

## Article

# Prevalence of Musculoskeletal Disorders in Germany—A Comparison between Dentists and Dental Assistants

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**Abstract:** Background: Dental professionals suffer frequently from musculoskeletal disorders (MSD). Dentists and dental assistants work closely with each other in a mutually dependent relationship. To date, MSD in dental assistants have only been marginally investigated and compared to their occurrence in dentists. Therefore, the aim of this study was to compare the prevalence of MSD between dentists and dental assistants by considering occupational factors, physical activity and gender. Methods: This was a cross-sectional observational study. A Germany-wide survey, using a modified version of the Nordic Questionnaire and work-related questions, was applied. In total, 2548 participants took part, of which 389 dentists (240 females and 149 males) and 322 dental assistants (320 females and 2 males) were included in the analysis. Data were collected between May 2018 and May 2019. Differences between the dentists and dental assistants were determined by using the Chi<sup>2</sup> test for nominal and the Wilcoxon–Mann–Whitney U test for both ordinal and non-normally distributed metric data. Results: A greater number of dental assistants reported complaints than dentists in all queried body regions. Significant differences in the most affected body regions (neck, shoulders, wrist/hands, upper back, lower back and feet/ankles) were found for the lifetime prevalence, annual prevalence and weekly prevalence. Data from the occupational factors, physical activity and gender analyses revealed significant differences between dentists and dental assistants. Conclusions: Dental assistants appear to be particularly affected by MSD when compared to dentists. This circumstance can be explained only to a limited extent by differences in gender distribution and occupational habits between the occupations.

**Keywords:** MSD; dentists; dental assistants; prevalence; occupational factors; physical activity; gender

## 1. Introduction

The prevalence of musculoskeletal disorders (MSD) in dental professionals has been found to be tremendous [1–7]. The most affected body areas are, according to a recent meta-analysis [1], the neck (58.5%) followed by the lower back (56.4%), the shoulders (43.1%) and the upper back (41.1%). Similar observations have been reported in a recent review by Moodley and colleagues [7]. In addition, women have been found to display significantly more severe pain more frequently than men [7]. This is in line with the

current evidence that reports that women show a higher prevalence of clinical pain conditions [8–10]. Furthermore, in the dental profession field, the fact that more women work in this occupational setting should be taken into account. The high proportion of women among dental assistants (99.1% in Germany) is particularly noticeable [11].

In daily practice, dentists and dental assistants work closely together as a team: both work concurrently alongside the patient, working simultaneously in the patient's mouth; thus, their working field is small. Poor visibility and light conditions render the work even more challenging. In this context, unpleasant and unhealthy postures have to be maintained statically throughout a treatment for long periods of time, setting up high physical work demands in this occupational group [4,12–14]. Partido et al. [5] have recently demonstrated dependencies between the postures of dentists and dental assistants by using risk scores. It can, therefore, be assumed that the collaborative, mutually dependent work also favors the development of MSD. Consequently, the prevalence of MSD should be considered and analyzed together in dentists and dental assistants.

However, MSD in dental assistants have only been marginally investigated worldwide. The single study that has met the criteria of the meta-analysis of Lietz et al. [1] for investigating dental assistants evaluated only the 7-day prevalence of MSD in the back (71.9%) and neck (75.0%) [15]. A review by Morse and colleagues from 2010 [4] summarized five studies between 1995 and 2001; this reported the annual prevalence of MSD in the neck and shoulders to be 22.0–62.0% in dental assistants; however, two of the studies examined only 30 [16] and 29 [17] participants. Even less studies have investigated the differences in the occurrence of MSD between dentists and dental assistants. The remaining studies [6,18] that have met the scientific quality criteria have demonstrated that dental assistants report pain in the knee, leg and foot significantly more often than dentists. On the other hand, significantly less MSD were reported in the shoulders and scapula of dental assistants than in other groups [18]. Furthermore, female dental assistants had, significantly, the highest incidence of serious low back pain in comparison to all female dental health workers [6]. In most analyses cited here, a modified Nordic Questionnaire was used as the methodological survey instrument.

