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Identifying and managing factors contributing to low back injuries in golfers

A systematized literature review

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Abstract

The sport of golf has seen a rise in popularity in recent years, especially with the time of the COVID pandemic showing significant growth in the player base. At the same time, the global burden of disability associated with low back pain has been increasing. A significant portion of golf-related injuries are related to the lumbar spine, and it is desirable to find ways to identify and manage the factors contributing to these injuries.

The objective of this thesis was to write a systematized literature review and to find methods to identify and manage the various factors that contribute to lumbar spine injuries in golfers.

This systematized literature review was written from August 2023 to May 2024. The database that was used in finding suitable literature is PubMed. The results that fit the scope of the review were limited, eight studies with useful information were applied.

The results of this review were information and general principles to recognize the factors contributing to low back injuries in golf and similar sports with asymmetric loading. Correct swing mechanics, adequate flexibility and mobility, muscle strength and load management arose in multiple studies that were reviewed. In addition, sport-specific coaching and resistance training that mimics the motion of the golf swing can be beneficial in avoiding low back injuries and pain, by improving mobility, flexibility, strength and tolerance in the specific structures used in the golf swing.

No definite conclusions can be made based on this review. Further high-quality research on the topic is required to clearly identify factors contributing to low back injuries in golfers.

Keywords
golf, low back pain (LBP), injury

CONTENTS

1 INTRODUCTION

Lately the sport of golf has been on a rise in popularity, with covid times (2019 to 2021) especially increasing the popularity significantly. “The number of registered golfers in Europe has grown by 4.6% to a total of 4.32 million, with increases seen in nearly three out of four European countries.” (EGA & R&A, 2021.)

157,175 registered golfers were in Finland alone in 2021. In Finland, the amount of registered golfers grew by 2% between 2017 and 2019, and by 10% between 2019 and 2021. (EGA & R&A, 2021, p.32.)

At the same time, lower back issues are at an all-time high in the general population. The global burden of disability regarding low back pain (LBP) has been reported to be increasing since 1990. The disability associated with LBP saw an increase in all age groups since 1990. LBP seems to have the biggest occurrence in people aged between 20 and 65 years. (IASP, 2021.)

The golf swing is a complicated movement that requires plenty of mobility and strength in the correct areas. The risk especially for lower back injuries is quite high. In a 2017 study by Cole & Grimshaw, the authors concluded that the modern golf swing is a complicated movement, which aims to increase the clubhead speed during a golf swing to be as fast as possible. It can be hypothesized that the lumbar spine cannot handle the forces that the modern golf swing produces. (Cole & Grimshaw, 2017.)

2 AIM AND OBJECTIVE

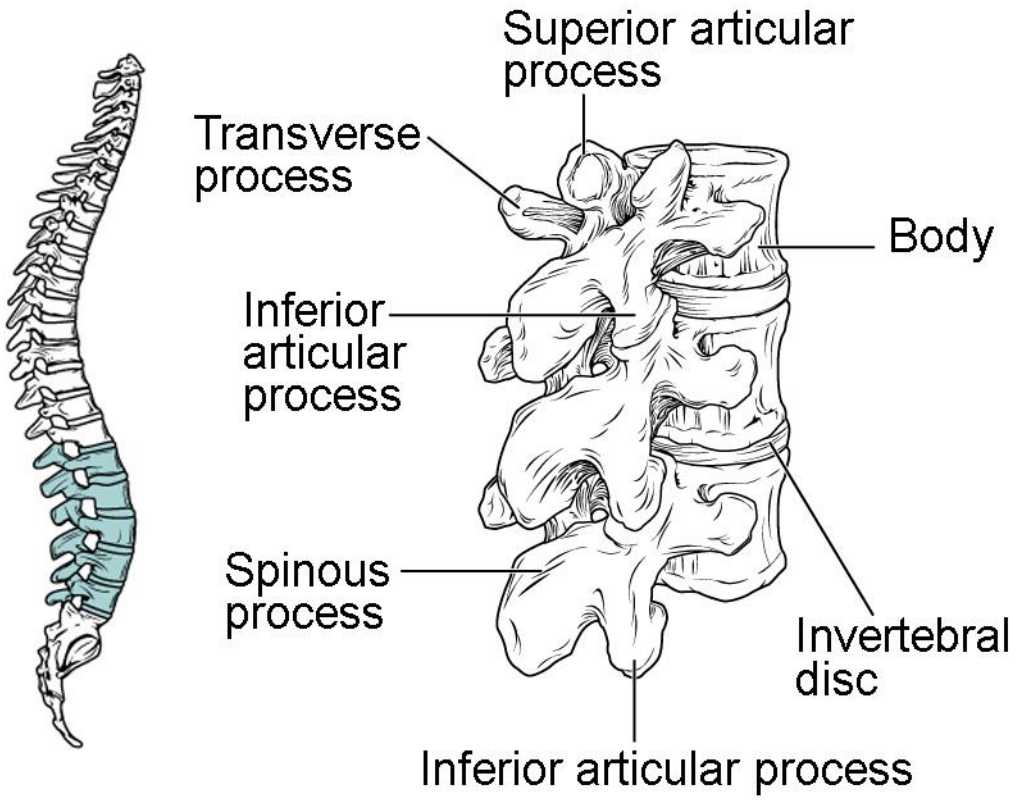
The aim of this literature review is to identify the factors that affect to lumbar spine issues in golfers by studying literature of the biomechanics of the golf swing, literature of the factors that put one at a risk of lower back injuries and to find literature of

