



## SYSTEMATIC REVIEW

# REVISED Prevalence of musculoskeletal disorders among dental healthcare providers: A systematic review and meta-analysis

## [version 2; peer review: 2 approved]

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### Abstract

**Background:** Work-related musculoskeletal disorders (MSD) are common in dentistry due to the prolonged static work involved during patient care, making dental health care personnel vulnerable to musculoskeletal complaints. We aimed to pool the prevalence estimates of MSD among various dental healthcare providers, including dentists, dental students, dental hygienists, and auxiliaries.

**Methods:** A systematic search of five databases was performed (Scopus, Embase, CINAHL, Web of Science, Dentistry & Oral Sciences Source). The studies that reported the prevalence of MSD among dental healthcare workers and those written in English were selected. Screening and data extraction were performed by two review authors independently. Discrepancies were resolved by another review author. Risk of bias assessment was done using a nine-item questionnaire developed by Hoy *et al.* Pooled estimates were calculated using meta-analysis of proportions (random effects model).

**Results:** Among the 3090 publications screened, 234 publications were included for full-text screening. Meta-analysis was performed for 89 estimates from 88 publications. Females showed significantly higher prevalence [OR = 1.42 (95% CI = 1.09–1.84);  $I^2 = 66.02$ ; N = 32]. The analysis yielded a pooled estimate of 78.4% (95% CI = 74.8–82). The meta-regression showed similar prevalence over the years (Coefficient: 0.001; P-value: 0.762).

**Conclusions:** A high prevalence of MSD was noted among dental healthcare providers, with about seven out of ten having experienced MSD in the past. This emphasizes the need for awareness and adoption of appropriate ergonomic postures by dental healthcare

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2

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view



view

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providers from early in their careers to minimize work-related MSD.

### Keywords

musculoskeletal disorders, workplace, dentist, dental students, dental auxiliary, systematic review



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**REVISED Amendments from Version 1**

Minor edits like MSD definition, intra-examiner reliability, additional information on the number of publications sought from databases in PRISMA flow chart, few grammatical errors were included in the manuscript as per the recommendations of the reviewers.

**Any further responses from the reviewers can be found at the end of the article**

**Introduction**

“Musculoskeletal disorders (MSD) are injuries to the human support system of muscles, ligaments, tendons, nerves, blood vessels, bones, and joints” (<https://www.cdc.gov/>). MSDs are defined as musculoskeletal system and connective tissue diseases and disorders when the event or exposure leading to the case is bodily reaction (e.g., bending, climbing, crawling, reaching, twisting), overexertion, or repetitive motion. MSDs do not include disorders caused by slips, trips, falls, or similar incidents (Bureau of Labor Statistics of the Department of Labor. NIOSH workers health chartbook 2004. NIOSH Publication No. 2004-146. Washington, D.C). Such injuries resulting due to occupation or work-related exposure are termed work-related MSD. Work-related MSD is common in dentistry due to the prolonged static work involved during patient care, making dental health care personnel vulnerable to musculoskeletal complaints. Moreover, the current lifestyle practices make the onset of such problems likely at an early stage of life. MSD includes pain, discomfort, or limitation in a range of activities in the head, neck, shoulders, arms, wrists, fingers, elbows, upper and lower back, buttocks, thighs, feet, ankle, etc.

MSD among dental healthcare personnel can potentially impact the individual and the community. Literature has shown a decrease in work efficiency, stress, poor sleep quality, multisite pain, frequent absenteeism, and/or early retirement resulting in loss of workforce.<sup>1,2</sup> The preventive strategies adopted to mitigate MSD are massage treatments, increased physical activity, adopting ergonomically designed equipment, maintaining correct postures, and using complementary and alternative medicine.<sup>3,4</sup>

The studies on self-reported MSD have reported a high prevalence among dental healthcare personnel.<sup>5–10</sup> Studies have also evaluated the associated risk factors of MSD among dentists,<sup>7,11–19</sup> dental hygienists,<sup>6,20,21</sup> and dental students.<sup>22,23</sup> Increasing age, gender (female), comorbidities, prolonged working hours, increased patient load, lack of physical exercise, non-usage of loupes, stress, lack of breaks between patients, awkward postures, administrative work, vibration, and repetition were some of the reported risk factors of MSD.<sup>4,24</sup> A few literature reviews and meta-analysis on these conditions have reported a high prevalence among dental healthcare personnel.<sup>25–31</sup> However, there was no attempt to study the overall prevalence estimates of MSD burden among various dental healthcare providers, including dentists, dental students, dental assistants, and auxiliaries at a global level. Hence, we aimed to pool the estimates of the MSD burden among dental healthcare providers.

**Methods****Inclusion and exclusion criteria**

The studies that reported the overall prevalence of MSD among dental healthcare personnel (dentists, dental students, hygienists, or dental auxiliaries), and the studies written in English were included. Only cross-sectional studies and cohort studies, where prevalence data can be extracted or calculated were included. The studies reported as commentaries, letters, or conference abstracts were excluded. The protocol was registered with INPLASY (DOI: [10.37766/inplasy2021.5.0100](https://doi.org/10.37766/inplasy2021.5.0100)).<sup>32</sup>

**Literature search**

A systematic search in five databases (Scopus (RRID:SCR\_022706), Embase (RRID:SCR\_001650), CINAHL (RRID:SCR\_022707), Web of Science (RRID:SCR\_022706), Dentistry & Oral Sciences Source (RRID:SCR\_022705)) from inception to 5 August 2021 was performed. The keywords used were “dentist OR dental hygienist OR dental personnel OR dental student” AND “musculoskeletal disease OR musculoskeletal disorder OR occupational disease OR work-related musculoskeletal disorder.” Suitable filters (reports on humans, research articles) for each database were applied.

**Screening**

The search was imported to **Rayyan**, a web-based application (RRID:SCR\_017584).<sup>33</sup> The screening and data extraction were done by two review authors independently (MK and MM). Disagreements were arbitrated by another review author (PKC). Agreement between the reviewers for title and abstract screening and full text screening showed almost perfect agreement (Kappa: 0.94 and 0.98 respectively).

### Risk of bias (RoB) assessment

All studies were assessed using the 10 item [Quality Assessment Checklist for Prevalence Studies](#) questionnaire<sup>34</sup> by two review authors independently (HS and PKC). Disagreements were arbitrated by another review author (CD). Each question has two levels, low risk (0) and high risk (1). The total of all nine questions was used to categorize the studies as “low (0–3), moderate (4–6), or high risk (7–9)”.