The few existing studies demonstrate that research into the specific demands, strains and needs of dental assistants is inadequate. The consideration of the specific occupational demands of dental assistants in research is necessary because both dentists and dental assistants work closely together. However, the dental work environment is predominantly oriented towards the ergonomic improvement of the dentist's activity and not of the dental assistant's.

This study is part of the research project SOpEZ (study for the optimization of ergonomics in the dental practice [19], which investigates, amongst others, the prevalence of MSD and occupational parameters in dentistry. Due to the close collaborative work of dentists and dental assistants, and the assumed effects on posture and movement patterns in occupational practice, it is crucial to compare dentists and dental assistants in terms of the prevalence of MSD and ergonomics. Therefore, the aim of this study was to compare the prevalence of MSD between dentists and dental assistants by considering the occupational factors, physical activity and gender, based on a Germany-wide survey.

## 2. Methods

An anonymous online questionnaire was used and distributed among dental professionals via the SoSci Survey platform [20]. Thus, data of this cross-sectional observational study were collected in Germany between May 2018 and May 2019.

### 2.1. Participants

In this study, 389 dentists (240 females and 149 males) and 322 dental assistants (320 females and 2 males) were analyzed. The inclusion criteria were a minimum age of 18 years and completed questionnaires by currently practicing dentists or dental assistants. Dental students or apprentices; employees working in administration, industry and the dental laboratory; and dental hygienists were excluded from further analysis.

All participants accepted a declaration of informed consent online at the beginning of the survey. This study was approved by the ethics research committee of the Goethe-University (356/17) in Frankfurt am Main, Germany.

## 2.2. Questionnaire

The questionnaire of this survey included a modified version of the Nordic questionnaire [21] and further work-related questions. The Nordic questionnaire was developed in 1987 [21] and has been applied internationally to a wide range of professions [22]. It records musculoskeletal complaints of different body areas; querying; and primarily the lifetime prevalence, 12-month prevalence and the 7-day prevalence of disorders. The questionnaire was validated in a pretest with 13 representatives of the target group before the test data were collected. In the pretest, comments (feedback) were collected in addition to the regular answers. Further details of the questionnaire, the editing process and the pretest can be obtained from Ohlendorf et al. [2,3].

## 2.3. Recruitment

The recruitment took place via different access routes. Flyers were distributed at the “Deutscher Zahnärztetag” 9–11 October 2018 in Frankfurt am Main (Germany) and at the “Internationale Dental-Schau” in Cologne (Germany) 15–16 March 2019 to promote the survey. In addition, the survey was promoted with articles and information in two dental journals (“Die Zahnarzt Woche” and “Zahnärztliche Mitteilungen”), which are received by practicing dentists regularly. Furthermore, Germany-wide social networks of dentists and dental assistants were used to promote the survey. Finally, the Federal Dental Association supported the promotion with information and flyer distribution.

## 2.4. Statistical Evaluation

Data analysis was conducted using IBM SPSS Statistics 25 [23]. With respect to the main objective of the survey questionnaire regarding the prevalence of MSD, it can be assumed with a two-sided 95% confidence interval that, with a prevalence of approximately 87% [24], the current prevalence can be accurately calculated with an accuracy of  $\pm 2\%$ . A survey of 1085 individuals is necessary to obtain this information. In order to test for normal distribution, the Kolmogorov–Smirnov test was applied. For non-normally distributed metric data and ordinal data, the median and interquartile range were defined. In order to test significant differences between dentists and dental assistants, the Chi<sup>2</sup> test for nominal and the Wilcoxon–Mann–Whitney U test for ordinal and non-normally distributed metric data were used. The Fisher’s exact test was applied to nominal data when more than 20% of the cells had an expected count below five. The significance level was set at  $\alpha = 0.05$ .