possible physiotherapy interventions that would be effective in prevention and management of these issues.

The objective of the thesis is to find answers to the following research questions: “which factors attribute to low back injuries in golfers” and “can the factors contributing to low back injuries in golfers be managed through physiotherapy practices”. The findings will be published on the free research database ResearchGate as well as Theseus.

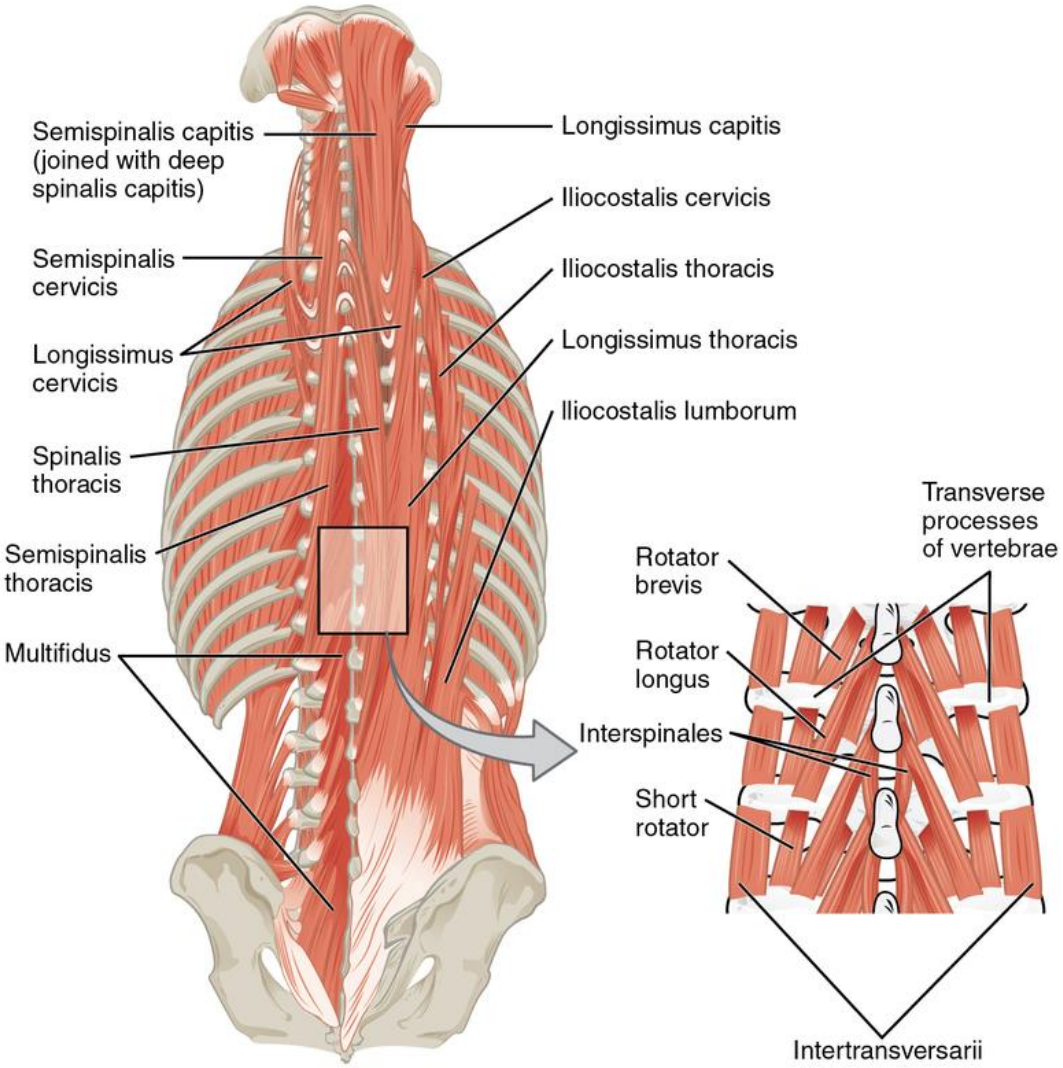
3 ANATOMY AND PHYSIOLOGY OF THE LUMBAR REGION

