobs. Dentists are prone to musculoskeletal disorders due to their job characteristics such as the need for high attention and concentration and being in the one posture for a long time [13]. Because they work on a small and limited region of the patients (mouth), they often have to adopt unsuitable, asymmetrical, and static positions. The head is bent, arms are kept distanced from the body, and continuous rotation and repetition of these positions exacerbates and highlights the disorder in this profession and results in excess pressure on muscles and joints especially in the neck, shoulders, back, and waist that ultimately leads to reduced working efficiency and early disabled individuals [14]. As resting intervals between the working times are short in dentistry, and necessary activities and the time spent vary between different patients, muscular activity in a specific position sometimes continues for several hours. This working characteristic leads to pain, spasms, joints rigidity, shivers, and disturbances in the daily life of the dentist and leaving the job as long-time effects [15,16].

Numerous studies have shown that prevalence and incidence of musculoskeletal injuries in different parts of the body are higher in dentists compared with other professions. The prevalence of these complaints in different studies throughout the world has been reported as 63–93% in waist, neck, shoulder, and hands [17–21].

In meta-analysis studies, data of searched documents that have a common aim are gathered and meta-analyzed, so that a reliable estimation of some interventions or observations efficacy in medicine is proposed [22,23]. A systematic review of all the documents and combining them by meta-analysis method could produce a valid overview of musculoskeletal disorders prevalence in different regions of the body in Iranian dentists. The current study was performed because of controversy in reports of the prevalence rate of musculoskeletal disorders in different regions of the body in Iranian dentists, lack of access of non-Iranian researchers to this factor in Iran, evaluation of the studies for the final conclusion and interventional policy making, and suitable managerial planning in the country. This study was conducted to determine the prevalence of musculoskeletal disorders in various regions of the body in Iranian dentists.

2. Materials and methods

This study is the first systematic review and meta-analysis study with the aim of estimating the prevalence of musculoskeletal disorders in various regions of the body in Iranian dentists in the world until January 1, 2017. This meta-analysis study was performed according to the preferred reporting items for systematic reviews and meta-analyses (PRISMA) guideline [24]. In order to prevent bias in publication, all the steps of the study including search, studies selection, qualitative evaluation of the studies, and data extraction were separately and independently done by two researchers and a third individual assessed them in the case of disagreement.

2.1. Inclusion and exclusion criteria

The main criterion for entering the study was an estimation of musculoskeletal disorders prevalence in different parts of the body in Iranian dentists. The exclusion criteria included the following: (1) lack of mentioning the prevalence of musculoskeletal disorders in various parts of the body in dentists; (2) nonradiologic assessments; (3) limited information; (4) lack of relation with the subject of study; (5) nonrandom sample size; (6) letter to the editor; (7) repeated articles; and (8) the non-Iranian study sample size (Fig. 1).

2.2. Search strategy and study selection

The results of this study are based on all the published articles in national and international journals, theses, and reference sites.

Review of Persian and English articles was performed in national databases including SID, Magiran, Irandoc, IranMedex, and Medlib, and international databases such as MedLine, Web of Sciences, Scopus, PubMed, ScienceDirect, Cochrane, Embase, Springer, Online Library Wiley, Ebsco, CEBM, CINAHL, and Google Scholar search engine. Article searching was done using Persian and standard MeSH English equivalent keywords such as: “musculoskeletal”, “disorder”, “prevalence”, “incidence”, “epidemiology”, “symptom”, “disease”, “discomfort”, “complaint”, “trauma disorder”, “workplace or occupational injury”, “musculoskeletal injury”, “dentist”, and all the possible word combinations using Boolean operators (AND, OR, and NOT) for English databases. Moreover, a manual search was performed to find more articles through evaluation of identified articles reference list (Fig. 1).

The important point was in searching the databases by using “Highly Sensitive Searching” method and also it was done by researchers and experts in databases searching. In order to prevent bias, searching was performed independently by two separate researchers. When searching was finished, titles of the gathered articles were entered into the reference management software, EndNote Ver. x8 (Clarivate Analytics (previously Thomson Reuters), Philadelphia, USA), to find duplicated articles. Manual searching was done as evaluation of related articles reference list.

