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The Role of Ergonomic Interventions to Prevent Low Back Pain Among Dentists: A Scoping Review

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ABSTRACT

Dentists are typically at high risk of developing low back pain (LBP) due to their working position. Therefore, this study aimed to evaluate the role of ergonomic interventions in preventing LBP. The study procedures were carried out using a scoping review method with Boolean search based on PCC (Population, Concept, and Context) on PubMed, Wiley, and Google Scholar. Article management and selection process was then conducted using Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) as a guide. Inclusion criteria were experimental articles from 2011 to 2021, while exclusion criteria included scoping, rapid, and systematic reviews, gray literature, or papers that were not fully accessible. A total of 1775 articles were obtained and only 12 were selected with a total of 557 participants. The selected articles consisted of 2, 1, and 7 in the work environment, organizational, and individual domains, respectively, while 2 articles had more than 1 ergonomic intervention in different domains. The results showed that ergonomic interventions could prevent LBP among dentists. The clinical significance reported across all included articles showed that participants experienced positive changes in posture, decreased pain levels, and improved work quality after receiving the treatment across all domains.

Keywords: Dentists, Ergonomic, Intervention, Low Back Pain (LBP)

ABSTRAK

Dokter gigi berisiko tinggi terkena nyeri punggung bawah (LBP) karena posisi kerjanya. Tujuan dari penelitian ini adalah mengevaluasi bagaimana intervensi ergonomic dapat mencegah LBP tersebut. Metode penelitian adalah scoping review yang menggunakan Boolean search berdasarkan PCC (Population, Concept, and Context) pada PubMed, Wiley, dan Google Scholar. Pengelolaan artikel dan proses seleksi studi menggunakan PRISMA-ScR sebagai panduan. Kriteria inklusi adalah artikel penelitian eksperimental dari tahun 2011 hingga 2021. Kriteria eksklusi meliputi tinjauan pelingkupan, tinjauan cepat, tinjauan sistematis, literatur abu-abu, atau artikel yang tidak dapat diakses sepenuhnya. Diperoleh 1775 artikel dan hanya 12 artikel yang terseleksi dengan total partisipan sebanyak 557 orang yang terdiri dari: dua artikel pada domain lingkungan kerja, satu artikel pada domain organisasi, tujuh artikel pada domain individu dan dua artikel dengan lebih dari satu intervensi ergonomis pada domain berbeda. Hasil penelitian menunjukkan intervensi ergonomis dapat mencegah LBP pada dokter gigi. Signifikansi klinis dari semua penelitian menunjukkan bahwa partisipan mengalami perubahan positif pada postur tubuh, penurunan tingkat nyeri, dan peningkatan kualitas kerja setelah menerima intervensi ergonomis, baik dalam domain lingkungan kerja, organisasi, individu dan kombinasi beberapa intervensi ergonomi pada domain yang berbeda.

Kata kunci: Dokter Gigi, Ergonomi, Intervensi, Nyeri Punggung Bawah

1. Introduction

Dentists are typically at high risk of musculoskeletal disorders (MSDs), with the common complaint being pain in the neck, shoulders, elbows, hands, and especially in the lower back. [1] A previous study in Korea showed that 86.8% of 401 dentists experienced symptoms of MSDs, with 69.3% complaining of waist disorders. [2] Another study on 234 dentists in Saudi Arabia found that 70% experienced work-related musculoskeletal disorders (WMSDs), and the most affected region was the lower back at 85%. [3] In addition, 71.1% of 187 participants in Sweden had symptoms of MSDs in the form of pain in several parts of their body, including low back pain (LBP).[4]

According to previous studies, this high prevalence is primarily due to the confined working area of the oral cavity, which often leads to awkward and static posture during work. Improper posture while working causes almost all dentists to experience LBP. [5,6] In addition, risk factors of LBP include physical characteristics, such as posture [7], repetitive movements [8], strength [9], and work environment [10]. Others include psychosocial [11] and individual factors, such as age [12], gender [13], and general health [14]. Previous studies have shown that working with pain and discomfort in the back significantly impacts the quality of life and professional performance. [15,16]

Various ergonomic interventions have been carried out among dentists to overcome LBP, but there is no standardization. Ergonomic interventions are efforts or actions to apply ergonomics to the work environment, organization, and individual factors to prevent WMSD. [17] Therefore, this scoping review aimed to summarize and present data regarding various ergonomic interventions to prevent LBP, examine methods for diagnosis and evaluation, and determine supporting factors and limitations in previous studies.