## 3. Results

### 3.1. Individual Characteristics and Sociodemographic DATA

In total, 2548 participants took part in this survey, of which 711 participants were eligible for further analysis. The median age of the total participants was 35 years (IQR = 18 years) and the median height was 170 cm (IQR = 11 cm). The median weight was 69 kg (IQR = 21 kg) with a median BMI of 25.51 kg/m<sup>2</sup> (IQR = 5.66 kg/m<sup>2</sup>).

Statistical differences were found in sex, age, height, BMI and smoking between the occupational groups. Dental assistants were significantly younger and smaller and had higher BMIs (Table 1) than dentists. Only a few male dental assistants ( $n = 2$ ) took part in the survey; consequently, there was a significantly higher relative share of female dental assistants who participated than female dentists (Table 1). Furthermore, significantly more dental assistants indicated a smoking habit (28.4%) than the dentists (9.5%).

**Table 1.** Individual characteristics of the participants.

	Dentists			Dental Assistants				
	Total	Missing	Females	Males	Total	Missing	Females	Males
	[Median ( $\tilde{x}$ (IQR)) or %]							
Participants ( <i>n</i> )	389		240	149	322		320	2
Sex (% female)	61.7 ***	0	-	-	99.4	0	-	-
Age (years, $\tilde{x}$ (IQR))	39(22) ***	1	35 (17) ***	50 (24)	32(15)	0	32 (15)	25
Height (cm, $\tilde{x}$ (IQR))	172 (12.3) ***	3	168 (8) ***	182 (9)	166 (9)	2	166(9)	166.5
Weight (kg, $\tilde{x}$ (IQR))	70 (23)	3	62 (14) ***	83.5 (15)	68 (18)	2	68 (18)	50
BMI (kg/m <sup>2</sup> , $\tilde{x}$ (IQR))	23.03 (5.16) ***	3	21.5 (4.16) ***	24.81 (4.12)	24.19 (5.88)	2	24.22 (5.89)	18.1
Smoking (% non-smoker)	90.5 ***	1	91.7 ***	88.5	71.6	2	72.0	0
Handedness (% right)	93.6	1	93.8	93.2	93.5	0	93.4	100

Test for significant differences between dentists and dental assistants.  $p < 0.05 = *$ ;  $p < 0.01 = **$ ;  $p < 0.001 = ***$ .

### 3.2. Differences in Occupational Parameters and Physical Activity

Regarding ergonomics in the occupational setting, dentists tend to have a better daily work routine than the dental assistants (Table 2): dentists indicated significantly more frequently that they have “regular breaks between treatments”, “corrective exercises between treatments” and “participation in an ergonomics training course”.

**Table 2.** Occupational parameters and physical activity.

	Dentists Missing ( <i>n</i> )		Dental Assistants Missing ( <i>n</i> )		
	[Median ( $\tilde{x}$ (IQR)) or %]				
Occupational parameters					
Working years since approbation or end of apprenticeship	11 (20)	1		12 (17)	2
Working hours per week	40 (10)	24	***	38 (10)	22
of which treatment time	30 (9)	25	***	30 (15)	24
of which administration time	6 (6)	25	***	4 (7)	27
Hours per week spent at desk	8 (10)	2	***	3 (7)	15
Relative sitting time	94.9%	2	***	82.0%	1
Regular breaks (e.g., every hour) between treatments	41.9%	3	***	28.9%	3
Physical activity					
Corrective exercises between treatments	11.3%	3	*	5.9%	3
“back education program” participation	30.9%	0		30.7%	0
Ergonomics training course participation	26.2%	0	*	18.6%	0
Ergonomics as part of study or apprenticeship	9.8%	289		8.1%	262
Sports in leisure time	83.0%	0	***	62.1%	0
Hours per week performing sports	4 (2)	69		3.5 (3)	125
Strength training	47.8%	0	***	31.4%	0
Hours per week performing strength training	2 (2)	205		2 (2)	224

