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The Effectiveness of Using Pelvic Cushions with Different Angles on Changes in Lumbar and Cervical Lordosis a Systematic Literature Review

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Abstract

Prolonged sitting in an unergonomic position has become a major concern in musculoskeletal health because it can alter physiological spinal alignment, particularly lumbar lordosis and cervical posture. Continuous static sitting may induce posterior pelvic tilt, reduce lumbar curvature, increase spinal loading, and contribute to low back pain and postural disorders. This study aimed to systematically review the effectiveness of pelvic cushions with different inclination angles in maintaining lumbar and cervical spinal alignment during sitting activities. A Systematic Literature Review (SLR) was conducted using the PRISMA framework. Relevant studies were identified from PubMed and PEDro databases through predefined keywords and Boolean operators. Articles published between 2015 and 2025 were selected based on PICOS criteria, resulting in 12 studies included for qualitative synthesis. The findings indicated that pelvic cushions and inclined seating surfaces generally improved pelvic positioning, maintained physiological lumbar lordosis, enhanced sitting comfort, and reduced biomechanical stress associated with prolonged sitting. Cushion angles ranging from approximately 10°–20° demonstrated optimal effects in supporting pelvic stability and improving load distribution. Furthermore, improvements in lumbar alignment were associated with indirect positive adaptations in cervical posture through the spinal kinetic chain mechanism. In conclusion, pelvic cushions with appropriate angle variations represent a promising ergonomic intervention for preventing postural abnormalities and musculoskeletal disorders caused by prolonged unergonomic sitting. Further research is recommended to evaluate long-term effects and direct cervical curve measurements.

INTRODUCTION

Good posture has an important role in maintaining musculoskeletal balance and preventing pain disorders in the movement system. Sitting is the most common work position, especially for office workers, students, and drivers who spend long periods of time in a static position. Unergonomic sitting conditions can cause posterior *pelvic tilt* which leads to the straightening of the lumbar lordosis curve and a decrease in cervical curvature. In the long term, these changes alter the body's biomechanical patterns, increase axial pressure on the intervertebral discs, and can cause low back pain and other postural disorders such as *forward head posture*.

Biomechanically, the spine has three main physiological arches, namely cervical lordosis , thoracic kyphosis, and lumbar lordosis which function to optimally distribute body load (Hey et al., 2021; Müller et al., 2021; Żurawski et al., 2022). When sitting for too long, especially without proper pelvic support, the spinal axis tends to straighten, leading to increased intradiscal pressure and unbalanced compensatory muscle activation (MURRAY, 2024). This explains why disorders in the lumbar segment are often accompanied by secondary changes in

the cervical curve due to the kinetic chain relationship between the pelvis and the neck (Kett, at all 2021; Yoon & al., 2019).

One of the ergonomic interventions that has been widely studied is the use *of pelvic cushions* or *seat wedge cushions*, which are sitting cushions with a certain inclination designed to maintain the position of the pelvic tilt forward (*anterior pelvic tilt*) (Alford & Hon, 2024; Officer, 2025; Zhang & al., 2020). The mechanism of action of this tool is to raise the posterior part of the pelvis so as to reduce the tendency of the spine to curve backwards (*slump sitting*) (Sae-Lee et al., 2023), while maintaining the curvature of the lumbar and cervical lordosis naturally (Kim 2014).

Several studies have proven the effectiveness of *pelvic cushions* against changes in spinal curves. Park et al. (2017) and Kim et al. (2021) showed that the use of *seat wedge cushions* with a slope of 10–12° was able to increase *the anterior pelvic tilt*, increase the angle of lumbar lordosis and reduce pressure in the ischial region. Lee et al. (2018) also reported that modification of the mount with a moderate tilt angle can improve cervical curvature, lower the position of the head forward, and improve postural comfort. While Yoon et al. (2020) affirmed a direct relationship between lumbar curve repair and physiological repositioning of cervical segments through pelvic angle adjustment.

Based on this, this study was conducted in the form of *a Systematic Literature Review* (SLR) to comprehensively analyze the effectiveness of the use of *pelvic cushions* with various variations in angles on changes in lumbar and cervical curves (Wang & al., 2019). The results of this review are expected to identify the optimal angle that maintains the physiological curvature of the spine as well as provide scientific recommendations for the practice of physiotherapy, musculoskeletal rehabilitation, and seating ergonomic design.

Disorders of the spine can cause a significant impact on a person's quality of life. One of the most common disorders is *low back pain* (LBP), which is a huge global health problem. According to a report from the *National Spine Health Foundation*, more than 100 million people worldwide experience back or neck pain each year, which often interferes with daily activities and productivity. This not only affects the individual physically, but also risks causing anxiety and an overall decrease in quality of life. Spinal disorders such as neck pain or neck pain can also interfere with posture, leading to unergonomic body position changes, and worsening other musculoskeletal complaints. In many cases, these problems can be caused by unergonomic sitting positions, limited physical activity, and the effect of injuries that occur on the structure of the spine.