2. Material and Methods

This study was conducted based on the framework recommended by the Joanna Briggs Institute. Figure 1 shows the study selection process using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) as a guideline. [18] Meanwhile, JBI laid the framework on for conducting scoping reviews uniformly, and PRISMA-ScR focused on how it could be reported effectively. The study teams conducting scoping reviews using the JBI framework were encouraged to use the PRISMA-ScR checklist to ensure the reporting standards are met. Furthermore, the source study was carried out using PCC (Population, Concept, and Context) based on the question: "How do ergonomic interventions prevent LBP in dentists?" The population was dentists; the concept of this study was the prevention of LBP, while the context was an ergonomic intervention. Articles were searched using Boolean sentences in the PubMed, Wiley, and Google Scholar databases for article publications from 2011 to 2021. In addition, these databases were selected for several reasons, such as a large number of academic works of literature related to the fields of biomedicine and healthcare, including peer-reviewed articles. This ensured the finding of relevant and high-credibility resources for this study. The search engines of these databases were also known for being easy to use and efficient in conducting detailed and precise searches. PubMed and Google Scholar were also freely available, making them accessible to study teams. The Boolean search sentence was obtained from the MeSH terms: low back pain, LBP, musculoskeletal disorders, MSD, ergonomic, dentist, prevention, and intervention. Keywords in Indonesian include, *nyeri punggung bawah*, *gangguan musculoskeletal*, *ergonomic*, *dokter gigi*, *pencegahan*, and *intervensi*. The inclusion criteria in this study included (1) original articles obtained from the PubMed, Wiley, and Google Scholar databases, (2) articles published from 2011 to 2021, (3) articles in English and Indonesian language, and (4) articles with experimental study designs and related to study questions. The exclusion criteria included (1) all types of review articles (scoping review, rapid review, and systematic review), (2) gray literature, and (3) articles that were not fully accessible.

3. Results

The Boolean search across PubMed, Wiley, and Google Scholar resulted in 1775 articles published between 2011 and 2021, including 52 from PubMed, 134 from Wiley, and 1589 from Google Scholar. Subsequently, the articles were organized to identify when there were any duplicates. After removing 47 duplicates, 1216 articles remained. During the screening process, 1199 articles were excluded. Six articles

were subsequently excluded after the eligibility assessment, and one additional article was included at the final stage of the inclusion stage. This entire process is illustrated in Figure 1 (PRISMA-ScR flow diagram), which outlines the screening and selection procedure. In addition, it ultimately resulted in the inclusion of 12 articles involving 557 participants. Table 1 presents the selected articles evaluating ergonomic interventions in the work environment [19,20], organizational [21], and individual domains [22-28], and two studies have conducted more than one intervention in different domains. [29,30]

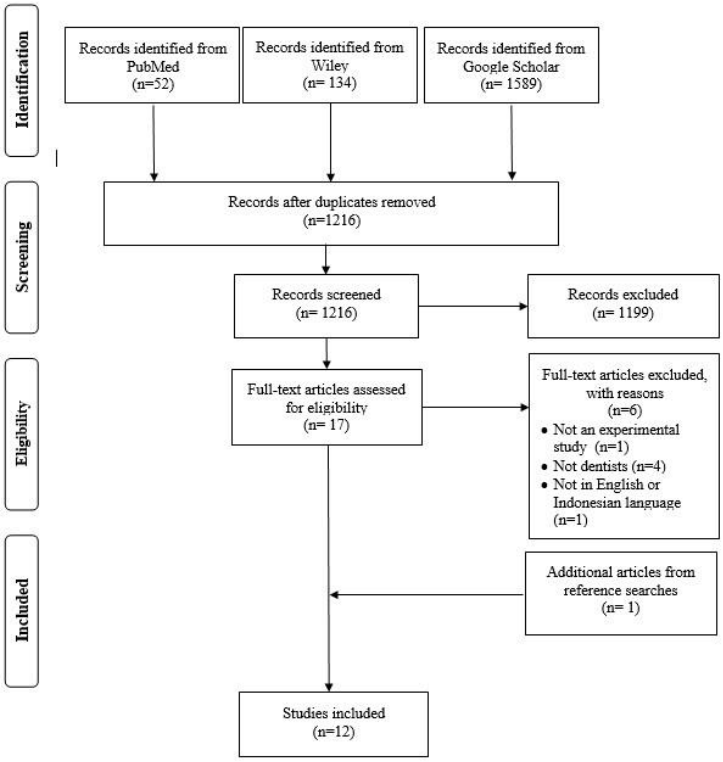

Figure 1. PRISMA-ScR flow diagram

Table 1. Summary of ergonomic interventions studies to prevent LBP among dentists