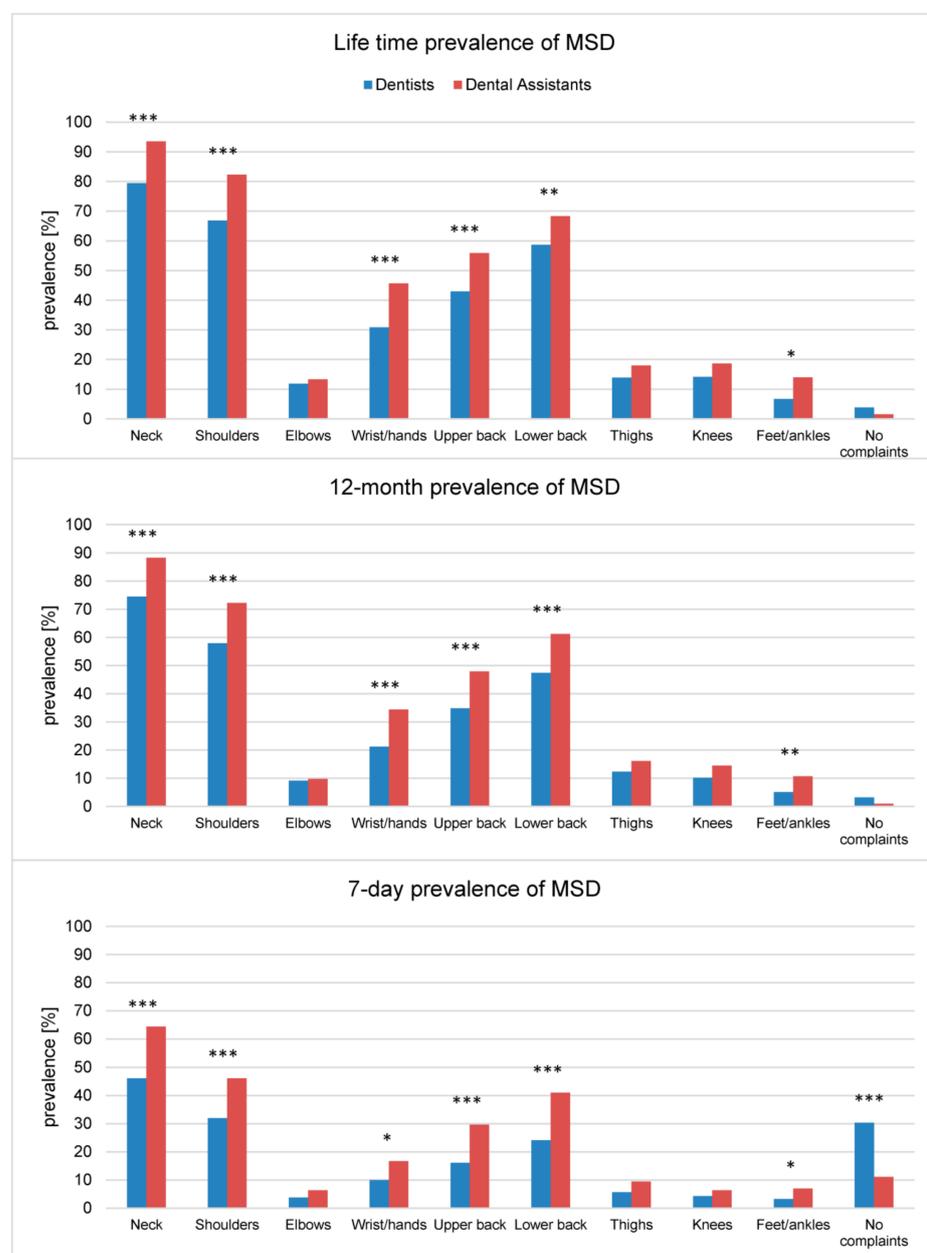
Test for differences between dentists and dental assistants.  $p < 0.05 = *$ ;  $p < 0.01 = **$ ;  $p < 0.001 = ***$ .

On the other hand, dentists have a significantly higher relative sitting time (94.9%) in comparison with dental assistants (82.0%). In addition, dentists work more hours a week compared to dental assistants (40 h/38 h) and spend more hours a week at the desk (8 h) than dental assistants (3 h).