2.3. Quality assessment

In the next step, after determination of related assessments, the articles chosen by researchers were evaluated using STROBE (strengthening the reporting of observational studies in epidemiology) checklist [25]. This checklist includes 22 scores and evaluates different methodology aspects. The researchers chose a simple method for scoring; scores of 0–2 were given to each of the checklist questions, thus the highest accessible score was considered as 44. The articles were divided into three categories including low quality (0–15), middle quality (16–30), and high quality (31–44). Those articles that gained a score of at least 16 entered meta-analysis stage.

2.4. Data extraction

Firstly, a checklist was designed according to the aims and by studying other available references. The designed checklist included items such as authors, year, city, sample size, evaluation questionnaire, prevalence of musculoskeletal disorders in body regions. All the mentioned information was extracted by two of the researchers independently and author’s name, institution, and the journal were blinded, and if necessary more information, the raw data were requested through calling the author (e-mail/fax/phone call; Table 1).

2.5. Statistical analysis

In each study, after considering the prevalence of musculoskeletal disorders in different regions of the body in Iranian dentists as two-sentence distribution probability, its variance was calculated through two-sentence distribution, and Cochran test (Q) and I^2 index were used to assess studies’ heterogeneity. Regarding the heterogeneity of the studies, random effects model was used to combine the results of studies altogether. Heterogeneity was 70.1% in this study which is considered as average (I^2 index < 25% is low heterogeneity, between 25% and 75% is average, and > 75% is high heterogeneity). Data analysis was performed using meta-analysis specialized software, Comprehensive Meta-analysis Ver.2 (Englewood, NJ 07631, USA), and level of significance was considered as $p < 0.05$.

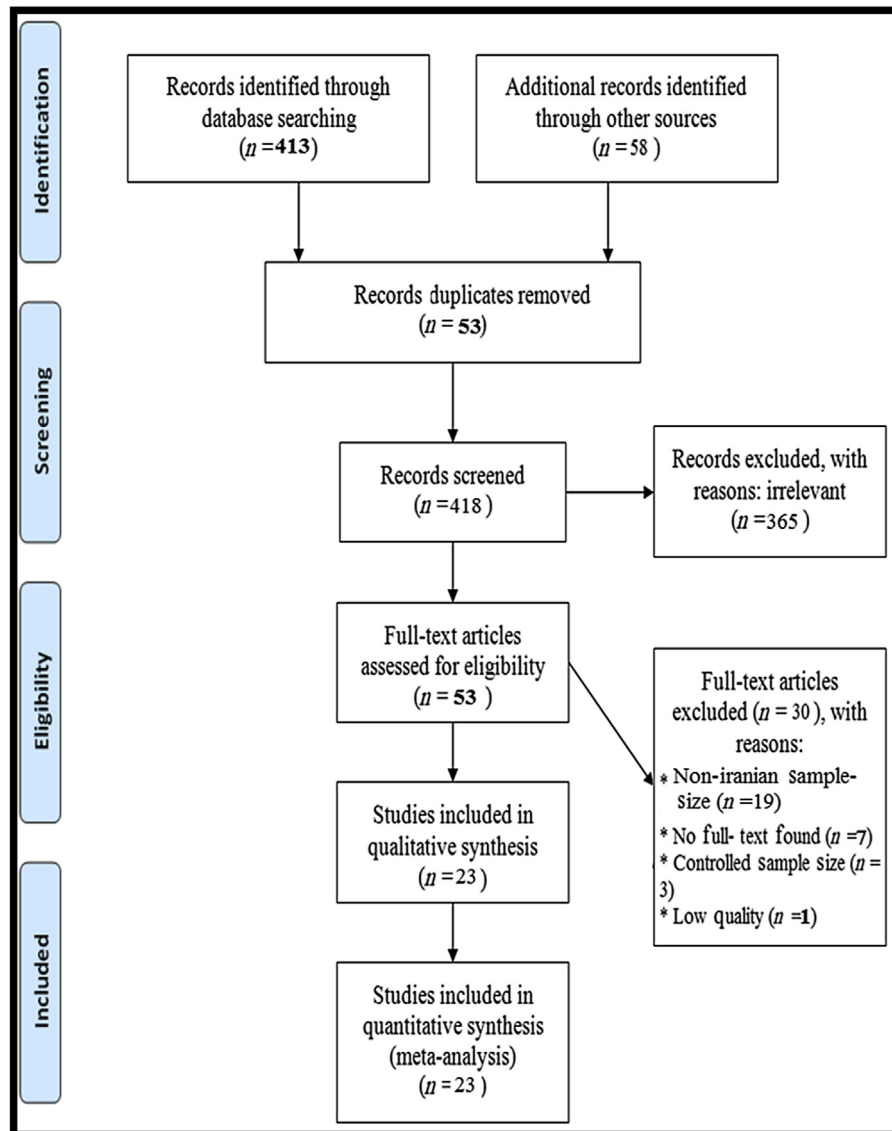


Fig. 1. A flow diagram following the PRISMA template (depicted by Review Manager ver: 5.3.5 software, Cochrane Collaboration company). PRISMA, preferred reporting items for systematic reviews and meta-analyses.