### Data extraction

The variables for data extraction included study details such as authors, year, country, continent, study design, sample size, type of participants (dentist or dental students, or dental auxiliaries), age distribution, sex distribution, the overall prevalence of MSD at maximum recall along with lifetime, annual, one-week prevalence, gender and site-specific estimates.

### Statistical analysis

Due to variation in the reporting of the prevalence of MSD among the included studies, the prevalence estimates at the maximal follow-up were used to calculate the pooled estimates of MSD. Measures of heterogeneity ( $Q$  and  $I^2$ ) were calculated. A random-effects model (restricted maximum likelihood estimation method) was used to calculate the prevalence estimates using the [OpenMeta\[Analyst\]](#) software for Windows 8 (Metafor Package 1.4, 1999) (RRID: SCR\_022698). Time trends of MSD were evaluated using meta-regression. A sub-group analysis based on the continent, country, type of dental personnel, site of MSD, and sex was performed. A funnel plot was used to evaluate the publication bias. Complete data for the analysis can be accessed at Mendeley datasets.<sup>35</sup>

### Results

A comprehensive systematic search of five databases (Scopus (1080), Embase (592), CINAHL (728), Web of Science (514), Dentistry & Oral Sciences Source (750)) yielded a total of 3664 articles. Reviews, conference proceedings, case reports, clinical trials, studies on ergonomics, quality of life, burnout, etc. letters, magazine reports, work related hazards other than MSD, studies among health professionals other than dentists were excluded ( $n = 2856$ ). A further 146 publications were excluded after screening the full-text. Meta-analysis was performed for 89 estimates ([Table 1](#) and [Figure 1](#)).

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

Author and year	Continent	Sample size	Population	ROB	Prevalence
Osborn <i>et al.</i> 1990	NA	385	Dentists	Low	68.31
Rundcrantz <i>et al.</i> (a) 1990	Eu	311	DA	Low	83.28
Rundcrantz <i>et al.</i> (b) 1991	Eu	311	Dentists	Low	84.24
Marshall <i>et al.</i> 1997	Au	355	Dentists	Low	81.97
Akesson <i>et al.</i> 1999	Eu	74	ALL	Low	91.89
Kerosuo <i>et al.</i> 2000	Eu	228	Dentists	Low	70.61
Lalumandier <i>et al.</i> 2001	NA	5119	ALL	Low	47.14
Anton <i>et al.</i> 2002	NA	95	DA	Low	92.63
Szymanska 2002	Eu	268	Dentists	Low	91.42
Tezel <i>et al.</i> 2005	Asia	221	DS	Low	85.97
Leggat <i>et al.</i> 2006	Au	285	Dentists	Low	87.37
Polat <i>et al.</i> 2007	Asia	120	Dentists	Low	94.17
Puriene <i>et al.</i> 2008	Eu	1670	Dentists	Low	86.53
de Carvalho <i>et al.</i> 2009	SA	227	DS	Low	70.93
Akar <i>et al.</i> 2009	Asia	185	DA	Low	23.78
Ayers <i>et al.</i> 2009	Au	560	Dentists	Low	59.82
Dajpratham <i>et al.</i> 2010	Asia	163	ALL	Low	96.93
Kierklo <i>et al.</i> 2011	Eu	220	Dentists	Low	90.00
Ellapen <i>et al.</i> 2011	Africa	94	Dentists	Low	54.26
Moradia and Prakash 2011	Asia	77	ALL	Low	63.64

**Table 1.** *Continued*

<b>Author and year</b>	<b>Continent</b>	<b>Sample size</b>	<b>Population</b>	<b>ROB</b>	<b>Prevalence</b>
Sankar <i>et al.</i> 2012	Asia	259	Dentists	Low	41.70
Tzu <i>et al.</i> 2012	Asia	197	Dentists	Low	92.39
Muralidharan <i>et al.</i> 2013	Asia	73	Dentists	Low	78.08
Kumar <i>et al.</i> 2013	Asia	536	Dentists	Low	100.00
Vuletic <i>et al.</i> 2013	Eu	89	Dentists	Low	69.66
Kazancioglu <i>et al.</i> 2013	Asia	608	Dentists	Low	87.01
Rafeemanesh <i>et al.</i> 2013	Asia	58	Dentists	Low	82.76
Zoidaki <i>et al.</i> 2013	Eu	80	Dentists	Low	82.50
Movahhed <i>et al.</i> 2013	Asia	177	DS	Low	83.62
Sustova <i>et al.</i> 2013	Eu	182	DS	Low	39.01
Vora <i>et al.</i> 2014	Asia	86	Dentists	Low	62.79
Zarra and Lambrianidis 2014	Eu	120	Dentists	Low	60.83
Mendegeri <i>et al.</i> 2014	Asia	60	Dentists	Low	88.33
Shadmehr <i>et al.</i> 2014	Asia	446	Dentists	Low	80.94
Kursun <i>et al.</i> 2014	Asia	264	DS	Low	48.48
Tirgar <i>et al.</i> 2015	Asia	60	Dentists	Low	93.33
Gupta <i>et al.</i> (a) 2015	Asia	877	Dentists	Low	71.04
Humann <i>et al.</i> 2015	NA	488	DA	Low	98.36
Sakzewski <i>et al.</i> 2015	Au	466	Dentists	Low	86.05
Kanaparthi <i>et al.</i> 2015	Asia	134	DS	Moderate	53.73
Aljanakh <i>et al.</i> 2015	Asia	68	Dentists	Low	77.94
Alghadir <i>et al.</i> 2015	Asia	146	Dentists	Low	84.93
Hodacova <i>et al.</i> 2015	Eu	575	Dentists	Low	97.91
Bhagwat <i>et al.</i> 2015	Asia	200	Dentists	Low	57.50
Gupta <i>et al.</i> (b) 2015	Asia	2879	Dentists	Low	100.00
Sahu <i>et al.</i> 2015	Asia	206	Dentists	Low	81.07
Tamo <i>et al.</i> 2015	Asia	156	Dentists	Low	70.51
Batham and Yasobant 2016	Asia	93	Dentists	Low	92.47
Rehman <i>et al.</i> 2016	Asia	120	DS	Low	70.00
Kriangkrai <i>et al.</i> 2016	Asia	68	DS	Low	100.00
Rayyan <i>et al.</i> 2016	Asia	191	DS	Low	83.77
Cho <i>et al.</i> 2016	Asia	401	Dentists	Low	86.78
Phedy <i>et al.</i> 2016	Asia	241	Dentists	Low	63.49
Freire <i>et al.</i> 2016	SA	94	Dentists	Low	90.43
Al-Rawi <i>et al.</i> 2016	Asia	101	Dentists	Low	67.33
Barry <i>et al.</i> 2017	NA	337	DA	Low	80.42
Garbin <i>et al.</i> 2017	SA	204	Dentists	Low	81.37
Taib <i>et al.</i> 2017	Asia	82	Dentists	Low	100.00
Al-Hourani <i>et al.</i> 2017	Asia	81	DA	Low	100.00
Revankar <i>et al.</i> 2017	Asia	150	Dentists	Moderate	81.33
Hegde <i>et al.</i> 2018	Asia	200	Dentists	Low	97.00
Hosseini <i>et al.</i> 2019	Asia	136	Dentists	Low	91.91
Scepanovic <i>et al.</i> 2019	Eu	87	ALL	Low	79.31