During leisure time, significantly more dentists do sports than dental assistants (83/62.1%) and significantly more do strength training (47.8/31.4%). However, there were no significant differences in the hours spent per week doing sports or strength training between dentists and dental assistants. Both dentists and dental assistants showed comparable participation in the “back education program” and work similar lengths of time in service since qualifying (Table 2).

### 3.3. Prevalence of MSD—Comparison between Dentists and Dental Assistants

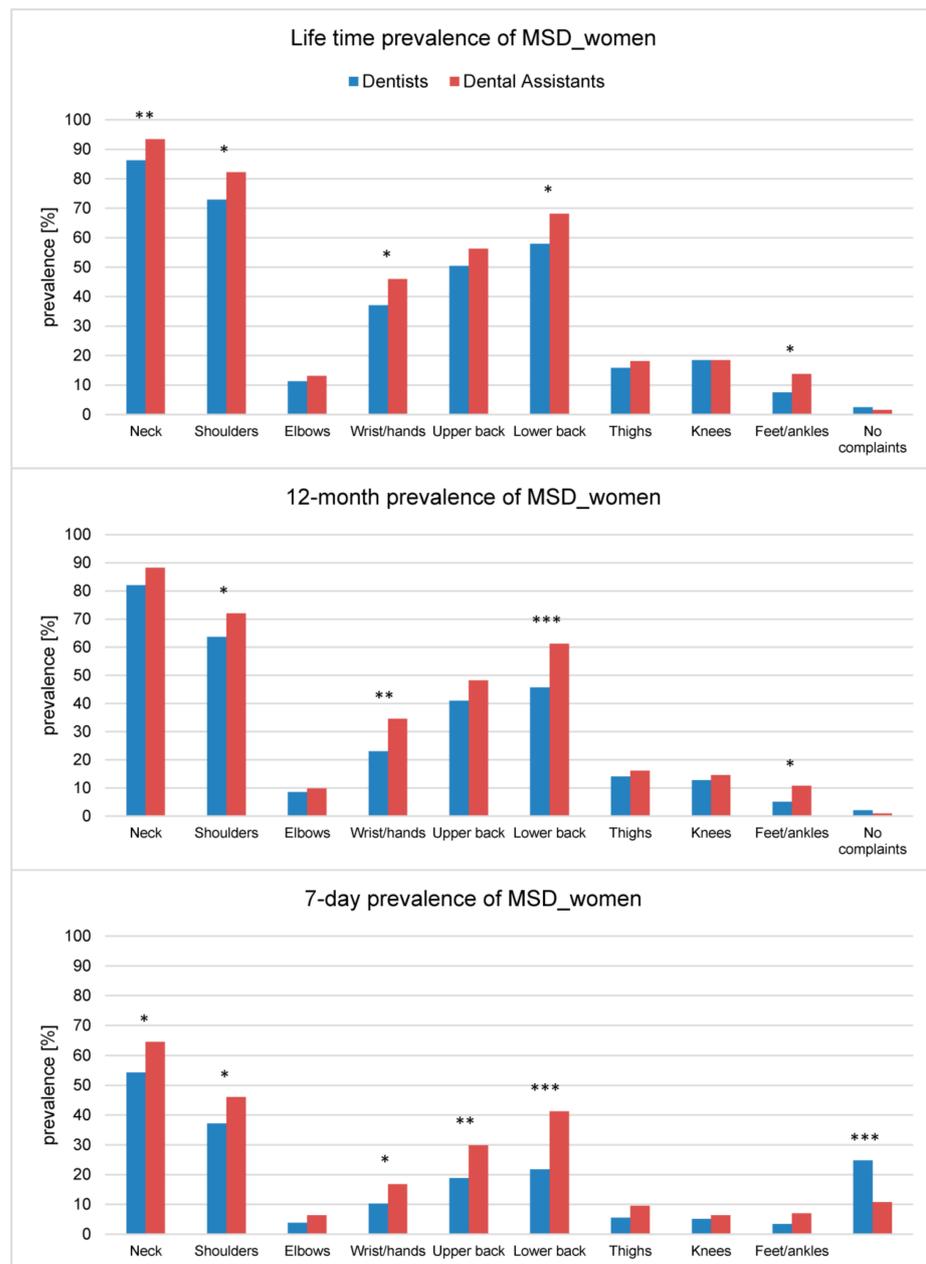
The comparison of the prevalence of MSD between dentists and dental assistants revealed, in general, a higher occurrence of MSD among dental assistants than among dentists, independent of the region or the queried period of time (Figure 1). The comparison showed that, for all time periods (lifetime, 12-month and 7-day periods), there was a significantly higher occurrence of MSD in dental assistants in the areas of the neck, shoulders, upper back, lower back and feet/ankles (Figure 1). Dental assistants indicated more frequently, in all three queried time periods and for every region, that they suffer from MSD than dentists (Figure 1). Regarding the 7-day prevalence, almost three times as many dentists indicated that they have had no complaints than dental assistants (Figure 1). Scarcely any dentists or dental assistants stated that they have had no complaints in their lifetime or the last 12 months (Figure 1).