No.	Author(s) and Year	Study Design	Country (Region)	Participants	Intervention and Control	Diagnostic and Evaluation Methods	Results
				Work Environment			
1	Aghilinejad et al.[19] (2016)	Quasi experi-mental	Tehran-Iran	Dentists (n=75)	Dental loupes	Nordic Musculoskeletal Questionnaire and Corlett and Bishop Scale	There was a significant reduction in discomfort in the neck, shoulders, back, elbows and forearms
2	De Bruyne et al.[20] (2016)	True experi-mental	Derby-England-UK	Dentists (n=15) and dental students (n=10)	Comparison of 3 dental stool designs: standard stool, saddle stool, and Ghopec (Gaining Height on Professional Ergonomic Chair) stool.	Electromyography and strain gauge	The Ghopec stool is the best stool design.
				Organizational			
3	Blanc et al.[21] (2014)	Pre-post study	Toulouse-France	Dentists (n=6)	Comparing of 3 work concepts: dental chair equipped with a cart, over-the-patient delivery system without an assistant, and Dr. Daryl Beach's concept with the help of an assistant.	Electromyography and goniometer during *scaling*	Concept of Dr. Beach's with an assistant reduces lumbar muscle tension compared to other concepts.
				Individual			
4	Deolia et al.[22] (2017)	Pre-post study	Wardha Maharashtra-India	Dental interns (n=120)	Yoga	Questionnaire	After yoga, 44.3% of participants almost never experienced LBP and stress.

5	Shrivastava et al.[23] (2018)	True experimental	Haryana-India	Dentists (n=30)	Group A (n=15): Hamstring stretch with pelvic control Group B (n=15): Hamstring stretch in supine position	Straight Leg Raise test, Numeric Pain Rating Scale to assess pain, Oswestry Disability Index, and Work Ability Index.	In group A, the intervention of hamstring stretching with pelvic control showed better results.
6	Aras D et al.[24] (2018)	Quasi experimental	Makassar-Indonesia	Dentists who experienced myogenic LBP (n=15)	Mc. Kenzie exercise	Physical examination	Mc. Kenzie exercise significantly reduces the intensity of myogenic LBP pain.
7	Cosoroaba et al.[25] (2019)	True experimental	Romania	Dentists (n=4)	Stretching exercises	Thermal Imaging Camera. (TIC) on the participants' bodies (the lumbar, cervical, and right arm areas)	Stretching exercises had an effect in decreasing participants' body surfaces temperature which indicates that muscle tension in lumbar, cervical, and arm regions is reduced, preventing the occurrence of MSDs.
8	Partido et al.[26] (2019)	True experimental	Ohi-USA	Dental educators (n=31)	Self-assessment of working posture with photos and feedback from researchers to correct posture errors.	Comparison of ergonomic scores, self-assessment with the Modified-Dental Operator Posture Assessment Instrument (M-DOPAI)	Self-assessment and feedback involving photos showed improvements in participants' ergonomic scores.
9	Aliakbari et al.[27] (2019)	Quasi experimental	Bojnourd-Iran	Dentists (n=63)	Educational interventions through digital media	Standard Nordic Questionnaire and Rapid Upper Limb Assessment (RULA)	Educational interventions using digital media were only effective for increasing knowledge

							of ergonomics but not for changing participants' behaviour.
10	Partido et al.[28] (2021)	True experi-mental	Ohio-USA	Dentists and dental hygienists (n=50)	Self-assessment of working posture with photos and feedback from researchers to correct posture errors.	Comparison of ergonomic scores, self-assessment with M-DOPAI	Self-assessment and feedback involving photos showed significant improvement in ergonomic scores in the intervention group
2 Domains (Work Environment and Individual)							
11	Dehghan et al.[29] (2016)	True experi-mental	Tehran-Iran	Dentists (n=102)	Various ergonomic intervention programs (education, modification of work environment, training and improvement of work posture, and regular exercise program)	NMQ	The prevalence of MSDs on the neck, shoulders, arms, wrists, back, thighs, knees, and legs decreased after intervention.
12	López-Nicolás et al.[30] (2019)	True experi-mental	Murcia-Spain	Dentists (n=36)	Day 1: Received education about ergonomics Day 2: All participants took part, first without any ergonomic tools (conventional dental stool), then using 3 different ergonomic tools (ergonomic stool, dental loupes, and ergonomic stool & dental loupes) with a 15 minutes rest between each procedure.	Electromyography to record *m. trapezius* and *m. erector spinae* activities	The use of dental loupes was effective in reducing *m. trapezius* and *m. erector spinae* However, the opposite effect occurred with the use of ergonomic stools only and ergonomic stools & dental loupes. Muscle activities increased in almost all procedures performed.