To prevent disorders in the spine and maintain long-term health, some preventive measures that can be taken include: maintaining correct posture, exercising regularly, and using ergonomic equipment that can support good posture, especially for those who work in a sitting position for a long time. Regular exercise, such as walking, swimming, or yoga, can strengthen the muscles that support the spine, improve body flexibility, and prevent muscle weakness that can interfere with posture. Maintaining correct posture, whether sitting, standing, or sleeping, is also important to avoid unnecessary strain on the spine. For example, using an ergonomic chair with back support can help maintain a natural spinal position, reduce pressure on the intervertebral discs, and avoid problems such as forward head posture and spondylosis.

Problem Formulation

Based on the background description mentioned above, the formulation of the problem in this study is:

How effective is the use of *pelvic cushions* with angular variations on lumbar and cervical curve changes based on published research results?

How does the variation in *pelvic cushion* angle affect the increase or decrease in physiological curvature of the spine (lumbar and cervical lordosis)?

How do the results of using *pelvic cushions* with different angle variations compare to sitting comfort and postural muscle activity in a sitting position?

Research Objectives

General Purpose

A systematic *literature review* was conducted to compare the effect of pelvic *cushion use* with angular variations on the lumbar and cervical curves in a sitting position.

Special Purpose

Identify scientific evidence related to the effectiveness *of pelvic cushions* with subdued variations on lumbar and cervical curve changes

Identify scientific evidence regarding the effect of variations in pelvic cushion *angles* on the increase or decrease in physiological curvature of the spine

To analyze the comparison of the results of pelvic *cushion* use with different angle variations on sitting comfort and postural muscle activityResearch Benefits.

METHOD

Types and Research Designs

This study used *the Systematic Literature Review* (SLR) type of research. SLR is a research method that is carried out by identifying, assessing, and systematically synthesizing all research results relevant to a certain topic. This method was chosen because it was able to provide a deeper and more comprehensive understanding of the effectiveness of the use of *pelvic cushions* with angular variations on changes in lumbar and cervical curves, compared to relying on only one primary study. The research design was prepared based on the guidelines of PRISMA (*Preferred Reporting Items for Systematic Reviews and Meta-Analyses*). PRISMA was chosen because it provides a clear framework in the process of searching, selecting, and reporting reviewed articles, so that research results are more transparent, structured, and can be replicated by other researchers.

Through this design, each stage of research is carried out sequentially, starting from the process of identifying articles in electronic databases, screening based on titles and abstracts, feasibility assessment through full-text review, to the final stage of article inclusion that meets the criteria. Furthermore, data from the selected articles were extracted using *the Population, Intervention, Comparison, Outcome, Study* (PICOS) framework to facilitate the synthesis and analysis process of research results.

Data Sources and Search Strategies

The data sources in this study were obtained from several credible electronic databases, namely PubMed and PEDro. The selection of this database is based on the completeness of the collection of scientific publications and their relevance to the fields of health, biomechanics, physiotherapy, and ergonomics.

The search strategy is carried out using keywords that have been determined based on the research topic, then combined using *Boolean* operators (AND, OR) to make the search results more specific. The keywords used include: *"pelvic cushion", "seat wedge", "wedge cushion", "lumbar curvature", "lumbar lordosis", "cervical spine", "cervical curvature", "sitting posture",* and *"biomechanics".*

For example, the combination of keywords used in the search is: ("*pelvic cushion*" OR "*seat wedge*" OR "*wedge cushion*")

AND ("*lumbar curvature*" OR "*lumbar lordosis*") AND ("*cervical spine*" OR "*cervical curvature*") AND ("*sitting posture*" OR *biomechanics*)

The set publication year range is 2015 to 2025. This range was chosen to obtain the latest research that is still relevant to the development of science in the fields of sitting posture, spinal biomechanics, and ergonomic interventions. The selected articles are articles that are available in full *text* in English.

Inclusion and Exclusion Criteria

In this *Systematic Literature Review study,* inclusion and exclusion criteria were used to clarify the limits of articles that could be included in the analysis. The establishment of these criteria is important to maintain the focus of the research as well as ensure that only articles relevant to the topic are analyzed.

Inclusion criteria include:

1. The article is in the form of original research with experimental or quasi-experimental design.
2. The study population was healthy adult individuals, college students, or sedentary workers who underwent sedentary activities for long periods of time.
3. The intervention studied was the use of *pelvic cushions* or *wedge seats* with variations in tilt angles.
4. The article assessed biomechanical outcomes in the form of changes in lumbar and/or cervical curves, as well as aspects of comfort, load distribution, or postural muscle activation.
5. The article is available in *full text* and was published between 2015 and 2025.