**Figure 1.** Lifetime prevalence, 12-month prevalence and 7-day prevalence of MSD among dentists and dental assistants. Significant differences between dentists and dental assistants are marked with asterisks:  $p < 0.05 = *$ ;  $p < 0.01 = **$ ;  $p < 0.001 = ***$ .

### 3.4. Prevalence of MSD—Comparison between Female Dentists and Dental Assistants

The analysis of the prevalence of MSD in only the female dentists and dental assistants revealed a higher prevalence in all queried time periods and body regions for the dental assistants (Figure 2). For the lifetime prevalence, significantly more female dental assistants indicated MSD in the neck, shoulders, wrist/hands, lower back and feet/ankles than the female dentists. With the exception of the neck, the annual prevalence was also significantly higher in the dental assistants than the dentists for the same regions as the lifetime prevalence. Significantly more female dental assistants indicated that they have had MSD in the last seven days in the neck, shoulders, wrist/hands, upper back and lower back than the female dentists, whilst more than twice as many female dentists stated that they have had no complaints in the last seven days compared to the female dental assistants (Figure 2).



**Figure 2.** Lifetime prevalence, 12-month prevalence and 7-day prevalence of MSD among female dentists and dental assistants. Significant differences between dentists and dental assistants are marked with asterisks:  $p < 0.05 = *$ ;  $p < 0.01 = **$ ;  $p < 0.001 = ***$ .

#### 4. Discussion

This is the first study that has investigated a comprehensive comparison of MSD and occupational parameters between dentists and dental assistants. Previous studies focused either on MSD occurrence in dentists or general dentistry or conducted limited comparisons between dentists and dental assistants with regard to evaluated body regions or sample size [1,4,7,16,17,25,26]. The comparison of the prevalence of MSD in this study revealed that more dental assistants reported complaints than dentists in all queried body regions. Significant differences in the most affected body regions (neck, shoulders, wrist/hands, upper back, lower back and feet/ankles) were found for all time periods (Figure 1). Furthermore, the weekly prevalence revealed that almost 90.0% of the dental assistants work while in pain, whereas more than 30.0% of the dentists reported no complaints. In total, these results show that dental assistants are significantly more affected by MSD than dentists. In total, the comparison of the current findings show that dental professionals have higher 7-day, 12-month and lifetime prevalence in MSD than the general population in Germany [27].

The results are partly in line with comparable studies [6,18,25,26]; for example, Dajpratham et al. [18] only found significant higher prevalence rates in the lower limb (knee, leg and foot), while the prevalence of MSD in the shoulder and scapula were fewer in dental assistants than dentists. Similarly, in the current study, significant differences were found in the foot, while, in the knee, a non-significant trend with a 4.0% higher prevalence in dental assistants was revealed (Figure 1). In contrast to the abovementioned study [18], however, the dental assistants stated that they experienced significantly more frequent annual shoulder pain than dentists.