The lumbar spine includes five vertebrae in the lumbar area (Picture 1). There are intervertebral discs throughout the spine between these vertebrae. The intervertebral discs function like shock absorbers as the body moves. There are thirty-one pairs of nerves that are rooted along the spinal cord. (Agur et al., 2020, p. 14.)



Picture 1. Lumbar vertebrae. (Nursinghero, 2024) CC BY 3.0

There are several groups of muscles supporting the trunk (Picture 2). These can be divided into functional groups of flexors, extensors, lateral flexors and rotators. Extensor muscles of the back can be arranged in three layers: the most superficial one which is erector spinae, the middle layer which is the multifidus, and third layer of small muscles which have a variety of functions not only in extension but also rotation and lateral flexion. There are two groups of flexors associated with the lumbar region, the intrinsic and extrinsic group. The intrinsic group consists of the psoas major, psoas minor and iliacus muscles, while the extrinsic group consists of abdominal wall muscles. (Physiopedia, 2020.)



Picture 2. Deep muscles of the back. (OpenStax, 2016) CC BY 4.0

3.1 The lumbar region during a golf swing

There are various types of loads that occur in the lumbar spine during a golf swing. Compressive loads appear to be quite high, with the highest being up to 800% of one's bodyweight (BW). The forces vary between different swing phases. During the take-away, average compression was shown to be about 370% BW. During the impact phase, approximately 600% BW compression has been measured. Lastly, during the early and late follow-through forces of 530% and 300% BW have been shown. (Lim, 2000.)

Many trunk-supporting muscles are involved in producing the golf swing. These include the gluteus maximus (GM), pectoralis, psoas major (PM), quadratus lumborum (QL), latissimus dorsi (LD), internal obliques (IO), external obliques (EO), rectus abdominis (RA) and the erector spinae (ES). Out of these muscles, external and internal obliques, latissimus dorsi, erector spinae, quadratus lumborum and the rectus abdominis seem to provide the most stabilization during axial twisting. During the golf swing, the gluteus maximus is a major contributor to both power generation and hip stabilization. In addition, during the various phases of the golf swing, trunk flexor-extensor co-activation is greatly present in healthy individuals. (Gluck et al., 2008.)

4 LUMBAR SPINE INJURIES IN GOLF

There are various lumbar spine injuries that are prevalent in the sport of golf. These can include non-specific lower back pain, disc herniations, spondylolysis and other less common injuries such as facet joint pain, rib stress fracture, paraspinal muscle injuries and compression fractures. (McHardy et al., 2006.)

4.1 Non-specific low back pain

Non-specific LBP is generally defined as low back pain that cannot be linked to any specific pathology. LBP is a very common issue in the standard population. It has been shown to cause the most disability out of any other conditions, with 60 – 80% of people experiencing LBP in their life. The rate of re-occurrence is also high, at approximately 60%. (Hoy et al., 2014.)

The possible causes for LBP are various. Any structure in the lumbar spine that is innervated can cause the feeling of pain in the lower back, or lower extremities. These structures include ligaments, muscles, nerve roots and dura mater, zygapophyseal joints, annulus fibrosis, thoracolumbar fascia and vertebrae. While modern imaging has improved, there can often be false-positive findings, such as disc degeneration that