3. Results

In the systematic review, 471 related possible documents were identified, and 53 articles were excluded after evaluation of titles. The full text of the 418 remaining articles was investigated. After evaluation of inclusion/exclusion criteria and measurement of articles quality, 23 qualified studies which had been conducted between January 1, 2017 finally entered the meta-analysis (Figs. 1, 2 and Table 1). The first systematic meta-analysis study of musculoskeletal disorders is on 2,531 dentists in Iran. The mean of age and working experience in Iranian dentists are 37.1 ± 4 years and 10.37 ± 2.78 years, respectively.

Prevalence of skeletal disorders in Iranian dentists has been 17.6% [confidence interval (CI) 95%: 11.7–25.5] in knees, 33.2% (CI 95%: 24.1–43.8) in shoulders, 33.4% (CI 95%: 26.8–40.8) in the thorax, 51.9% (CI 95%: 46.7–57.2) in necks, 33.7% (CI 95%: 28.2–39.6) in wrists/hands, 12.9% (CI 95%: 7.7–20.6) in elbows, 37.3% (CI 95%: 31.5–43.5) in the lower back, 11.9% (CI 95%: 8.7–16.1) in thighs, 12.9% (CI 95%: 3.8–36) in the foot, and 10.5% (CI 95%:

7–15.4) in legs. Therefore, the most affected region in Iranian dentists is the neck with 51.9% and the lowest prevalence of musculoskeletal disorders is in the leg (10.5%) (Table 2, Figs. 3, S1–15).

In the evaluation of the difference between men and women for these disorders, a significant relationship with low-back ($p < 0.001$), neck ($p = 0.01$), and wrist ($p = 0.011$) was seen and there was not a significant relationship in the other reported cases including the waist ($p = 0.284$) and shoulder ($p = 0.334$). It has been reported that prevalence of musculoskeletal disorders in the thorax and wrist is higher in women and disorders of the neck are more common in men than women. Although no significant correlation has been observed between the two groups of men and women, the prevalence of these musculoskeletal disorders has been estimated higher in women (Table 2 and Figs. S2, S4, S6, S8, S10).

Publication bias was also examined by Begg and Egger tests and was determined as $p = 0.54449$ and $p = 0.9462$, respectively, which in this test, the probability of publication bias was not statistically significant (Fig. 4).

Table 1
Included studies into meta-analysis

Refs	First author	Y	Questionnaire	Place	SS	No. men	No. women	Age	Work experience
[13]	Ahmadi	2012	NMQ	Hamedan	71	60	11	39.02 ± 7.22	11.76 ± 5.41
[26]	Asgaripoor	2013	NMQ & REBA	Semnan	48	27	21	38.40 ± 7.1	8.50 ± 6.1
[27]	Baroonizade	2014	NMQ & LUBA	Hamedan	30	–	–	28.74 ± 2.74	3.35 ± 2.14
[28]	Choobineh	2012	NMQ	Shiraz	160	97	63	38.50 ± 7.5	–
[29]	Dehghani	2003	NMQ	Tehran	99	66	33	38.50 ± 9	12.50 ± 8.6
[14]	Ebrahimian	2014	NMQ & REBA	North-Khorasan	60	44	16	41.17	14.80
[30]	Eyvazi	2013	NMQ	Tabriz	100	80	20	42.12 ± 8.99	–
[31]	Ezoddini	2004	Self-administered	Yazd	7	52	18	36.61 ± 9.57	–
[32]	Ilbeigi	2014	NMQ & RULA	Mashhad	80	65	15	39.90 ± 9.7	8.20 ± 8.1
[33]	Kardani	2007	Self-administered	Ahvaz	172	–	–	–	–
[34]	Koosha	2016	NMQ & RULA	Tehran	100	53	47	38.28 ± 6.76	10.89 ± 6.03
[35]	Nadri	2015	Self-administered	Tehran	116	–	–	38.20 ± 7.1	12.60 ± 7.1
[36]	Nasl Saraji	2005	NMQ & REBA	Birjand	48	39	9	36.70	11.7
[37]	Nokhostin	2016	Self-administered	–	600	195	405	42.18 ± 9.59	–
[38]	Pargali	2010	Self-administered	Shiraz	82	40	42	37.70 ± 7.65	–
[39]	PurAbbas	2004	Self-administered	Tabriz	97	76	21	–	–
[40]	Rabiei	2012	NMQ & RULA	Rasht	92	59	33	30.14 ± 8.7	12.20 ± 7.99
[41]	Rafie	2015	NMQ & RULA	Kerman	130	84	46	36.21 ± 2.07	9.19 ± 4.31
[42]	Rahnamaye	2015	NMQ & RULA	Tehran	92	–	–	–	–
[43]	Sarami	2007	NMQ & REBA	Tehran	47	30	17	36 ± 5.56	9.91 ± 5.85
[44]	Seifi	2016	NMQ	Babol	64	29	35	38.16 ± 7.43	11.31 ± 7.80
[45]	Varmazyar	2012	NMQ & REBA	Qazvin	63	29	34	27.38 ± 7.37	8.28 ± 6.44
[46]	Chamani	2012	NMQ	Kerman	110	80	30	38.20 ± 7.5	–