**Table 1.** *Continued*

Author and year	Continent	Sample size	Population	ROB	Prevalence
El Naji <i>et al.</i> 2019	Asia	134	Dentists	Low	19.40
Benlidayi <i>et al.</i> 2019	Asia	99	DS	Low	85.86
Zafar <i>et al.</i> 2019	Asia	142	DS	Low	58.45
dos Santos <i>et al.</i> 2019	SA	241	DS	Low	82.57
Meisha <i>et al.</i> 2019	Asia	234	Dentists	Low	70.09
Gandham <i>et al.</i> 2019	Asia	150	Dentists	Low	58.67
Khandan <i>et al.</i> 2020	Asia	51	Dentists	Low	84.31
Netanely <i>et al.</i> 2020	Asia	102	DA	Low	89.22
Harris <i>et al.</i> 2020	NA	647	DA	Low	82.53
Pope-Ford <i>et al.</i> 2020	NA	14	Dentists	Moderate	92.86
Senosy <i>et al.</i> 2020	Asia	66	Dentists	Low	89.39
Shekhawat <i>et al.</i> 2020	Asia	72	Dentists	Low	100.00
Rahman <i>et al.</i> 2020	Asia	82	DA	Low	81.71
Uppada <i>et al.</i> (b) 2020	Asia	624	Dentists	Low	69.07
Aboalshamat 2020	Asia	332	ALL	Low	81.33
Ohlendorf <i>et al.</i> (b) 2020	Eu	450	ALL	Low	95.78
Ohlendorf <i>et al.</i> (a) 2020	Eu	406	DA	Low	98.52
Uppada <i>et al.</i> (a) 2020	Asia	156	Dentists	Low	84.62
Kumar M <i>et al.</i> 2020	Asia	151	ALL	Low	58.28
Berdouses <i>et al.</i> 2020	Eu	1500	Dentists	Low	54.07
Ahmad <i>et al.</i> 2020	Asia	244	Dentists	Low	86.48
Hashim <i>et al.</i> 2021	Asia	202	DS	Moderate	68.32
Alnaser <i>et al.</i> 2021	Asia	186	Dentists	Low	47.85
Gandolfi <i>et al.</i> 2021	Eu	284	ALL	Low	84.86
Felemban <i>et al.</i> 2021	Asia	377	DS	Low	91.25
Bhuvaneshwari <i>et al.</i> 2021	Asia	545	Dentists	Low	88.07

Eu: Europe; NA: North America; SA: South America; Au: Australia; DA: Dental auxiliaries; DS: Dental students; ALL: All types of dental health care personnel; ROB: Risk of Bias.

### Prevalence

The prevalence of MSD ranged from 19.4 to 100%. Only seven publications showed less than 50% of MSD.<sup>17,36–41</sup> More than one-quarter (n = 24) of the included publications reported more than 90% prevalence.<sup>5–12,16,18,23,42–54</sup> One fourth of the studies (n = 21) reported a lifetime prevalence,<sup>3,37,39,44,45,49,51,53–66</sup> while only eight studies reported a one-week prevalence.<sup>8,18,19,22,42,53,54,67</sup> Most of the included studies reported a one-year prevalence (n = 65) (Table 1).

### Age

Most of the studies reported the age distribution of the participants (n = 61), while 14 studies reported only the age range of the participants. Prevalence estimates could not be calculated as there was substantial variation in age grouping.

### Gender

Most of the studies reported the gender distribution of the participants (n = 80). Only one-third of the studies (n = 32) reported gender-specific estimates. The pooled prevalence of MSD among males and females was 72.4% (95% CI = 65.2–79.6) and 77.4% (95% CI = 69.4–85.4) respectively<sup>6,7,10,12,13,16,18,22,23,38,39,41,53,56,58,59,62,67–80</sup> (Table 2). Females had significantly higher estimates of MSD than males (OR = 1.42) (Figure 2).