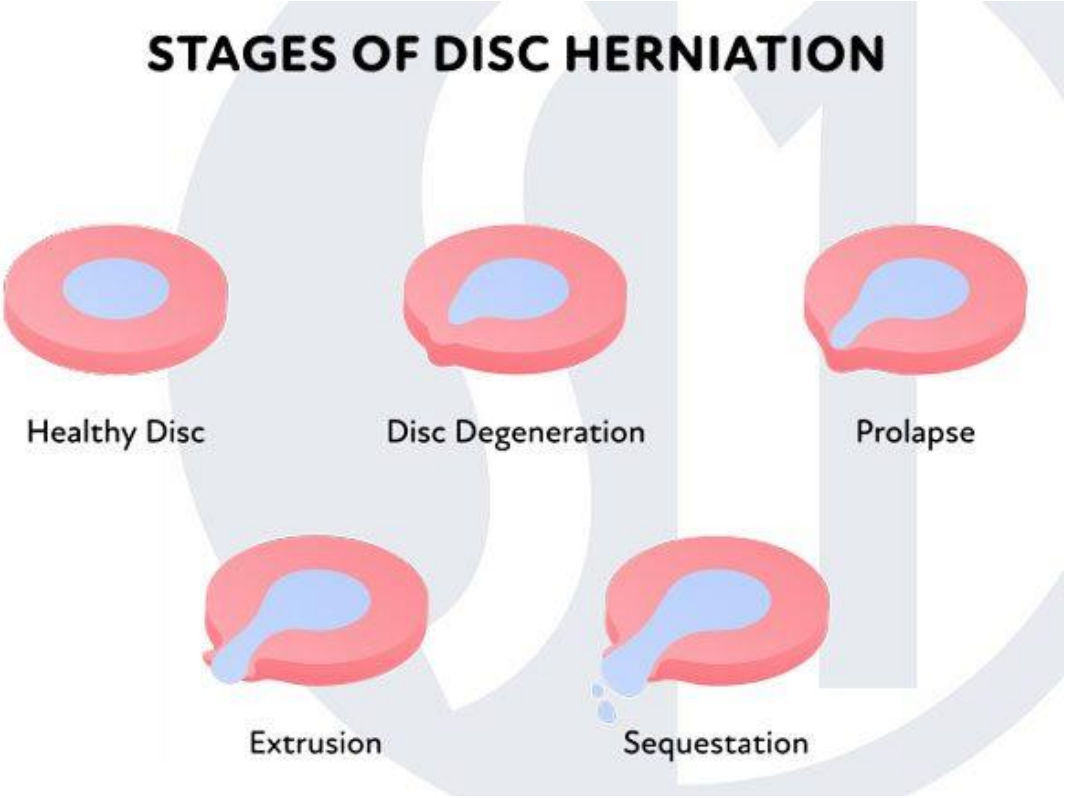
is asymptomatic. This further increases the difficulty of finding the root cause of non-specific LBP. (Physiopedia, 2024b.)

4.2 Disc herniation

Other possible injury mechanisms related to golf include herniated discs. A herniated disc occurs when the inner part of the disc is pushed out from the intervertebral space. Often the patient recalls a specific incident during which the pain started with disc herniations. There can be radiating symptoms to the lower limbs as the herniated disc is pressing on the spinal cord. There can also be weakness and changes in sensation if the disc herniation is more severe. (Physiopedia, 2024a.)

95% of disc herniations happen in the L4-L5 and L5-S1 areas. (McGill, 2007). Herniated discs can be divided into four stages: bulging, protrusion, extrusion and sequestration (Picture 3). (Physiopedia, 2024a.)

A *bulging disc* is the least severe case, with the core of the disc (nucleus) pushing the annular fibers further into a bulge that can cause inflammation and irritate the spinal nerve. In *disc protrusion*, the nucleus impinges on the outer layer of the disc. In *disc extrusion*, the jelly-like material of the nucleus pushes through the outer layer of the disc. In a *full sequestration* or *herniation*, fragments of both the nucleus and annulus break through into the epidural space, compressing the spinal nerve. (Physiopedia, 2024a.)



Picture 3. The stages of disc herniation. (SpineOne, 2024) CC BY 3.0

4.3 Spondylolysis

Spondylolysis is also associated with golf injuries. Spondylolysis is a fracture in the vertebrae of the spine. It usually involves the lumbar vertebrae but can also occur in the cervical and thoracic vertebrae. Spondylolysis can cause slipping of the vertebrae, which is called spondylolytic spondylolisthesis. (Physiopedia, 2024c.)

Spondylolysis can be defined as a stress fracture in the pars interarticularis. This often occurs because of repetitive load and stress rather than a single event. The stress in these structures is at its peak in rotation and extension movements. (Haun & Kettner, 2005.) These factors are all present in the golf swing.

4.4 Lumbar facet joint pain

One of the less common injuries associated with golf is facet joint pain, which can be a result facet joint syndrome or an injury in the facet joints. Facet joints are the joints between two different vertebrae in the spine.