NMQ, nordic musculoskeletal questionnaire; REBA, rapid entire body assessment; LUBA, Postural Loading on the Upper Body Assessment (LUBA); RULA, Rapid Upper Limb Assessment; SS, Sample Size.

4. Discussion

Prevalence of skeletal disorders in Iranian dentists is 33.2% in the shoulder, 33.4% in the thorax, 51.9% in the neck, and 33.7% in hand/wrist. The results of similar studies in other countries including Finland, Canada, Australia, America, and Denmark reported 59% waist injury, 62% problems in the neck, 60% shoulder pain, and 40% pain in wrists which are all consistent with the current study and show that these pains are not related to the living region, and come from the nature of this job [47].

Prevalence of complaints in the back ($p < 0.001$), wrist ($p = 0.011$), waist ($p = 0.284$), and shoulder ($p = 0.334$) have been reported higher in women which is consistent with the findings of studies in other countries. Neck problems ($p = 0.01$) were reported more in men than women, which is not consistent with the findings of foreign studies, although it was significant. Religious, cultural, and behavioral differences of women in Iranian society with other countries could be mentioned as the reasons for the difference [3,36,48–50].

Long sitting positions, head bent forward for a long time, repeating the movements which result in asymmetrical imbalance in muscles and forces, lack of balance between those muscles that fix the shoulder and upper-body and the muscles that move this part which leads into nerve trapping, muscular pain, degenerative disorders and disk herniation, could all be mentioned as factors effective in increased musculoskeletal disorders prevalence in necks of dentists. Lack of sufficient secretion of synovial fluid as a result of being motionless and elevated pressure on intervertebral disk and induction of trigger points because of muscular hypoxia could be the most important reasons for pain in the neck, as the first common region for musculoskeletal disorders in dentists. According to the performed studies, pain in the trapezius muscle of the dominant hand, because of the high electrical activity of trapezius muscle during posture maintenance for filling caries is more common and its occurrence has been reported higher in

women than men which are consistent with the findings of the current study [51–55].

The national in the state of The Danish Working Environment Authority (Arbejdstilsynet) of Denmark located in Copenhagen, stated in a research titled “Biomechanical aspects of neck postures during dentistry works”, that increased knowledge and information regarding neck anatomy affects understanding of how different tissues are under pressure and helps to reduce these complaints [56].

Prevalence of neck disorder in foreign dentists has been reported (57% in Australia, 56% in Poland, 51% The Netherlands, and 20% in Saudi Arabia) and this prevalence is also high in the current study [57–60].

Low-backache as the second common skeletal disorder in Iranian dentists could occur due to ischemia in shortened muscles, weakness of waist fixing muscles, unsuitable light angle, wrong position of elbow and shoulders, over excessive rotation of upper-body and long maintenance of these positions during work and contraction of eccentric muscles over a long time [51].

Prevalence of this disorder in dentists in other countries has been reported as 60% in Denmark, 54% in Australia, 60% in Poland, 45% in The Netherlands, and 36% in Saudi Arabia which is almost higher than results of the current study [2,57–60].