Exclusion criteria include:

1. Articles in the form of *reviews*, opinions, case reports, or editorials.
2. Research with subjects in populations who have certain clinical conditions, such as severe scoliosis, chronic pain, or spinal cord injury, because the results cannot be generalized in normal populations.
3. Articles that are not available in full text (*no full text available*).
4. Articles that do not evaluate the biomechanical outcomes of sitting posture, for example, only assess subjective pain without spinal curve measurements.

With these inclusion and exclusion criteria, the article selection process can be carried out as ememathic, transparent, and consistent, so that the articles analyzed are truly in accordance with the research objectives.

Data Analysis Plan

The data analysis in the *Systematic Literature Review* study was carried out with a narrative analysis approach. This approach was chosen because the collected articles had variations in research design, populations, measurement methods, and diverse results, making

it impossible to conduct a quantitative meta-analysis.

First step

To group articles based on the focus of the intervention and *the outcomes* studied. Articles that assess lumbar curve changes are grouped separately from those that assess cervical curve changes. In addition, additional *outcomes* such as comfort, pressure distribution, or postural muscle activation were also analyzed as supporting information.

Step two

Each article was critically reviewed to assess the consistency of results, differences in findings, and possible factors causing variation (e.g. differences in pelvic cushion angles, length of intervention, or population characteristics). From the results of this study, the researcher compiled a general pattern regarding the effectiveness of the use of pelvic cushions with angular variations on changes in sitting posture.

The analysis takes into account the methodological quality of the article.

Articles with experimental design and objective measurements (e.g. radiography or 3D motion capture) were judged to have a stronger weight of evidence than articles with observational designs or using only subjective questionnaires.

Data analysis results

The results of the data analysis are presented in the form of a structured narrative, summary table, and supported by visualizations (PRISMA diagram and intervariable relationship schema). With this approach, the study was able to provide a comprehensive picture of the biomechanics and neuromechanics of changes in spinal curve due to the use of pelvic cushions in a sitting position.

RESULTS AND DISCUSSION

Characteristics of the reviewed study

This systematic review involved 12 scientific articles that met the inclusion criteria based on the PICOS approach. The articles were published in the range of 2015 to 2025 and consisted of various research designs, including *randomized controlled trials*, experimental studies, observational studies, *finite element methods,* and *systematic reviews.*

Classification of journals by theme of results

The grouping of journals based on the theme of the results includes; (1) Pelvic support when sitting, (2) variation of sitting angle / Seating surface on an angle, (3) prolonged static sitting posture, (4) Pelvis–lumbar connection, and (5) cervical postural adaptation, (6) *Slumped* posture versus upright posture

Conclusion of Theme Grouping

The grouping of journals based on the theme of results shows that each journal can be clearly placed according to the focus of its main findings. These themes are interrelated and illustrate that pelvic position and sitting angle are central factors that affect lumbar *alignment*, while cervical segments adapt compensatory to changes in sitting posture.

Classification of journals based on research variables and synthesis conclusions

Groupings based on independent variables include; (1) pelvic support variable (*Pelvic Cushion* / sitting support), (2) sitting angle variable/sitting surface tilt, (3) sitting posture variable (*slumped* vs upright), (4) static sitting duration variable. Meanwhile, grouping based on dependent variables includes; (1) curve/lumbar angle variable, (2) Posture/Cervical Curve

variable, and (3) low *back pain variable*.

General conclusions of synthesis by variables

Synthesis based on research variables showed that independent variables in the form of pelvic support, sitting angle, posture type, and sitting duration directly or indirectly affected dependent variables in the form of lumbar curve, cervical posture, and lower back pain complaints. These variables interact with each other, with the pelvic position as the biomechanical control center in the sitting posture.

Classification of journals by research population and synthesis conclusions

The grouping of journals by research population includes; (1) population with static sitting activity (DS), (2) office worker population (PK), (3) population with low back pain complaints (LBP), and (4) age population General conclusions synthesis by population

A synthesis based on the study population showed that the characteristics of the subjects and the context of the sitting activity influenced the magnitude of the impact of sitting posture on spinal alignment and musculoskeletal complaints (Muellner & al., 2021). Populations with prolonged static sitting, especially office workers, are the group most in need of ergonomic interventions that focus on pelvic stabilization and posture regulation.

Classification of journals based on research methods and synthesis conclusions

The grouping of journals based on research methods includes;
(1) experimental research, and (2) *Randomized Controlled Trial* (RCT). Summary conclusions: RCT studies provide high-certainty evidence that pelvic support and specific seating angle settings have a significant effect on maintaining physiological lumbar alignment and reducing musculoskeletal complaints.