Facet joint pain is usually identified as one-sided back pain and can radiate down the lower limbs. Clinical examination is usually required to confirm the source of the pain. Lumbar facet syndrome can have symptoms such as pain and stiffness alongside the spine, symptoms with certain movements such as hyperextension, as well as referred pain along the lower limb. Facet joint pain can be hard to diagnose, as imaging does not appear to have much validity. (Moon et al., 2013.)

4.5 Rib stress fracture

Another less common injury present in golfers is a stress fracture of the ribs. While the injury is more common in sports like rowing, there have been reports of golfers experiencing rib stress fractures as well. Rib stress fractures in golfers can be mistaken for back strains or other similar problems. Studies have shown that fatigue in the serratus anterior muscle can increase the risk for rib stress fractures (Lord et al., 1996.)

4.6 Paraspinal muscle injuries

Paraspinal muscles are required to stabilize the spine during peak effort in the golf swing due to the shear forces, compression and bending that occur. These muscles can be fatigued especially in amateur golfers with inconsistent swing technique. Various tools can be used to diagnose paraspinal muscle injuries, such as magnetic resonance imaging (MRI). (Sutcliffe et al., 2008.)

4.7 Compression fractures

Compression fractures of the spine are fractures in the vertebrae of the spine that can result in collapsing of the vertebrae. Compression fractures can be more common in high-impact sports such as ice hockey, but there have been cases in golfers as well. Literature shows that especially elderly golfers can be at risk, and other factors such as having osteoporosis can be risk factors as well. (Ekin & Sinaki, 1993.)

5 BIOMECHANICS OF THE GOLF SWING

To understand the various factors affecting lower back injuries in golf, a basic understanding of the various mechanics and structures involved in producing the golf swing is required.

5.1 The traditional and modern golf swing

In the traditional golf swing, the thorax and pelvis rotate in equal motion ranges, while the modern golf swing utilizes more of a “coiling” motion with restricted hip rotation. This causes more stress in the related structures to create more power and speed in the swing. It has been shown that the peak compressive load can be up to 8-times bodyweight, compared to for example rowing and jogging, which have shown 7- and 3-times bodyweight loads respectively. (McHardy et al., 2006.)

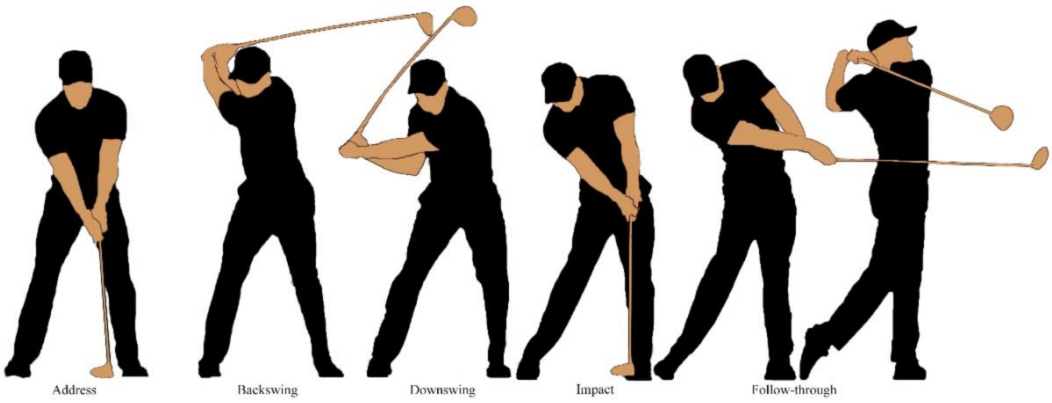
5.2 Professional and amateur golfers

Considering the differences between professional and amateur golfers, it has been shown that the amateur golfer has a higher peak muscle activation percentage (90% vs 80%) when compared to professional golfers. In addition, the load on the lumbar spine is higher in amateur golfers, with amateur golfers presenting 80% higher lateral

bending and peak shear loads and as well as 50% higher torque than professional golfers. It can be hypothesized that this is a result of the amateur golfer trying to swing farther by hitting the ball harder, while professional golfers have a more efficient and repeatable golf swing. (McHardy et al., 2006.)

5.3 The phases of the golf swing

Generally, the golf swing is divided into four phases. These phases are the address, backswing, downswing and the follow-through (Picture 4).