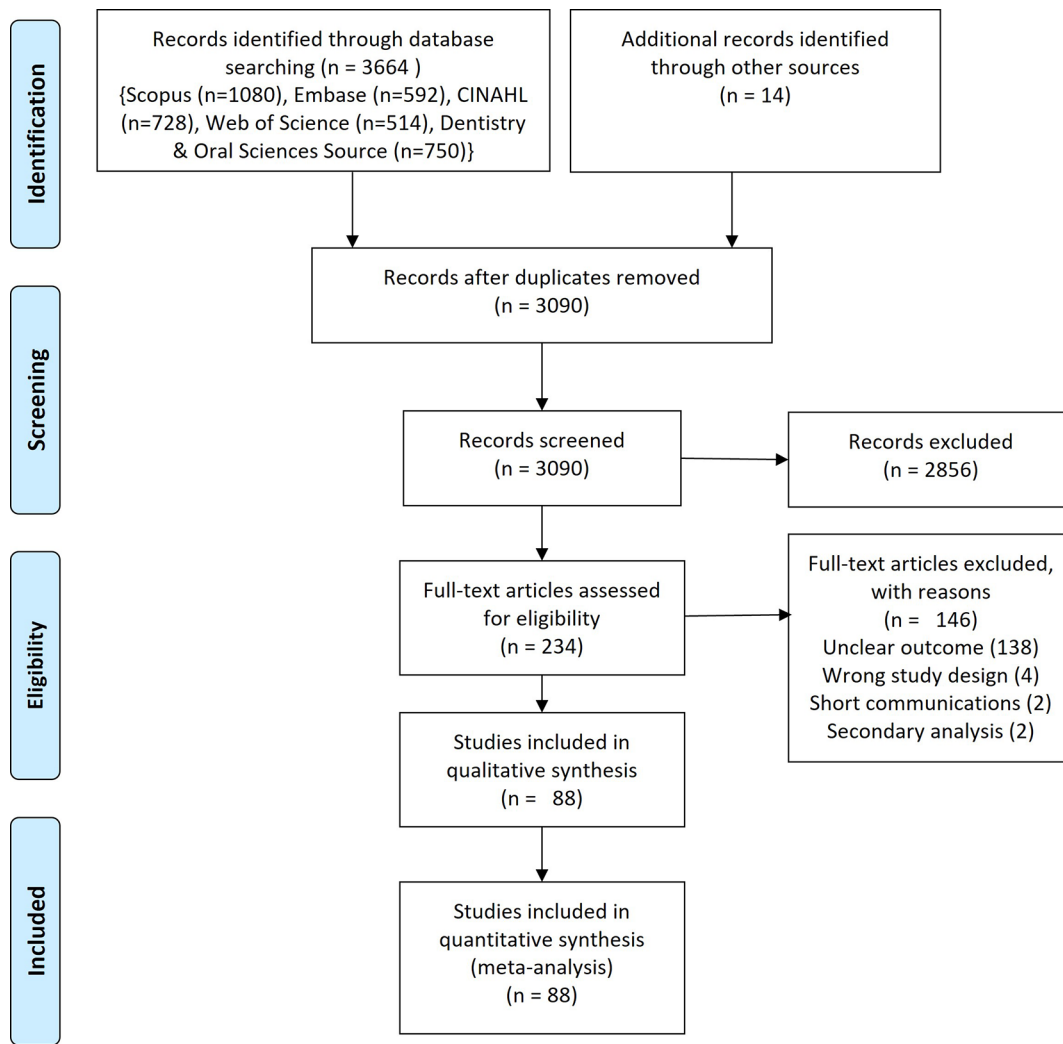


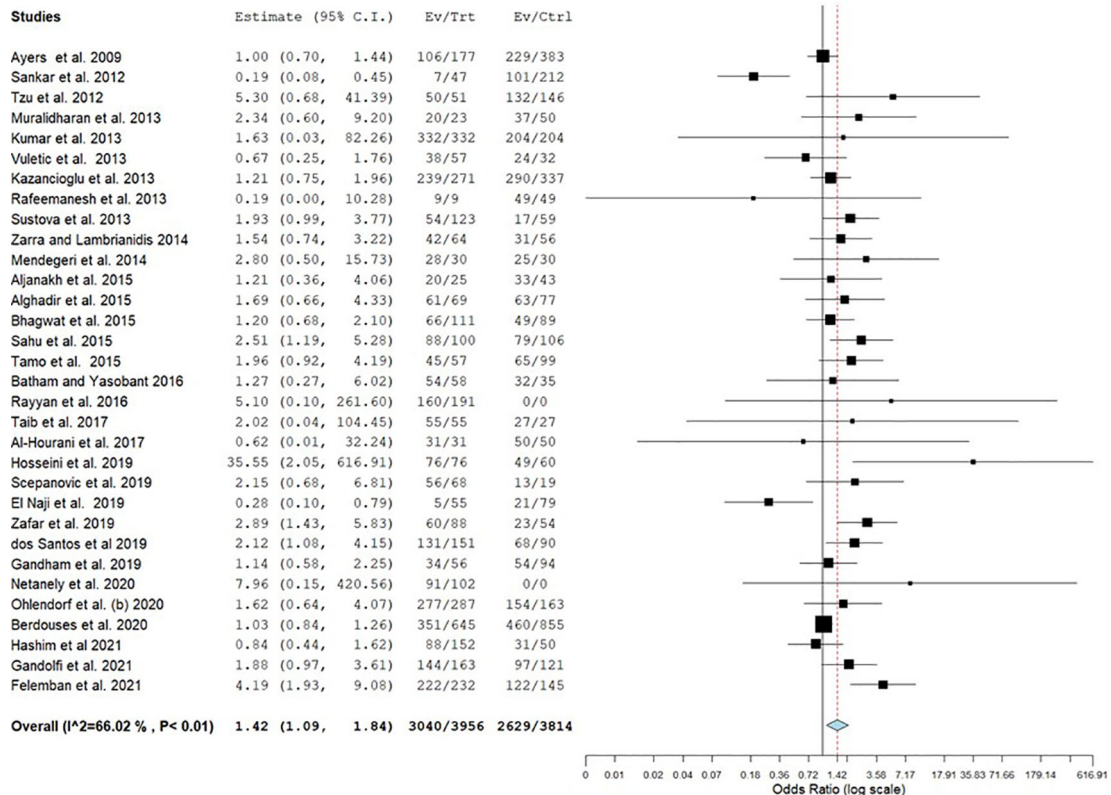
Figure 1. PRISMA flow chart.

Table 2. Sub-group analysis of the pooled estimates of overall musculoskeletal disorders.

Characteristic	Estimate (95% CI)	Q	I <sup>2</sup>	N
Recall interval				
Overall	0.78 (0.75–0.82)	13941.24	99.82	89
Lifetime	0.78 (0.7–0.85)	4752.99	99.4	21
One year	0.82 (0.78–0.85)	4922.35	99.79	65
One week	0.66 (0.52–0.79)	330.09	97.67	8
Sex				
Male	0.73 (0.65–0.8)	1914.47	98.69	30
Female	0.77 (0.69–0.85)	2047.83	99.41	32
Dental personnel				
Dentists	0.79 (0.75–0.83)	5788.91	99.85	56
Dental auxiliaries	0.83 (0.69–0.97)	768.63	99.7	10
Dental students	0.73 (0.64–0.82)	671.93	98.09	14
Mixed	0.78 (0.66–0.89)	2346.13	99.16	9