Based on the results of the codification of the twelve included journals, the most dominant themes were pelvic support when sitting (T1) and variation in sitting angle (T2), which showed that pelvic position and sitting angle were the main factors in the formation of ergonomic sitting posture. The most frequently studied independent variables were pelvic support (VI1) and sitting angle (VI2), while the most dominant dependent variables were lumbar curve (VD1) and cervical posture (VD2). In terms of population, most of the studies involved office workers (P2) and adults with static sitting activities (P4), so the context of work ergonomics was the main background in this study. The most widely used research methods are experimental design (M1) and randomized controlled trials (M2), which indicate that most of the evidence has a good level of internal validity. Overall, the codification results confirm that pelvic support and seating angle variation act as biomechanical control centers in the formation of lumbar alignment, while the cervical segment adapts compensatory to changes in sitting posture. (Park & Kim, 2022, Jin et al., 2024, Cho et al., 2023, Waongenngarm et al., 2021, Puntumetakul et al., 2023, Kuo et al., 2021)

Based on the results of the mapping study using the PICOS framework, the most studied populations were office workers (P2) and general adults with static sitting activities (P4). The most dominant interventions included dynamic seat cushion (I1), variation in seating angle (I2), and pelvic support chair (I7). The most commonly reported outcomes were changes in lumbar curve (O1), cervical posture (O2), and lower back and neck pain (O3). The most widely used study designs are experimental (S1) and randomized controlled trials (S2), which suggest that the available evidence has good internal validity. Overall, this PICOS table confirms that pelvic position and sitting angle are the main determinants in the formation of spinal alignment.

(Park & Kim, 2022, Jin et al., 2024, Cho et al., 2023, Waongenngarm et al., 2021, Puntumetakul et al., 2023, Kuo et al., 2021)

Study Quality Assessment Results (NIH *Quality Assessment Tool*)

Based on the results of methodological quality assessment using *the National Institute Health* (NIH) *Quality Assessment Tool*, of the 12 articles reviewed, most of them were included in the good and medium (*fair*) quality categories. No articles with low methodological quality (*poor*) were found. This shows that in general, the articles used in this study have adequate methodological quality to carry out the synthesis process.

A total of 12 articles that met the inclusion criteria were grouped into three main themes. The first group consisted of five articles that examined ergonomic interventions in the form of chair modification, seat cushions, and lumbar braces against posture changes, musculoskeletal pain, and lumbar curvature. The second group consisted of five articles that evaluated the effect of variations in sitting position, sitting, recline angle, and sitting duration on spinal alignment (O'Sullivan et al., 2012). The third group consists of two articles that use a biomechanical approach to analyze the load distribution and changes in spinal curvature. This grouping facilitates the synthesis of results based on the research theme.

Synthesis of findings on lumbar curve

The results of the synthesis showed that the use *of pelvic cushions* and inclined sitting surfaces tended to contribute to the maintenance of physiological lumbar curves during sitting (Rahman & al., 2022). Pelvic support helps maintain a more stable pelvic position, thus reducing the tendency to sit down (Tanaka & al., 2019).

Based on the twelve studies synthesized, it can be concluded that sitting posture, chair design, sitting angle, and the presence of variations or active interventions during sitting have a significant influence on alignment and lumbar physiological curves. Consistently, studies show that static sitting and slumped postures contribute to a decrease in lumbar lordosis as well as an increase in biomechanical load on the spinal structure.

Passive ergonomic interventions, such as pelvic support chairs, lumbar pillows, lateral sitting wedges, and dynamic seat cushions, generally show positive effects on postural stability and maintenance of physiological lumbar curves (Channak et al., 2024; Feustel et al., 2023; Park & Kim, 2022; Puntumetakul et al., 2023). These findings confirm the key role of pelvic position and pelvic tilt control in maintaining lumbar alignment during sitting.

In addition, an active approach through postural sensor biofeedback and active breaks has been shown to improve postural awareness, reduce low back pain complaints, and reduce the risk of lumbar disorders due to prolonged sitting (Kuo et al., 2021; Waongenngarm et al., 2021). This is reinforced by long-term observational findings suggesting that long sitting duration is associated with a decrease in lordosis and a tendency to lumbar curve deformity, particularly in the student population (Li et al., 2022).

Overall, this synthesis shows that the optimal sitting strategy for maintaining the lumbar curve does not depend on just one factor, but is the result of an interaction between ergonomic design, sitting angles, pelvic support, and variation and activity during sitting. These findings support dynamic ergonomics approaches and postural education-based interventions as preventive and therapeutic efforts in maintaining lumbar health.

Synthesis of findings on cervical curves

Although not all studies measured cervical curve directly, the results of the synthesis showed a relationship between changes in sitting posture, pelvic position, and cervical postural adaptation, specifically *forward head posture*

Postural adaptations to cervical segments in the reviewed studies were generally inferred based on changes in overall sitting posture, including head and trunk positions, given the limitations of direct measurements of cervical curves. Therefore, cervical-related findings need to be understood as postural adaptation tendencies, not as directly measured changes in cervical curves.