Picture 4. The phases of the modern golf swing

The *address position* usually has the golfer standing with their feet shoulder width apart with their knees slightly bent, trunk flexed to around 45° with weight placed evenly on both feet (Maddalozzo, 1987). The *backswing* is initiated when the clubhead is moved away from the ball. There are anterior shear forces produced by the trail foot and posterior forces produced by the lead foot, which create a clockwise torque rotating the pelvis and shifting the body weight to the trail foot. The *downswing* phase begins while the thorax and golf club are still turning away from the target. The hip and knee extensors are contracted on the trail side (right leg in right-handed golfers). This is done to shift the body weight back towards the lead leg, and to create a coiling effect between the upper and lower body. The *impact* and *follow-through* occur as the golfer hits the ball and completes the golf swing, with the club ending up behind the golfer's back. (Cole & Grimshaw, 2016.)

6 RESEARCH METHOD & PROCESS

This thesis was written as a systematized literature review. A systematized review may be identified as a 'systematic' review, but they are not the same. Systematized reviews are often conducted as postgraduate student assignments when there are not enough resources to conduct a full systematic review. Systematized reviews can be used as a basis for more extensive pieces of work. (Grant & Booth, 2009.)

6.1 Setting up the search

The database that was chosen for the search is PubMed. Boolean operators "AND" & "OR" were used in the search. The search terms were as follows: "golf", combined with "low" or "lower" back "injury" or "injuries". The terms were separated with "AND", see Table 1. PubMed filters were used to limit the results to full text publications within the last ten years.

Table 1. Database search

Database	**Search**	Search results	Results after filters
PubMed	Golf AND (Low OR Lower back) AND injur*	112	46

6.2 Inclusion and exclusion criteria

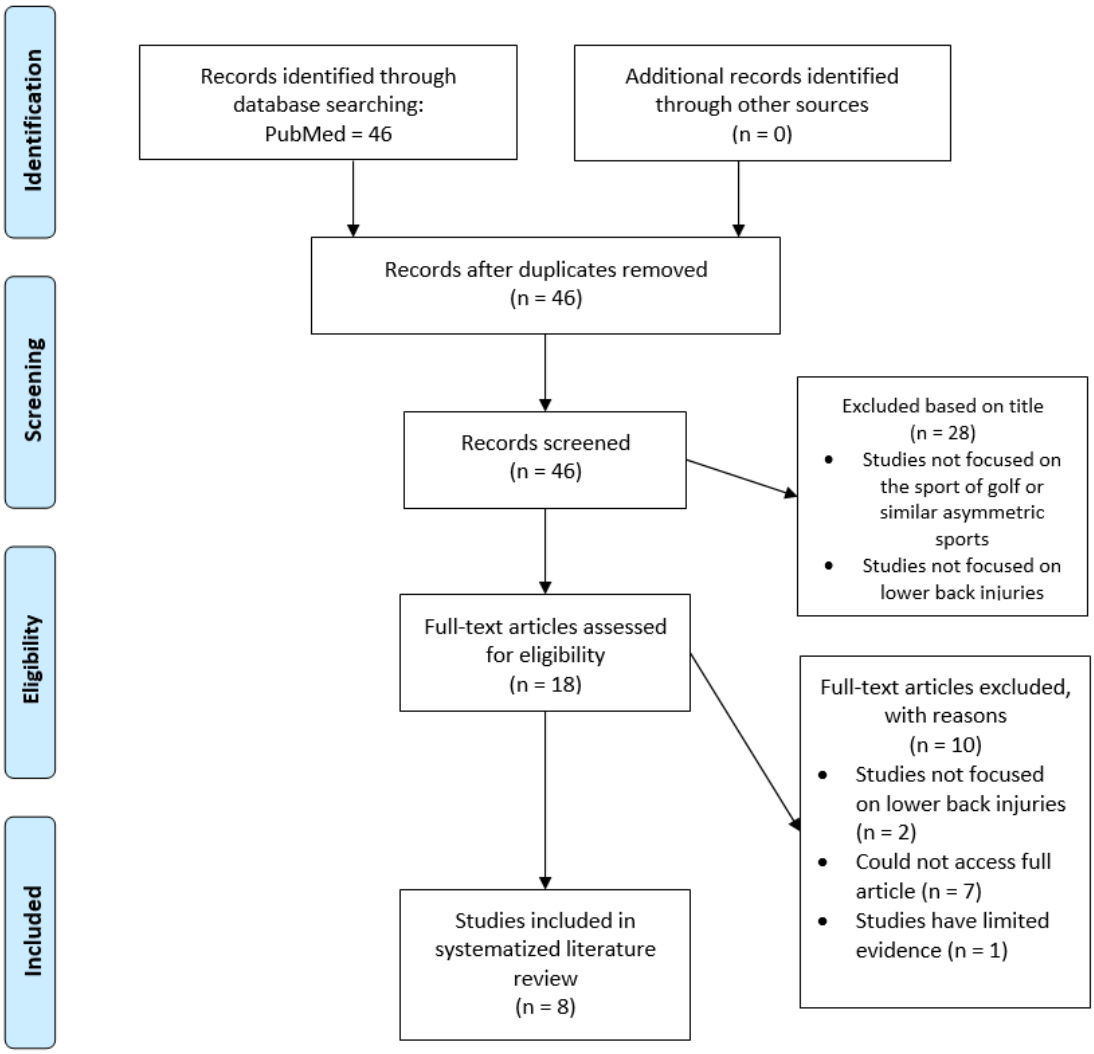
Publications were chosen based on set inclusion and exclusion criteria, see Table 2. This is done to narrow down the publications used to fit in the aim and objectives of the literature review.