**Table 2.** *Continued*

Characteristic	Estimate (95% CI)	Q	I <sup>2</sup>	N
Continent				
North America	0.8 (0.67–0.93)	3272.59	99.5	7
Europe	0.8 (0.72–0.88)	1530.95	99.29	17
Australia	0.79 (0.66–0.91)	124.04	97.79	4
Asia	0.78 (0.73–0.83)	4693.83	99.88	56
South America	0.81 (0.74–0.89)	21.15	87.39	4
Country				
US	0.8 (0.64–0.95)	3263.61	99.59	6
Sweden	0.86 (0.81–0.91)	5.485	67.53	3
Australia	0.85 (0.82–0.88)	3.984	49.84	3
Turkey	0.71 (0.48–0.94)	506.76	99.3	6
Brazil	0.81 (0.74–0.89)	21.15	87.39	4
India	0.77 (0.7–0.85)	1744.26	99.94	20
Iran	0.86 (0.82–0.91)	20.21	71.87	6
Greece	0.66 (0.49–0.82)	41.93	95.13	3
Saudi	0.76 (0.66–0.85)	133.73	95.64	8
Malaysia	0.9 (0.79–1)	43.86	94.73	3
Risk of bias				
Low	0.79 (0.75–0.82)	13700.42	99.83	85
Moderate	0.74 (0.58–0.9)	37.04	93.86	4



**Figure 2.** Forest plot of gender difference in the prevalence of musculoskeletal disorders (MSD).



**Table 3. Site-specific pooled estimates of overall musculoskeletal disorders.**

Site	Estimate (95% CI)	Q	I <sup>2</sup>	N
Neck	0.51 (0.46–0.56)	11158.95	98.86	78
Shoulder	0.41 (0.36–0.47)	8921.3	99.09	71
Wrist	0.31 (0.27–0.35)	4668.92	98.39	65
Arm	0.11 (0.07–0.15)	269.08	96.9	14
Elbow	0.16 (0.11–0.2)	1666.43	98.82	50
Fingers	0.18 (0.06–0.3)	260.81	98.23	6
Hip	0.16 (0.13–0.2)	1697.04	97.31	49
Thighs	0.1 (0.06–0.14)	92.07	89.32	10
Knee	0.18 (0.15–0.21)	1483.36	95.92	49
Leg	0.11 (0.06–0.17)	604.18	99.34	19
Ankle	0.14 (0.11–0.17)	1023.76	97.12	41
Feet	0.13 (0.06–0.2)	302.74	97.02	10
Back	0.5 (0.39–0.6)	8971.27	99.45	17
Lower back	0.46 (0.42–0.5)	3142.31	97.49	66
Upper back	0.35 (0.3–0.4)	3480.2	97.99	58

### Geographic distribution

Only a few studies were reported from North America (n = 7),<sup>37,43,49,52,63,81,82</sup> South America (n = 4),<sup>19,50,77,83</sup> and Australia (n = 4),<sup>14,68,84,85</sup> while only one study was reported from Africa.<sup>86</sup> Most of the studies were from Asia<sup>3,5–10,12,15–18,22,23,36,38,40,41,45,46,48,51,55–62,64–66,69–71,73–76,78,79,87–100</sup> and Europe<sup>11,13,39,42,44,47,53,54,67,72,80,101–105</sup> (Table 2). Countries with more than three studies were included for the sub-group analysis. The highest pooled prevalence was seen in Malaysia, and the lowest pooled prevalence was seen in Greece.

### Risk of bias (RoB)

Out of the 88 studies included, only four studies had a moderate RoB.<sup>22,52,57,60</sup> The pooled estimates for studies with low and moderate RoB were 79% and 74% (Table 2).

### Site distribution

The commonly reported sites were the neck, back, lower back, shoulder, upper back, and wrists. The least affected sites were thighs, legs, arms, feet, and ankles (Table 3).

### Meta-analysis

There was high heterogeneity among the included studies, as evidenced by Q and I<sup>2</sup> statistics. The model yielded a pooled estimate of 78.4% (Figure 3), and sensitivity analysis did not show any change in the overall estimate. The meta-regression showed no change in the trend of MSD (Coefficient: 0.001; 95% CI: -0.004 to 0.006) (Figure 4). Asymmetry was noted in the funnel plot (p < 0.001) (Figure 5).

### Discussion

MSD's result in pain, discomfort, or limitation in the range of movement. They are preventable conditions often due to poor ergonomic postures adopted by dental health care providers. We aimed to pool the estimates of MSD among dental healthcare providers. Eighty-eight publications recorded a comprehensive assessment of all body areas and reported the overall prevalence of MSD. The estimates needed to be evaluated carefully due to the high heterogeneity. The overall estimate was 78%, which was much higher than Greek and Czech surveys.<sup>37,80</sup> However, extensive surveys of dentists from India and Lithuania have reported similar or higher prevalence estimates.<sup>3,9,101</sup> Therefore, it is clear that dental professionals have quite a higher prevalence of MSD. Age-specific prevalence estimates could not be estimated due to a lack of standardized age groups or specific prevalence estimates. It was found that females showed higher prevalence estimates than males. Although the number of studies that reported gender distribution was high, only one-third of these studies reported gender-specific estimates of MSD.