Other studies that have investigated differences in MSD between dentists and dental assistants either did not meet scientific criteria, due to small sample sizes [25,26], or queried different time intervals and used different comparison groups [6].

As the proportion of women among dental assistants is known to be significantly higher than among dentists [11] and evidence exists showing that women report pain more frequently than men [8–10], the prevalence analysis was additionally conducted with a homogeneous gender group (only female participants). The reported gender distribution in the field of dentistry is also represented in the current study; only two dental assistants were men (99.4% female), while 149 men worked as dentists (61.7% female). When applying the analysis to only the female participants, the differences in pain prevalence were still present but reduced (Figures 1 and 2). This is in accordance with Proteau et al. [6], who analyzed only female dental professionals and determined that dental assistants had the significantly highest prevalence of low back pain of all dental occupations. In summary, gender may have a slight effect on the prevalence of MSD as the differences did narrow when considering only female dental workers.

Potential influencing factors can be differences in the work requirements and habits, since ergonomically different work routines and physical activity can have an impact on the occurrence of MSD [28–31]. In this sense, dentists manage to integrate preventive measures into their professional routine more frequently. As can be seen in Table 2, the dentists indicated significantly more often that they take “regular breaks between treatments”, perform “corrective exercises between treatments” and engage in “participation in an ergonomics training course”. In addition, the proportion of dentists who perform physical activities, for example, strength training, on a regular basis is significantly higher than the proportion of dental assistants who perform these activities. Further reasons could be that dental treatment units are predominantly dentist-oriented. In addition, the treatment chair is adjusted in such a way that the dentists have an optimal view into the patient’s mouth, regardless of ergonomic disadvantages on the part of the assistants. This effect could be additionally reinforced by differences in size between dentists and dental assistants. On the other hand, the working profile of dentists is characterized by more static sitting time and their overall workload is also higher (Table 2).

Although the literature has shown that working hours and corresponding higher stress levels can promote the development of MSD [32,33], dentists still show a lower prevalence of MSD in all queried regions and time periods, even though they have longer working hours and higher stress levels than the dental assistants in the current study.

A control group would have been helpful to better interpret the prevalence, but such a group was not included in this study. Another limitation is the imbalance in the gender distribution in the occupational groups. However, matching between the genders is impossible in Germany, since 99% of the dental assistants in Germany are female [11]. Since the population in our study matches the real world contribution of sexes in this occupational group very well, we believe this can also be seen as a strength of the study. Unfortunately, it was not possible to collect an exact response rate of the questionnaires. Due to data protection regulations in Germany, it was not possible to obtain the email addresses of the practices via the state medical association and to contact them ourselves. Instead, an open distribution strategy had to be chosen, at trade fairs and via magazine articles. It is also possible that a majority of people with pain decided to participate in the study.

It can be concluded, therefore, either that the physical activity of dentists and their occupational adaptations are highly effective in preventing MSD or that the underlying mechanisms for MSD are to be sought elsewhere. Future studies should compare the ergonomic risk of dentists and dental assistants during their co-work on patients.

## 5. Conclusions

This survey showed that dental assistants are considerably more affected by MSD than dentists, although the prevalence of MSD is already very high in dental professions. Dental assistants appear to be particularly affected, compared to dentists, in the shoulder-neck area, and the upper and lower back. The comparison between females revealed smaller but still substantial differences between dentists and dental assistants. In addition, differences in occupational parameters and physical activity were inconsistent. Therefore, we suggest that discrepancies in the occupational demands between both occupations may lead to high prevalence rates of MSD in dental assistants.

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**Informed Consent Statement:** Informed consent was obtained from all subjects involved in the study.

**Data Availability Statement:** The data presented in this study are available are included in this published article but are also available on request from the corresponding author.

**Conflicts of Interest:** The authors declare no conflict of interest.

## Abbreviations

MSD	musculoskeletal disorders
SOpEZ	study for the optimization of ergonomics in the dental practice
IQR	interquartile range

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