Table 2. Inclusion and exclusion criteria

Inclusion criteria	**Exclusion criteria**
The study involves the sport of golf	The study involves another sport
The study is in English	The study is in another language
The study is focused on lower back injuries	The study is focused on other types of injuries
The study is published during the last 10 years	The study was published over 10 years ago

6.3 Selection of studies

The selection of studies is presented with the Prisma flow diagram (Picture 5). The Prisma flow chart presents the different stages of the literature review. The diagram also shows the number of publications that are included and excluded in various stages of the selection.



Picture 5. Study selection diagram modeled from the Prisma flow diagram, altered by the author. (Prisma)

6.4 Analysis of data

The data that was found through the literature was analyzed with an inductive data analysis. An inductive data analysis is an effective way to analyze qualitative data, by allowing flexibility in the analysis process. However, an inductive data analysis may be time-consuming and is prone to be influenced by the researcher's biases. While it is not as strong of an approach as some other approaches, it is a simple and straightforward way to broadly view a study's findings. (Thomas, 2006.)

7 RESULTS

There were eight studies that fit the criteria to be included in the literature review. The studies explored lower back pain and injuries related to the sport of golf and more specifically the golf swing itself. Three studies focused on the biomechanical aspects themselves, one study analyzed the effects of a golf swing-assist device, one study analyzed the different ground slopes of a golf course, one study focused on general workload in relation to low back injuries in athletes and two studies were broader, systematic reviews of the topic.

7.1 Study results

In the 2023 study by Li et al. the researchers looked at the effects of ground slopes and shapes on the golf course on erector spinae muscle activity and the effects on swing mechanics. The researchers found that when compared to hitting the ball on a flat ground, having the ball above or below the feet caused noticeably low activation in lower back muscles on the lead side during the golf swing, specifically during the acceleration phase of a golf swing. They concluded that this increases the risk of back injury, as even though muscle activation is reduced, the shear and compression forces remain high at this specific phase of the swing. (Li et al., 2023.)

The 2023 randomized control trial by Park et al. focused on the effect of a Pulley Master (PM) machine to reduce the incidence of LBP and injuries. The PM machine mimics the motion of a golf swing, with added resistance with elastic bands at the thoracic and lumbar spine areas. The research had twenty-one amateur golfers with LBP randomly assigned to either PM or Transfer of Electricity-Capacitive and Resistive (TECAR) therapy. The researchers concluded that PM effectively reduced pain, improved mobility and offered a noticeable reduction in LBP in the short term by reducing tension and improving mobility. (Park et al., 2023.)

Zemková et al. studied the relationship of workload and back pain in athletes in their 2020 scoping review. The review focused on various different sports, focusing on the

Acute Chronic Workload Ratio (ACWR). The authors concluded that there is a correlation with training load and back issues in athletes, as well as fatigue in trunk muscles that increases the load on the spine. However, they questioned the reliability of ACWR in relation to back problems as there is a lack of evidence. (Zemková et al., 2020.)

The 2020 review by Edwards et al. focused on the biomechanical risk factors related to LBP in golf. They found that while every golfer has a unique swing that is based on learned motor patterns and physical characteristics, technically flawed golf swings produce a higher risk of injury. They concluded that the golf swing causes an imbalanced load on the body, that can lead to imbalances in muscles and other structures. The movement of the body in the golf swing with hyperextension of the lumbar spine and incorrect hip sequencing were identified to be contributing factors for LBP in golfers. (Edwards et al., 2020.)