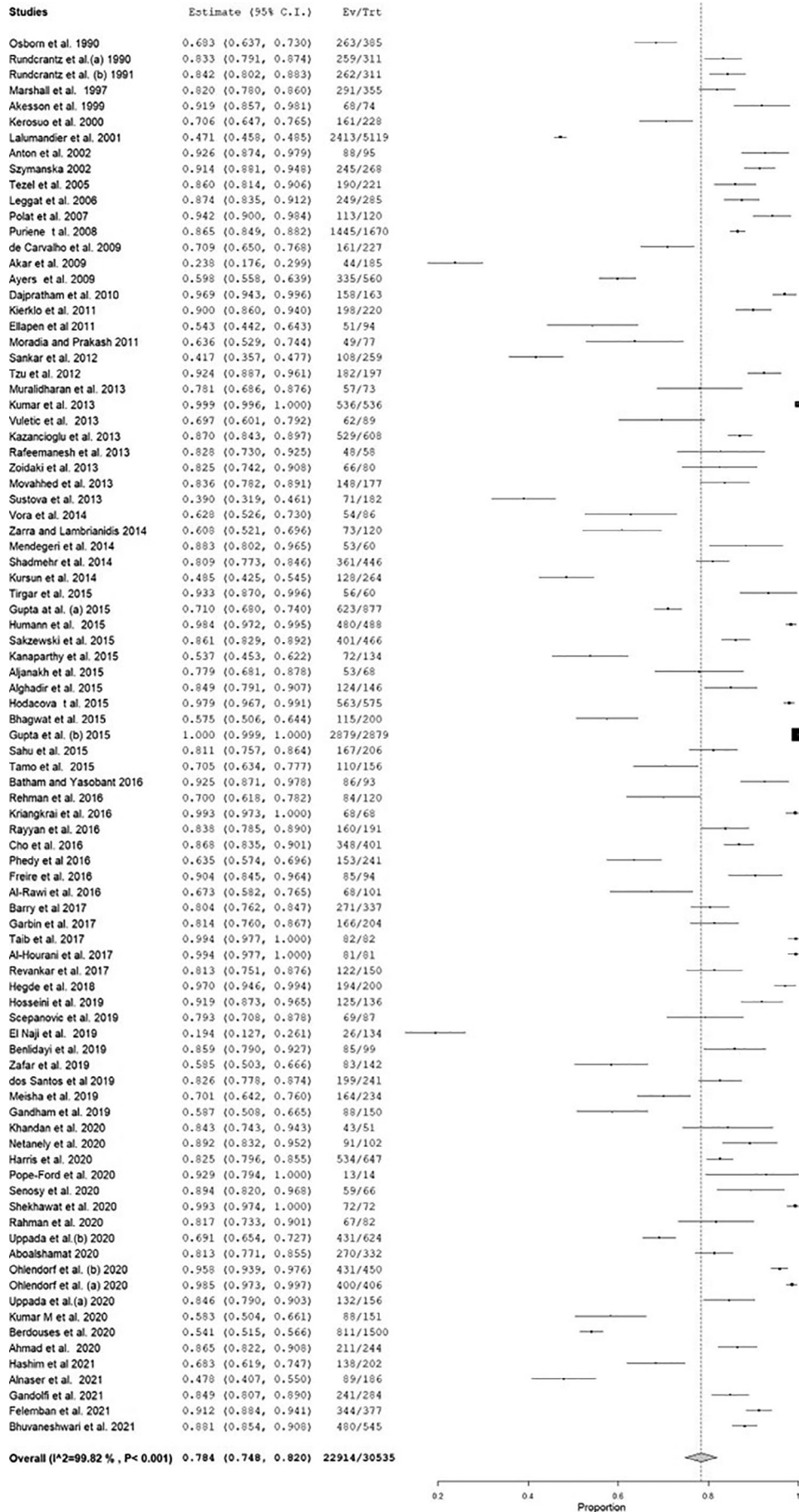
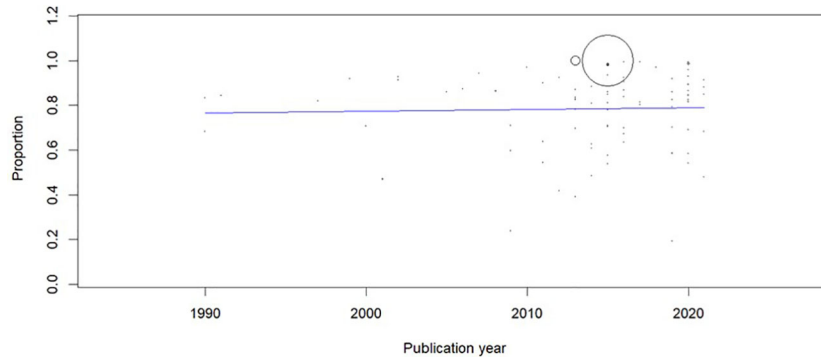
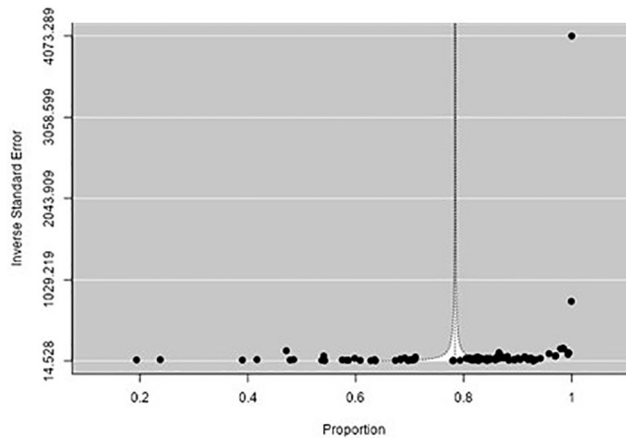


Figure 3. Forest plot of the prevalence of musculoskeletal disorders (MSD).



**Figure 4.** Meta-regression to evaluate the trends in the prevalence of musculoskeletal disorders (MSD).



**Figure 5.** Funnel plot to evaluate the publication bias.

The prevalence estimates were similar across the continents. The highest number of studies were reported from the Asian continent. The highest number of studies were from India,<sup>3,5,9,10,18,38,51,55,56,59,60,64,65,69,74,75,78,88,97,99</sup> followed by the US,<sup>37,43,49,52,81,82</sup> Iran,<sup>15,16,48,66,71,89</sup> and Turkey.<sup>36,40,45,61,70,87</sup> Studies from Malaysia<sup>7,95,98</sup> reported the highest prevalence estimates among various countries, followed by Iran,<sup>15,16,48,66,71,89</sup> Sweden,<sup>42,102</sup> Australia,<sup>14,84,85</sup> Brazil,<sup>19,50,77,83</sup> and the US.<sup>37,43,49,52,81,82</sup> There was not much variation in the prevalence estimates among the dentists, dental auxiliaries, and dental students. These observations suggest that all types of dental healthcare providers globally suffer from MSDs due to prolonged static postures. Over three decades, there was no significant change in the trend of MSD, indicating a consistently higher prevalence, highlighting the need to incorporate ergonomics into the dental curriculum.

There was substantial inconsistency in the assessment of prevalence estimates among the studies. The Nordic/standardized Nordic questionnaire was the most commonly used tool to assess MSDs. A few studies used generic questionnaires and single-item questions without adequate validity and reliability. Moreover, the studies used various time recall periods (lifetime, one year, six months, one month, and one week) to assess the prevalence estimates. The studies that used lifetime or extended recall periods might have included pre-existing MSDs that may not be work-related, which could have diluted the estimates of MSD.