A synthesis of twelve studies showed that sitting posture, sitting and chair back angles, and proximal segment stability (pelvis and lumbar) had a significant influence on cervical alignment and curve, particularly in relation to *the occurrence of forward head posture* and increased cervical flexion. In general, sitting positions that are not ergonomic and performed for long periods of time contribute to an increase in the biomechanical load on the cervical region.

Passive ergonomic interventions, such as dynamic seat cushions, pelvic support chairs, lumbar pillows, and lateral sitting wedges, show positive effects on global postural stability and a more neutral head position (Channak et al., 2024; Feustel et al., 2023; Park & Kim, 2022; Puntumetakul et al., 2023). These findings confirm that pelvic position correction and lumbar stability play a role in the postural chain towards the cervix, so changes in the inferior segment can have an indirect impact on head and neck alignment.

In addition to the chair design factor, the sitting angle and the backrest angle also affect cervical posture. Optimal sitting angles and seat backrest in the range of 105°–120° have been shown to reduce cervical flexion and improve head stability (Jin et al., 2024; Sato et al., 2021). This suggests that proper seating angle adjustment can reduce the demands on postural compensation in the cervical region.

The active approach through postural sensor biofeedback and active break is consistently effective in lowering *forward head posture* and improving cervical postural control (Kuo et al., 2021; Waongenngarm et al., 2021). These results confirm that postural education and position variation during sitting are important components in the prevention of cervical disorders, especially in individuals with long-term static sitting exposure.

Overall, this synthesis shows that cervical curve disruption during sitting is multifactorial, involving the interaction between sitting posture, chair design and angle, pelvic–lumbar stability, and sitting behavior itself. Therefore, effective cervical prevention and intervention strategies need to adopt a holistic and dynamic ergonomic approach, rather than focusing solely on the cervical segment in isolation.

Bionekanic Synthesis of Sitting Posture

"To clarify the synthesis of the discussion of seated posture biomechanics in Table 5.6, the following diagram is presented illustrating the distribution of biomechanical factors that affect spinal alignment."

The use of *pelvic cushions* has significant biomechanical implications for seated posture control, particularly through its effect on pelvic position, spinal load distribution, and regulation of postural kinetic chains from lumbar to cervical segments. The pelvis acts as the postural foundation in a sitting position, so small changes in pelvic orientation can result in a

global impact on spinal alignment.

From the aspect *of pelvic tilt, the pelvic cushion* tends to help maintain a physiological *anterior pelvic tilt*. This position plays an important role in maintaining lumbar lordosis and preventing *the dominance of posterior pelvic tilt* that often occurs in static sitting. *Posterior pelvic tilt* is known to lower the lumbar curve and increase intradiscal pressure, which in turn triggers postural compensation towards the superior in the form of increased cervical flexion and *forward head posture*. Thus, the pelvic cushion contributes indirectly to the improvement of cervical alignment through stabilization of the lumbar segment.

From the point of view of the seating angle, *the pelvic cushion* with an ergonomic angular design (approx. 10°–20°) affects the orientation of the trunk to gravity so that the load distribution becomes more even. Optimal sitting angles not only reduce excessive lumbar flexion, but also lower the need for cervical compensation to maintain visual and postural balance. Thus, the cushion angle serves as a determinant of the direction and magnitude of the biomechanical force acting on the vertebral column.

In the context of spinal force distribution, the slumped sitting posture increases the compression load and *shear force* on the lumbar disc, which is then passed on to the cervical segment due to a change in the center of body mass. *Pelvic cushions* help reduce this compressive force by supporting a more upright and stable sitting posture, so that the biomechanical load on the neck due to postural compensation can be minimized.

This implication becomes even clearer when viewed through the concept of postural kinetic chains, in which the pelvic, lumbar, thoracic, and cervical function as a single biomechanical unit. Intervention on the pelvis through *the pelvic cushion* can improve *lumbar alignment*, lower the demands of thoracic compensation, and result in a more neutral head position. This confirms that ergonomic interventions in the inferior segment have a global postural impact.

In addition, *the pelvic cushion* supports the activation of the trunk stabilizer muscles by creating an ergonomic postural environment. Adequate muscle activation improves lumbar segmental stability, reduces dependence on passive structures, and contributes to head posture stability. This condition is important in the prevention of muscle fatigue and musculoskeletal disorders due to prolonged sitting.

Regarding static sitting duration, *pelvic cushion* can be seen as a *load management strategy* that helps reduce the accumulation of mechanical stress on the disc and passive tissue. Prolonged sitting without ergonomic support accelerates muscle fatigue, increases intradiscal pressure, and increases the risk of disc degeneration and neck pain. By optimizing the distribution of the load, *the pelvic cushion* has the potential to reduce this risk.