Based on this meta-analysis study, pain in the hand and wrist has been reported as the third most prevalent disorder. Excessive dorsiflexion of the wrist could be among the major reasons for carpal tunnel syndrome in dentists. Working method (unsuitable ergonomics of upper limb), the equipment, and forearm muscles extension (more than their flexion) could be effective factors in increasing this prevalence [51,54].

Dequervain disease, Tenosynovitis disease, Guyon’s syndrome, and Raynaud’s syndrome are other common skeletal disorders in dentists, and not observing the ergonomics basics has these consequences [61]. Prevalence of wrist complaints was also higher in women than men (almost twice). Alexopoulos et al have reported the prevalence of carpal tunnel syndrome three times higher in



Fig. 2. Iranian selected studies based on random effects meta-analyses.

Table 2
Prevalence of WMSDs among Iranian dentists

Body regions	Prevalence	CI 95%	I ²	p	Online supplement (Related Forest Plot)	Prevalence subgrouped by gender						
						Gender	Prevalence	CI 95%	I ²	p	Subgroup p	Online supplement (Related Forest Plot)
Shoulder	33.2	24.1–43.8	94.0	0.000	Fig. S1	Male	44.6	38.7–53.7	48.4	0.245	0.334	Fig. S2
						Female	50.1	36.4–63.7	0.991			
Low-back	37.3	31.5–43.5	81.4	0.000	Fig. S3	Male	32.4	25.1–40.8	61.3	0.000	0.000	Fig. S4
						Female	41.9	26.8–58.6	0.340			
Neck	51.9	46.7–57.2	82.7	0.000	Fig. S5	Male	60.1	51.8–67.9	60.3	0.018	0.010	Fig. S6
						Female	55	48–61.7	0.161			
Wrist/hand	33.7	28.2–39.6	84.3	0.000	Fig. S7	Male	29.7	20.1–41.6	79.2	0.001	0.011	Fig. S8
						Female	47.4	35.2–59.9	0.684			
Thorax	33.4	26.8–40.8	82.5	0.000	Fig. S9	Male	34.9	16.9–58.6	90.9	0.208	0.284	Fig. S10
						Female	46.9	37.9–56	0.505			
Knees	17.6	11.7–25.5	84.6	0.000	Fig. S11							
Elbow	12.9	7.7–20.6	86.7	0.000	Fig. S12							
Thigh	11.9	8.7–16.1	55.9	0.000	Fig. S13							
Foot	12.9	3.8–36	95.4	0.000	Fig. S14							
Leg	10.5	7–15.4	0	0.000	Fig. S15							

CI, confidence interval; WMSD, work-related musculoskeletal disorder; I², Heterogeneity.

* Online Supplementary data related to this table can be found at <http://dx.doi.org/10.1016/j.shaw.2017.06.006>.