MSD can arise from various reasons, and there was a lack of clarity in most of the studies. Only one study explicitly recorded the estimates before and after joining the dental profession.<sup>58</sup> There was a general lack of clarity on the estimates reported for various body parts (shoulders, hands, elbow, wrists, legs, ankles, hips, fingers, toes). The studies reported right, left, and bilateral prevalence estimates of MSD without detailing the prevalence for each site. MSD in such areas could have been reported as unilateral and bilateral rather than right, left, and bilateral estimates. Furthermore, there was no uniformity in the evaluation of site-specific assessments among the studies included (e.g. lack of clarity on the terms hand and arms).

The strength of this review is the inclusion of studies that reported the overall estimates of MSD, including many databases, all types of dental healthcare personnel, overall, lifetime and annual estimates, sub-group analysis, gender, and site-specific prevalence estimates. A few limitations were observed in our study. They are the exclusion of studies published in other languages, lack of age-specific prevalence estimates, lack of differentiation between work-related and pre-existing MSDs, causes of MSDs due to inadequate reporting in primary studies, use of self-reported measures of MSD rather than objective measures, and exclusion of studies with no comprehensive assessment or overall estimates of MSD.

The additional confounding factors related to lifestyle (sedentary lifestyle, lack of regular physical exercise, and other extra-curricular activities) could significantly influence the onset and duration of MSD. Furthermore, the number of clinical working days/week, working hours/day, type and duration of procedures, specialization, number of patients/days, remedial measures, and history of MSD in the past could also substantially impact the estimates of MSD. These inconsistencies in the included studies could have influenced the overall prevalence of MSD.

## Conclusions

MSD among dental healthcare personnel is widespread and mostly chronic. Seven out of ten dental healthcare providers could have experienced MSD in the past. However, the severity and self-limiting nature of MSD cannot be underestimated. Awareness, adoption, and maintenance of appropriate ergonomic postures should be encouraged at dental schools and early in the career. Future studies should use the “Strengthening the Reporting of Observational Studies in Epidemiology (STROBE)” guidelines and use validated questionnaires for reporting MSD.

## Data availability

### Underlying data

Mendeley Data: Underlying data for ‘Musculoskeletal disorders among dental health care professionals’. <https://www.doi.org/10.17632/2ttwfmzm9n.2><sup>35</sup>

### Reporting guidelines

Mendeley Data: PRISMA checklist for ‘Musculoskeletal disorders among dental health care professionals’. <https://www.doi.org/10.17632/2ttwfmzm9n.2><sup>35</sup>

Data are available under the terms of the [Creative Commons Attribution 4.0 International license](https://creativecommons.org/licenses/by/4.0/) (CC-BY 4.0)

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# Open Peer Review

Current Peer Review Status:  

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Reviewer Report 29 November 2022

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## Preethi Balan

Singapore Oral Microbiomics Initiative, National Dental Research Institute Singapore, National Dental Center, Singapore, Singapore

The authors have studied the prevalence estimates of MSD among dental healthcare workers using a systematic search of five databases. The authors observed high prevalence of MSD among dental healthcare workers which highlights the importance of them becoming aware of and adopting appropriate ergonomic postures early in their careers in order to reduce work-related MSD.

The paper is well written and covers most of the aspects in this issue. There are a few suggestions below:

1. Were the two reviewers calibrated before doing the search? If possible the authors can provide the kappa statistics for agreement between the two reviewers.
2. The authors can provide the numbers of hits with each of the five databases in the prisma flowchart.
3. The authors can provide the years included in the search. Also if there was any manual search carried out in addition to the automated search.
4. Please elaborate in the inclusion/exclusion criteria regarding the type of studies considered, e.g. randomized and controlled clinical trials/observational studies/case control studies etc.

**Are the rationale for, and objectives of, the Systematic Review clearly stated?**

Yes

**Are sufficient details of the methods and analysis provided to allow replication by others?**

Partly

**Is the statistical analysis and its interpretation appropriate?**



Yes

**Are the conclusions drawn adequately supported by the results presented in the review?**

Yes

**Competing Interests:** No competing interests were disclosed.

**Reviewer Expertise:** Clinical oral health research

**I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.**

Reviewer Report 13 October 2022

<https://doi.org/10.5256/f1000research.137145.r151604>

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**Athira Nandakumar** 

Department of Epidemiology and Preventive Medicine, Kagoshima University Graduate School of Medical and Dental Sciences, Kagoshima, Japan

#### **Introduction:**

The authors showed the high prevalence of Musculoskeletal disorder (MSD) among dental health care providers in a worldwide scenario. MSD-related problems seem to be a significant issue for this profession and this is an already known problem. The authors tried to put up possibly all available publications related to MSD and did this attempt. However, certain changes in the manuscript and corrections to spelling mistakes or typos are recommended.

The exact definition of MSD is missing.

#### **Methods:**

##### 1) Inclusion Criteria:

**Question:** Is there any previously published systematic review included in this study?

**Question:** Hygienists mentioned here are missing in Table 2. Are they included in auxiliaries?

**Question:** What kind of studies were included - Cross-sectional/cohort/case-control?

**Question:** Were there any self-reported studies?

##### 2) RoB:

**Question:** What is the cutoff point used in this study? It is not mentioned that some cut-off point was used here.

**Question:** How many articles were excluded after RoB calculations?

##### 3) Results:

**Question:** Meta-analysis was performed for 89? Or 88?

**Question:** What is the reason for the exclusion of 146 publications after the full screening of the full text?

4) Prevalence: There is a repeated word "than than".

5) Geographic distribution:

**Question:** The authors mentioned that Australia (4), Africa (1), and north and south America (7,4) why not Asia and Europe (N=?)?

It may be better to revise this "One study from Africa (N=1)".

6) Figure 1:

**Question:** Where is the N=89 in this chart?

**Question:** What are the other sources used to identify additional records?

7) Table 2:

**Question:** Why is Africa not mentioned here?

**Question:** Malaysia has the highest estimates. What is the reason? Is it due to the inappropriate definition of MSD in Malaysia?

**Question:** The estimate for one year (0.82) is more than for a lifetime (0.78); What may be the possible reason?

**Question:** What is the definition of "mixed"?

**Question:** Dental auxiliaries seem to have more difficulties with MSD with an estimate of 0.83 (0.69-0.97). Is it not because 2-3 categories are grouped together?