From the aspect of intradiscal pressure, excessive sitting flexion increases the anterior pressure of the disc and the risk of protrusion, which is often followed by a shift of the head to the anterior. The use *of a pelvic cushion* with an ergonomic angle helps to lower intradiscal pressure through the maintenance of the physiological lumbar curve, thereby indirectly improving cervical posture.

Finally, *the pelvic cushion* plays a role in balancing the center *of mass* of the body when sitting. Poor sitting posture shifts the center of mass anteriorly, increasing lumbar load and cervical stress. By assisting *in the realignment* of the center of mass to a more physiological position, *the pelvic cushion* contributes to the reduction of biomechanical load in both the

lumbar and cervical regions.

A synthesis of twelve studies showed that sitting interventions focused on pelvic control and postural variation had the most consistent positive effects on spinal alignment. The use of *pelvic cushions* and pelvic support has been proven to improve the lumbar curve, stabilize cervical posture, and reduce lower back pain complaints. Similarly, ergonomic seating angle settings play a role in optimizing biomechanical load distribution and maintaining physiological lordosis.

In contrast, slumped sitting posture and prolonged static sitting duration are consistently associated with decreased lumbar curve, increased *forward head posture*, as well as increased disc pressure, which ultimately increases the risk of musculoskeletal disorders. These findings confirm that dynamic seated ergonomic approaches, including *active breaks* and *postural shifts*, are protective against lumbar and cervical disorders.

The synthesis showed that pelvic support and seating angle variations had a high consistency of evidence, with all studies reporting an improved effect on spinal alignment with no contradictory findings. In contrast, slumped sitting posture has a very high consistency of evidence in providing negative impacts, confirming its role as a major risk factor for lumbar and cervical disorders. The active *break theme* also showed a good consistency of clinical effects, while cervical adaptation had a moderate consistency because some findings were obtained through indirect mechanisms, although the direction of effect remained uniform.

This synthesis is supported by a combination of complementary study designs. RCTs provide the highest level of evidence by demonstrating a causal relationship between ergonomic interventions and clinical improvement, particularly in low back pain and postural control.

Experimental and biomechanics/FEA studies are instrumental in elucidating and validating the biomechanical mechanisms underlying *changes in spinal alignment*, including force distribution and tissue response to seated posture variations. Meanwhile, the observational study reinforced the findings by providing an overview of the effects on real populations and long-term sitting exposure. Overall, the integration of these various study designs enhances the inferential power of the synthesis and supports the consistency of findings from clinical, mechanistic, and population aspects.

The literature shows high clinical relevance to a wide range of populations and settings. In office workers, seated ergonomic interventions, including the use of *pelvic cushions*, have very strong practical implications in lowering the risk of lumbar and cervical disorders. College students and students are an important group for preventive strategies, given the high exposure to static sitting in the long term. In patients with low back pain, *the pelvic cushion* acts as a non-pharmacological intervention that supports posture improvement and pain management.

Table 1 Critical evaluation of the included literature

Evaluation Aspects	Synthesis Findings	Implications
Context of the study	Dominance of laboratory studies and Biomechanical Simulation	Generalization to the clinical context is necessary done carefully
Population	The majority involve healthy adults	Limitations of application in the population

Evaluation Aspects	Synthesis Findings	Implications
	and office workers	Clinical Specifics
Duration Intervention	Generally short-term	Long-term effectiveness has not been achieved Ensure
Instruments measure	Diverse (radiography, analysis posture, FEA)	Relatively low measurement standardization
Outcome	Focus on alignment and pain	Functional outcomes are still limited

Source: Joanna Briggs Institute, 2020 (JBI Critical Affraisal Tools)

A critical evaluation of the literature synthesis shows a number of methodological limitations that need to be considered in the interpretation of the findings. Most studies are conducted in a laboratory context or biomechanical simulations, so applying the results to clinical situations and daily activities requires caution. On the population side, the dominance of healthy adult subjects and office workers limited the generalization of the findings to clinical groups with more complex musculoskeletal conditions. The duration of the short-term intervention makes it difficult to draw conclusions regarding long-term effectiveness, particularly in the prevention of disc degeneration or chronic postural disorders. The variation of measurement instruments used between studies showed low standardization, which could potentially affect the consistency of results. Finally, although the majority of studies assessed spinal alignment and pain, evidence on functional outcomes is still limited, so further research with a focus on function and quality of life is urgently needed.