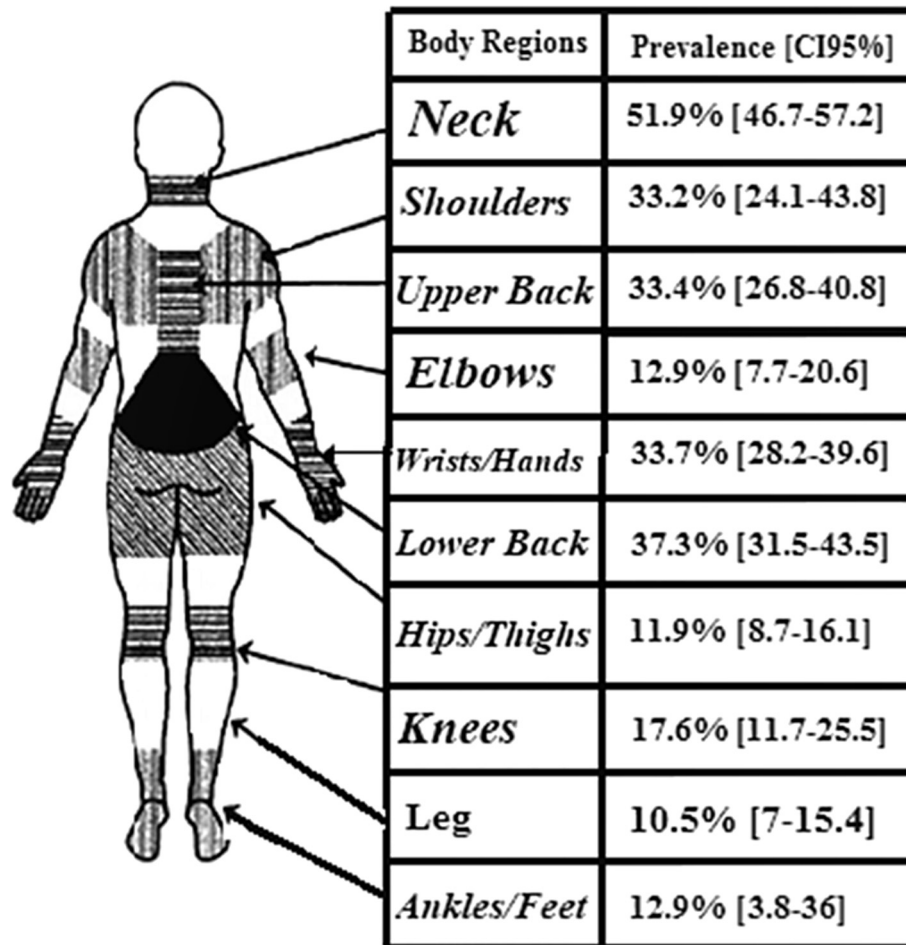


Fig. 3. Prevalence of WMSDs among dentists based on body regions. CI, confidence interval; WMSD, work-related musculoskeletal disorder.

women compared with men. Wrist pain could be considered as one of the cautionary signs of this syndrome [3].

Prevalence of this disorder in dentists of other countries has been reported as 34% in Australia, 44% in Poland, 21% and 14% in The Netherlands (hand and wrist, respectively), and 54% in Saudi Arabia, which are almost the same as the current study [15,57–59].

A waist pain as the fourth common disorder in Iranian dentists might be because of disk herniation, backache, waist ache, and sciatic [61].

Shoulder pain, the fifth prevalent complaint, is the referral pain from the neck, which is accompanied by a lack of rest during work, repeated activities, and continuous contraction of muscles [62]. Prevalence of this disorder in foreign dentists has been reported as 21% in the USA, 53% in Australia, and 53% in The Netherlands, which are relatively higher than the results of the current study [58,59,63].

According to the performed studies, knee pain, the sixth most common disorder in Iranian dentists could be due to ergonomics reasons during work, accepting more patients, repeated activities, and not paying attention to the pain in this part and justifying it as normal during work [51]. Prevalence of this disorder has been reported as 19% in Australia which is almost consistent with the result of this study [58].

Thigh position relative to the knee, bending of the upper body on the thigh and bearing high load on the iliopsoas muscle for a long time could be among the reasons for skeletal disorder prevalence in thighs of Iranian dentists [51,55,62]. Prevalence of this complaint has been 13% in Australia which is almost consistent with the results of this study [58].

The least prevalence in current meta-analysis belonged to pain in the leg. Based on the conducted studies, lack of exercise, motionlessness, keeping a position and trying to have access to further equipment which causes more load on the foreleg may be among the factors which contribute to increased prevalence of this problem [31,39,52]. Low prevalence of this skeletal disorder could be justified by the backing of the dentistry chair and its standard position [51]. The prevalence of this complaint has been reported as 6% in the USA which is lower than the current study [63].

Schedules that require practical training of maneuvers special for dentists with correct ergonomics basics, production and learning of correct habits and behaviors could reduce these disorders [51,62,64–71]. Differences in the prevalence of musculoskeletal disorders in the mentioned countries with the current study might be because of hardware facilities, university policy makings, and access to more favorable facilities and also the importance of mouth and tooth health for people and regular reference to dentist year round.

The worst common body posture is while working on the mandible [57,72]. According to the research, in order to reduce the work pressure and accelerate the dentistry process, twosome dentistry method or four handed position has been considered as the most favorable ergonomics method for reducing skeletal disorders [73].