8) Limitation:

**Question:** It's mentioned that "the exclusion of studies published in other languages"; does it mean other than English?

**Discussion:**

**Question:** What was the national survey estimate? Mentioned in references 37,80? Better to mention Greek and Czech surveys.

**Question:** Reference 37, is it a national survey?

**Question:** What was the prevalence of the studies that used the Nordic questionnaire?

**Are the rationale for, and objectives of, the Systematic Review clearly stated?**

Yes

**Are sufficient details of the methods and analysis provided to allow replication by others?**

Partly

**Is the statistical analysis and its interpretation appropriate?**

Yes

**Are the conclusions drawn adequately supported by the results presented in the review?**

Yes

**Competing Interests:** No competing interests were disclosed.

**Reviewer Expertise:** Epidemiologist

**I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.**

Author Response 19 Oct 2022

**Kalyana Pentapati**, Manipal College of Dental Sciences, Manipal, Manipal Academy of Higher Education, Manipal, India

We thank the reviewer for their effort in reviewing this manuscript. Please find responses for the queries. The changes that are required to be done in the manuscript will be incorporated.

Introduction:

The authors showed the high prevalence of Musculoskeletal disorder (MSD) among dental health care providers in a worldwide scenario. MSD-related problems seem to be a significant issue for this profession and this is an already known problem. The authors tried to put up possibly all available publications related to MSD and did this attempt. However, certain changes in the manuscript and corrections to spelling mistakes or typos are recommended.

The exact definition of MSD is missing.

**Response:** MSDs are defined as musculoskeletal system and connective tissue diseases and disorders when the event or exposure leading to the case is bodily reaction (e.g., bending, climbing, crawling, reaching, twisting), overexertion, or repetitive motion. MSDs do not include disorders caused by slips, trips, falls, or similar incidents (Bureau of Labor Statistics of the Department of Labor. NIOSH workers health chartbook 2004. NIOSH Publication No. 2004-146. Washington, D.C). We will add the same into the manuscript.

Methods:

1) Inclusion Criteria:

Question: Is there any previously published systematic review included in this study?

**Response:** No

Question: Hygienists mentioned here are missing in Table 2. Are they included in auxiliaries?

**Response:** Yes

Question: What kind of studies were included - Cross-sectional/cohort/case-control?

**Response:** We included studies from which prevalence could be calculated. However, most of the included studies were cross-sectional (n=86)

Question: Were there any self-reported studies?

**Response:** All the studies were self-reported

2) RoB:

Question: What is the cutoff point used in this study? It is not mentioned that some cut-off point was used here.

**Response:** Each question has two levels, low risk (0) and high risk (1). The total of all nine questions was used to categorize the studies as “low (0–3), moderate (4–6), or high risk (7–9)”. (This information was in the risk of bias assessment in the methodology section)

Question: How many articles were excluded after RoB calculations?

**Response:** Nil. Sensitivity analysis did not show any change in the overall estimate

3) Results:

Question: Meta-analysis was performed for 89? Or 88?

**Response:** Meta-analysis was performed for 89 estimates that yielded from 88 publications.

Question: What is the reason for the exclusion of 146 publications after the full screening of the full text?

**Response:** During the full-text screening of the publications, we excluded studies which had unclear outcome (n=138), inappropriate study design (n=4), short communications (n=2), and secondary analysis (n=2). This information is presented in figure 1.

4) Prevalence: There is a repeated word “than than”.

**Response:** Thank you. We will incorporate the change.

5) Geographic distribution:

Question: The authors mentioned that Australia (4), Africa (1), and north and south America (7,4) why not Asia and Europe (N=?)?

**Response:** We didn't want to replicate the data that has been presented in tables. Continent and country wise estimates with number of studies were presented in table 2.

It may be better to revise this “One study from Africa (N=1)”.

Response: We will incorporate the change.

6) Figure 1:

Question: Where is the N=89 in this chart?

**Response:** 89 estimates were obtained from 88 publications. In the flow chart we have highlighted the process flow with respect to the number of publications.

Question: What are the other sources used to identify additional records?

**Responses:** We have sought additional publications from the reference list given at the end of each article.

7) Table 2:

Question: Why is Africa not mentioned here?

**Response:** As there was only one study reported from Africa, we could not pool the estimate.

Question: Malaysia has the highest estimates. What is the reason? Is it due to the inappropriate definition of MSD in Malaysia?

**Response:** We could not identify the reason for this. Many factors like the number of clinical working days/week, working hours/day, type and duration of procedures, specialization, number of patients/days, remedial measures, and history of MSD in the past can have substantially impact on the estimates of MSD.

Question: The estimate for one year (0.82) is more than for a lifetime (0.78); What may be the possible reason?

**Response:** Different studies have used different time frames to report the MSD. Most studies have reported one year prevalence (n=65) followed by lifetime prevalence. Some studies reported both. Hence, it is not possible to substantiate what could be reason of this

disparity. There could be possibility of recall bias among the participants that report lifetime events when compared to one-year events.

Question: What is the definition of “mixed”?

**Response:** Studies that have not reported estimates separately for dentists, dental students or dental auxiliaries or studies that included different type of dental personnel.

Question: Dental auxiliaries seem to have more difficulties with MSD with an estimate of 0.83 (0.69-0.97). Is it not because 2-3 categories are grouped together?

**Response:** Among the ten publications that were included in the dental auxiliaries, 6 studies were among dental hygienists (prevalence: 80.42 to 98.36), two were among dental technicians (prevalence 23.8 and 100%) and one was among dental assistant (prevalence 81.71%) and one was among dental auxiliaries (prevalence 81.7). Hence, estimates are high and may not related to the categorisation.

8) Limitation:

Question: It’s mentioned that “the exclusion of studies published in other languages”; does it mean other than English?

**Response:** Yes

Discussion:

Question: What was the national survey estimate? Mentioned in references 37,80? Better to mention Greek and Czech surveys.

**Response:** Yes, we will incorporate the change.

Question: Reference 37, is it a national survey?

**Response:** No. It is a study among dental personnel in US dental army.

Question: What was the prevalence of the studies that used the Nordic questionnaire?

**Response:** 45 studies used Nordic questionnaire.

**Competing Interests:** No competing interests were disclosed.

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