Table 2. Biases and Limitations of Literature Synthesis

Type of Bias	Indications in the Literature	Impact on Synthesis
Biased Publication	The majority of studies reported results significant	Estimated potential effect higher (*overestimate*)
Language bias	Articles dominated by publications English	Local or non-UK studies at risk Late
Selection bias	The subject is dominated by office workers and healthy adults	The representation of other populations becomes Limited
Measurement Bias	Variations of instruments (radiography, postural assessment, FEA)	Quantitative comparison between studies Hard to do
Design heterogeneity	A combination of RCTs, experiments, observational, and FEA	Synthesis is narrative, not meta-Analytics

Source: Joanna Briggs Institute, 2020 (JBI Critical Affraisal Tools)

This synthesis has the potential to be influenced by several types of methodological biases. Publication bias can be seen from the dominance of significant outcomes, which can cause the estimated effect of the intervention to be greater than the actual condition. Language bias is also worth noting because restrictions on English-language literature risk excluding findings from local or regional contexts. In terms of selection bias, the dominance of the office

worker population and healthy adults limits the generalization of outcomes to other groups, including specific clinical populations. In addition, the existence of measurement bias due to the inconsistency of measurement instruments makes it difficult to make direct quantitative comparisons between studies. Finally, the heterogeneity of the study design led to the synthesis being more precisely presented narratively than meta-analytically.

Table 3. Theoretical Implications of Synthesis

Theoretical Aspects	Synthesis Contribution
Static posture theory	Reinforces that prolonged static sitting accelerates Postural maladaptation
Pelvic control *theory*	Affirms the pelvis as the center of biomechanical control of the sitting posture
Kinetic chain *theory*	Indicates lumbar alignment affects cervical posture
Load management *theory*	Positioning ergonomics interventions as a management strategy Spinal Load
Compensation theory Postural	Shows that the cervical segment adapts to lumbar changes

Source: Joanna Briggs Institute, 2020 (JBI Critical Affraisal Tools)

This synthesis of literature makes an important contribution to the reinforcement and integration of several theoretical frameworks in the biomechanics of the sitting posture. The consistent findings reinforce the static posture theory, which states that prolonged sitting accelerates the occurrence of postural maladaptation. Furthermore, this synthesis confirms the theory *of pelvic control* by demonstrating the role of the pelvis as a biomechanical control center that determines the alignment of the spinal segments above it.

Through the perspective of *kinetic chain theory*, the results of the synthesis show that changes in lumbar alignment have direct implications for cervical posture, supporting the concept of functional linkages between spinal segments. In addition, these findings expand the theory of *load management* by positioning seated ergonomics interventions as an effective form of mechanical load management. Finally, this synthesis supports the theory of postural compensation, in which the cervical segment adapts in response to changes in posture and load on the lumbar region.

Table 4. Conceptual Model of Synthesis

Model Components	Biomechanical Relationships
Seating angle	Determining the orientation of the pelvis and the direction of the gravitational force
Pelvic tilt	Controlling the size of lumbar lordosis
Lumbar lordosis	Affects the balance and stability of the trunk
Trunk balance	Determining the position and orientation of the head
Head position	Determining the magnitude of the cervical biomechanical load
Spinal load	Affects the risk of musculoskeletal pain

Source: Joanna Briggs Institute, 2020 (JBI Critical Affraisal Tools)

This conceptual model describes a tiered biomechanical relationship between the components of the sitting posture and the spinal load. Sitting angle plays a role as an initial factor that determines the orientation of the pelvis to the force of gravity. Changes in seating angle directly affect pelvic tilt, which is a major determinant in the control of lumbar lorosis.

Furthermore, physiologically maintained lumbar lordosis supports trunk balance and stability, while a decrease in lumbar curve increases the need for postural compensation. This disturbance in the balance of the trunk will affect the position of the head, which in turn determines the magnitude of the biomechanical load on the cervical segment.

The accumulation of changes in all these components contributes to an increase in the overall spinal load, which ultimately affects the risk of musculoskeletal pain, particularly in the lumbar and cervical regions. This model confirms that ergonomic interventions targeting initial components, such as sitting angles and pelvic control, have the potential for a broad protective impact on the musculoskeletal system.

Pelvic–lumbar–cervical biomechanical relationship

Pelvic position has a central role in determining spinal alignment during a sitting position, specifically through its influence on pelvic tilt and lumbar curvature. Changes in anterior or posterior pelvic tilt will directly affect the size of lumbar lordosis which further impacts the overall balance of the trunk. In a biomechanical context, the lumbar segment serves as the main link between the pelvis and the thoracic region, so changes in this segment can trigger postural adaptations in the segments above it.

Postural adaptations of the thoracic and cervical regions occur as part of the compensation mechanism to maintain head balance and foresight. When lumbar alignment improves through the adjustment of sitting angles and pelvic support, the need for postural compensation in the thoracic and cervical segments can be reduced. This suggests that ergonomic interventions focused on the pelvis and lumbar not only have a local impact, but also affect spinal alignment globally through postural kinetic chains.