A 2019 study on primary prevention of lumbar spine injuries in golfers by Goebel et al. aimed to create a clear definition for a golf swing to replace the classic golf swing. They studied different biomechanical aspects of the golf swing as well as golf stances. The authors concluded that the classic golf swing should be changed to a less restrictive swing that has a more balanced center of pressure and center of mass instead. (Goebel et al., 2018.)

In the 2018 systematic review by Smith et al., the authors set out to summarize evidence for factors associated with LBP in golfers. They found that individual characteristics of golfers such as history of LBP, body mass and age may correlate to LBP in golfers, but they did not find a correlation between golf swing mechanics and occurrence of golf-related LBP. The authors emphasize a need for high-quality studies in the future. (Smith et al., 2018.)

The 2015 study by Mun et al. used infrared cameras to record fifteen professional golfers to study the movement of the lower back and hips when performing a golf swing. The aim was to determine specific factors that correlate with LBP. The authors note that a majority of the professional golfers that participated had a similar movement pattern in their lumbar spine and hips. However, they did not find or

conclude any correlation with swing mechanics in relation to lumbar spine injury, instead emphasizing that the study can provide basic information that can be used in further studies analyzing lumbar spine injuries in golf. (Mun et al., 2015.)

Lastly, the 2014 review by Lindsay & Vandervoort examined scientific literature to discover factors that are associated with developing LBP in golf, and possible methods to manage these factors. They conclude that the noticeable occurrence of LBP appears to be multifaceted, but the asymmetrical movement with the high speeds of the golf swing in addition to excessive playing and practice time appear to be common factors. Also, abnormal muscle recruitment patterns and poor posture and swing mechanics appear to be contributing factors to LBP in golf as well. The authors emphasize the importance of flexibility, load management and professional golf assistance to manage LBP in golf. (Lindsay & Vandervoort, 2014.)

8 CONCLUSION

The result of this review, including eight studies, suggests that the factors related to low back injuries in golfers are multifaceted and require more high-quality studies in the future. Still, some conclusions can be made. The importance of correct swing mechanics, adequate flexibility and mobility, muscle strength and load management arose in multiple studies that were reviewed. Deficiencies in muscle recruitment and incorrect sequencing appear to be relevant as well.

In addition, sport-specific coaching and resistance training that mimics the motion of the golf swing can be beneficial in avoiding low back injuries and pain, by building strength and tolerance in the specific structures used in the golf swing. Still, due to the asymmetric nature of the golf swing and the unique characteristics of individual golfers, a definite “one size fits all” answer can’t be found in the current literature. More specific research is needed regarding the subject.

9 DISCUSSION

Some changes were made to the original thesis plan. The timespan of studies chosen was changed from the last 15 to the last ten years to avoid dated data in the literature. The exclusion and inclusion criteria were also expanded further. An inductive data analysis was opted for to analyze the studies that were found.

The aim of this thesis was to find methods to identify and manage lumbar spine issues in golfers, and to find literature of possible physiotherapy interventions that would be effective in prevention and management of these issues. The choice of topic stems from the increase of the popularity of golf as a sport, as well as the increasing number of LBP worldwide. (EGA & R&A, 2021, p.32; IASP, 2021.)

The search on PubMed yielded acceptable results. Due to the relatively low popularity of the sport of golf, there were not many high-quality studies such as randomized controlled trials. Thus, the selection criteria for studies included in the literature review was loosened to gather enough information about the topic. A significant amount of the studies found with the search keywords “Golf AND (Low OR Lower back) AND injur*” were either related to sports with totally different characteristics than the golf swing or were discussing other injuries besides low back related ones. Still, enough data was found that was applicable and suitable for the review.

Despite only one of the studies used in the review being physiotherapy-specific, some general conclusions and guidelines can be hypothesized. While no definite results were found regarding the factors contributing to low back pain, most studies emphasized the unique characteristics of individual golfers and their biomechanics, and noted only general principles, much of which is quite general information in the space: load management, optimal swing technique, flexibility, mobility and the strength of the structures used in the golf swing, especially ones supporting the lumbar spine.

As was stated earlier in the review as well as in multiple of the studies reviewed, further research is required on the subject. A possible future trial could make use of the data regarding swing mechanics and biomechanics gathered from healthy golfers that have

experienced longevity in the sport and compare the data to golfers who have a history of lumbar spine issues.

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