Split unit/care position for increasing the extra movements, transthorax position for decreasing the dentist's sight-line deviation from activity region, rear delivery position for extra rotation to access the tools and side delivery position, in which the dentists

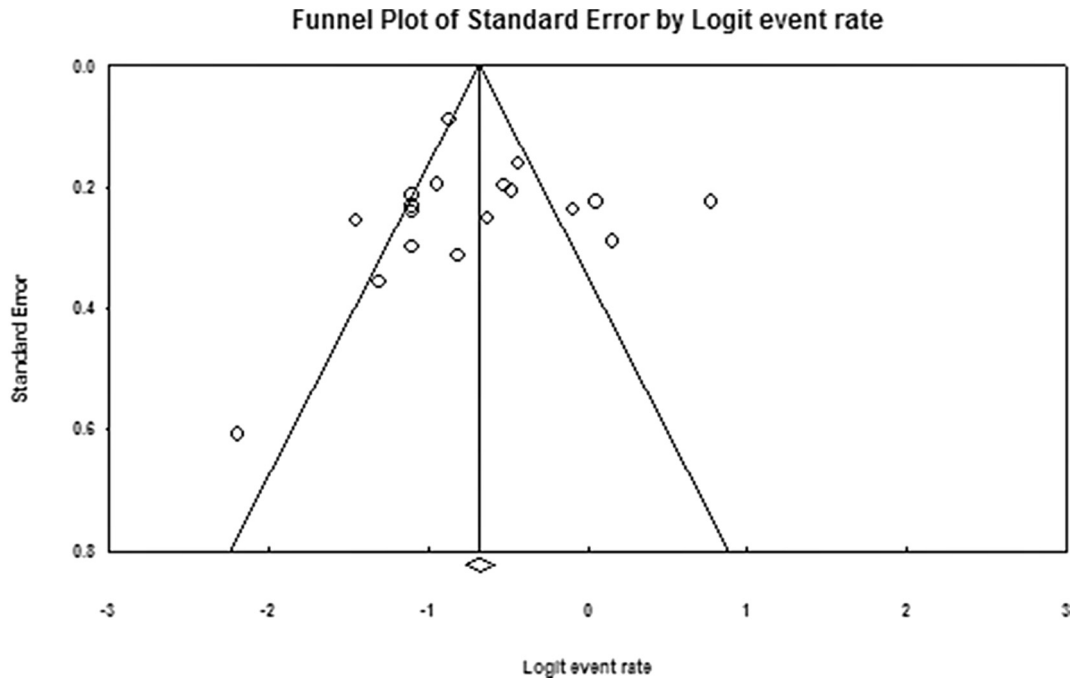


Fig. 4. The funnel plot of the prevalence of work-related musculoskeletal disorders in Iranian dentists.

have to move their sight from surgery and treatment region to grab and put the tools and rotate the upper body so that they can grab the needed tool and focus their eye on the region again, are among the various designs for dentistry units that could be effective in reducing the musculoskeletal disorders [70].

In different studies, traditional sitting and close focus sitting standing have been introduced as the acceptable ergonomics sitting types in dentists [47,52,73,74].

Ergonomics recommendations for reducing these disorders are as follows: (1) working on the teeth of the mandible: patient gets completely slept on back, so that the patient's body is posed horizontally. Working on the teeth of the maxilla: patient get almost slept on the back; (2) working in sitting position; (3) wrist is not deviated $> 15^\circ$ while working; and (4) using magnifying facilities to reduce the need for bending the neck during work.

Moreover, heterogeneity of 70.1% in this study puts it in the level of average heterogeneity studies. Therefore, random effects model was used for evaluations. Based on the random effects model, it is hypothesized that existing differences are due to different sampling and variety in measured parameters in various studies.

The heterogeneity rate (I^2) has been calculated as 70.1% in this study, which lies among the middle heterogeneity. It is assumed that the observed differences are due to different sampling as well as differences in measured parameters in different populations [75,76].

Lack of access to the complete text of all the articles, lack of separation for disorders prevalence by dentists' specialty, lack of a special framework for reporting the published articles, lack of access to the results of thesis, and low quality and quantity of local databases were all among the limitations of the current study.

Generally, insufficient training, unsuitable designing of the working facilities, lack of continual observations for correct ergonomics basics, and the present stress while working may all lead to the adoption of unsuitable positions during work which is among the important reasons for occurrence of the disorders [50,52,77].

Considering the high prevalence of musculoskeletal disorders in Iranian dentists, ergonomics should be included as a lesson in preclinic courses in order to prevent these disorders and the taught

basics should also be observed continuously, and reeducation courses for ergonomics basics should be executed for graduate dentists.

Conflicts of interest

The authors declare no conflict of interests.

Acknowledgments

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Appendix A. Supplementary data

Supplementary data related to this article can be found at <http://dx.doi.org/10.1016/j.shaw.2017.06.006>.

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