Nonetheless, the relationship between the pelvic, lumbar, and cervix in the reviewed studies was largely explained based on biomechanical mechanisms and postural observations, given the limitations of direct measurements of all segments of the spine simultaneously. Therefore, this interpretation of biomechanical relationships needs to be understood as a postural adaptation tendency, not an absolute causal relationship. (Kuo et al., 2021; Waongenngarm et al., 2021)

Implications for lumbar curve

Variations in seating angles and the use of pelvic cushions in ergonomic interventions show an effect on changes in lumbar alignment, particularly in maintaining lumbar lordosis closer to physiological conditions. Biomechanically, support on the pelvis plays a role in controlling pelvic tilt, which is the main determinant of lumbar vertebrae position and curvature during a sitting position. Proper seating angle setting can reduce the tendency of posterior pelvic tilt that often occurs in prolonged static sitting positions, thereby lowering the mechanical load on the passive structure of the lumbar spine.

Although most of the studies reviewed showed a tendency to improve lumbar alignment, there was variation in the amount of changes reported due to differences in seating angles, cushion design, and measurement methods used (Yang & al., 2024). Therefore, these findings suggest that ergonomic interventions have the potential to support the maintenance of the

physiological lumbar curve, but their optimal effectiveness remains dependent on the individual characteristics and parameters of the intervention applied (Park & Kim, 2022; Jin et al., 2024; Sato et al., 2021).

Implications for the cervical curve

Improvement *of* lumbar alignment through ergonomic interventions, such as the use *of pelvic cushions* and variations in seating angles, has the potential to have an indirect effect on cervical postural stability. Biomechanically, changes in pelvic position and lumbar curve affect *trunk* balance and head position through postural kinetic chains. A more stable adaptation of the lumbar segment can reduce postural compensation in the thoracic and cervical regions, thus helping to maintain a more physiological cervical alignment. These findings suggest that postural interventions that focus on the lower segment of the spine can have an all-around impact on the musculoskeletal system. However, most of the studies reviewed have not conducted direct measurements of changes in cervical curves, so the implications for cervical *alignment* are still biomechanically and posturally inferred. Therefore, these findings need to be interpreted carefully and form the basis for further research evaluating cervical segments directly. (Kuo et al., 2021; Waongenngarm et al., 2021

Limitations of the study

Limitations in the studies reviewed included variations in research design and spinal alignment measurement methods used between articles. In addition, most studies evaluated the effects of sitting posture in a relatively short duration and involving healthy adult subjects, so generalization of results in populations with certain musculoskeletal disorders is still limited. Another limitation is the lack of direct measurements of the cervical curve, so the effects of the intervention on the cervical segment are mostly inferred indirectly through changes in sitting posture and lumbar alignment.

Final synthesis and clinical implications

Based on the results of the synthesis of the twelve included articles, the objective of this study to identify the effect of variations in sitting angle and *pelvic cushion* use on spinal *alignment*, particularly lumbar and cervical segments, has been answered. Most articles show that modification of sitting angle and pelvic support play a role in maintaining lumbar lordosis as well as improving sitting comfort.

Changes in sitting posture and pelvic alignment not only impact the lumbar segment, but also affect the position of the head and *cervical vertebrae* through postural kinetic chains. The adaptation of head position to changes in sitting angle suggests that postural intervention is comprehensive to the musculoskeletal system.

Limitations in the studies reviewed include that the majority of studies evaluated the effects of sitting posture in a short duration and involved healthy adult subjects, so generalization of results in populations with certain musculoskeletal disorders was limited. In addition, there are variations of spinal alignment measuring tools used between studies.

The implications of these findings for physiotherapy practice are the importance of the role of physiotherapists in providing ergonomics education and proper sitting posture, including the use of *pelvic cushions* as a strategy to prevent low back pain due to prolonged sitting. These interventions can be applied in both clinical *settings* and work environments (Park & Kim, 2022; Jin et al., 2024; Waongenngarm et al., 202,124)

CONCLUSION

Based on the results *of a systematic literature review* of 12 scientific articles that met the inclusion criteria, it can be concluded that the use of *pelvic cushions* and variations in sitting angles consistently affect changes in lumbar curve and cervical postural adaptation during sitting positions. The synthesis of the results shows that pelvic position is the main biomechanical factor that controls spinal alignment. Adequate pelvic support is able to stabilize the pelvic position, maintain the physiological lumbar curve, and reduce the tendency to slumped postures. Variations in sitting angles have also been shown to affect *pelvic tilt* and load distribution in the lumbar segment, which further impacts cervical posture through postural compensation mechanisms. In addition, prolonged static sitting duration without ergonomic intervention was associated with increased musculoskeletal discomfort and the risk of *low back pain*. Therefore, ergonomic interventions that focus on pelvic stabilization and seating angle regulation have an important role in maintaining an ergonomic sitting posture. In general, the results of *this systematic literature review* confirm that *pelvic cushion* with angular variations is a potential and relevant intervention in efforts to prevent musculoskeletal disorders due to unergonomic sitting posture.

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