4. Discussions

Ergonomic intervention in dentistry related to the work environment could take the form of modifying the dentist's work area or training in ergonomic tools. Intervention using dental loupes with 3.5x magnification in 75 male dentists aimed to determine when there would be any changes in MSD symptoms. The results of ergonomic intervention with dental loupes have a positive effect in reducing discomfort intensity in the back area. [19] In addition, the dentists also agreed that the use of loupes improved their posture and increased ease of work. The results of this study were supported by a study in Australia with dental hygienists as participants, which showed that 75% of participants who used dental loupes experienced an increase in their quality of work. [31]

These interventions with three dental stool designs (standard, saddle, and Ghopec stool) aimed to evaluate muscle activity and lumbar posture. Individuals with LBP within the past two years who underwent vertebral column surgery or were on pain medication were not included in this study. The results indicated that the participants' sitting postures on the Ghopec stool were closest to the lumbar neutral curve, while the postures on the standard stool were slightly flexed. In addition, using a saddle stool caused the participants' body postures to become hyperlordotic. [20]

Interventions aimed at organizational factors were performed to observe differences in muscle tension and body movements in daily dental practices. Different work concepts, such as using a dental chair equipped with a cart, an over-the-patient delivery system without an assistant, or Dr. Daryl Beach's concept with the help of an assistant, were applied. According to Dr. Beach's ergonomic concept, dentists maintained a neutral posture and adjusted the position of the patient's head in the desired position. Meanwhile, the assistant assisted the dentist during the procedure by providing the necessary instruments. The results of this study indicated that those who worked with Dr. Beach's concept had lower lumbar muscle tension. [21]

In the individual domain, ergonomic interventions included physical and psychosocial aspects, such as improving body posture, stretching, exercising, providing education, and reducing stress levels. Stretching, yoga, and McKenzie exercises were found in this scoping review.[22-25] However, yoga could overcome the physical and psychosocial problems of dentists. The study showed that 94.3% of participants were diagnosed with LBP (21.4% often experienced LBP, 40% quite often, and 32.9% sometimes). After performing yoga for a month, 44.3% seldom experienced LBP, and there was a decrease in stress levels.[22] In dentists who have experienced LBP, ergonomic intervention of hamstring stretching could reduce pain significantly. In this study, participants were divided into two groups: hamstring stretching with pelvic control and hamstring stretching in the supine position group. The reduction in pain and the increase in participants' workability were better in hamstring stretching with the pelvic control group than in the supine position group.[23] Furthermore, LBP could be caused by a lack of extensibility of the hamstring muscles, which limited movement during flexion, causing the pelvis to be more posterior and reducing lumbar lordosis.[32]

A study in Indonesia showed that McKenzie exercise significantly reduced pain intensity in dentists with myogenic LBP.[24] Another intervention was periodic stretching exercises that were evaluated using a thermal imaging camera.[25] This camera could show a decrease in surface temperature in the lumbar region. The study concluded that stretching was an effective preventive measure to avoid MSDs due to improper work posture. Previous studies proved that thermal imaging cameras could be a non-invasive diagnostic and evaluation method for MSDs.[33]

Ergonomic posture self-assessment using photos also revealed an improvement in participants' ergonomic scores because there was a role for study teams in providing feedback to correct posture errors. All participants agreed that understanding and proper application of ergonomics were important for dentists. [26,28] Furthermore, educational interventions were carried out using social or digital media in the form of messages and articles about MSDs to participants every day for a month, during which participants could also share their knowledge and experiences. After three months of intervention, it was found that the intervention using digital media was only effective in increasing knowledge but not changing participant behavior.[27]

Contrary to previous studies, two articles conducted more than one intervention in different domains. [29,30] First, a study in Tehran, Iran, used ergonomics education, work environment modification, and work posture improvement. The results had a positive effect in reducing the prevalence of MSDs in dentists. At 3 and 6 months of evaluation, the prevalence of MSDs in the intervention group was reduced. [29] Second, a study in Murcia, Spain, observed the effect of educational interventions, loupes, and ergonomic dental stools on dentist muscle activity during the composite restoration of posterior teeth. [29,30] The results showed that the use of dental loupes had a positive effect in reducing muscle activity. However, using an ergonomic chair alone or a combination of dental loupes and an ergonomic stool increased muscle activity. This contradicted the results of previous studies, stating that different dental stool designs could cause this contradiction.

This scoping review described several studies of ergonomic interventions to prevent LBP in dentists from 2011 to 2021. However, there were significant updates in information and technological developments during that period. The limitation of this scoping review was that the search for articles was only limited to the PubMed, Wiley, and Google Scholar databases. This search limitation suggested that some articles indexed were not considered in the article selection. In addition, it was difficult to conduct comparative studies in this scoping review due to significant variations in participants, duration of work, interventions, implementation, and evaluation methods.

5. Conclusion

In conclusion, ergonomic interventions significantly prevented LBP among dentists based on a review of 12 study articles. Common interventions used by the study teams were muscle stretching, regular exercise, and ergonomic tools. Furthermore, participants stated that there were positive changes in body posture, reduced pain due to LBP, and improved work quality after receiving ergonomic intervention.

6. Conflicts of Interest:

The authors declare no conflicts of interest.

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