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The relation between neck pain and text neck in adults - A narrative lit- erature review

DEGREE PROGRAMME IN PHYSIOTHERAPY
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ABSTRACT

Roininen, Niclas: The relation between neck pain and text neck in adults - A narrative literature review

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This thesis work is a narrative literature review that aimed to explore the phenomenon of "text neck". In fact, the research question is whether text neck and neck pain are related in any way.

The thesis begins with a theory part that includes important anatomical structures of the neck area which contribute to movement, protection of organs, and metabolism. Although non-specific neck pain is the most common type of neck pain, the other possible causes were discussed and researched throughout the work. Even though there are plenty of already known reasons for neck pain, this thesis includes the most common ones which are cervical radiculopathy, bone fractures, spinal osteoarthritis, different types of scoliosis, and musculoskeletal tissue strains and sprains.

From the point of physiotherapy, it was important to discuss some common rehabilitation methods such as therapeutic exercise, the client approach, and manual therapy. The objective was to provide the reader with a clear understanding of existing research on the causes, symptoms, impacts of text neck. By examining a range of peer-reviewed studies, the review highlighted the current understanding of text neck, identifying key patterns and areas of agreement or divergence in the literature.

The results from the studies included show that text neck is a risk factor in neck pain but that is where things get complicated. There might not be a 100 percent certain causation relation between text neck and neck pain, but instead there could be underlying individual factors such as the amount of device use, physical activity levels, and pre-existing conditions such as injuries, diseases, genetic structural problems etc. that are affecting the prevalence and intensity of neck pain. Future research is required to make stronger conclusions about the topic.

Keywords: neck pain, text neck, forward head posture (FHP)

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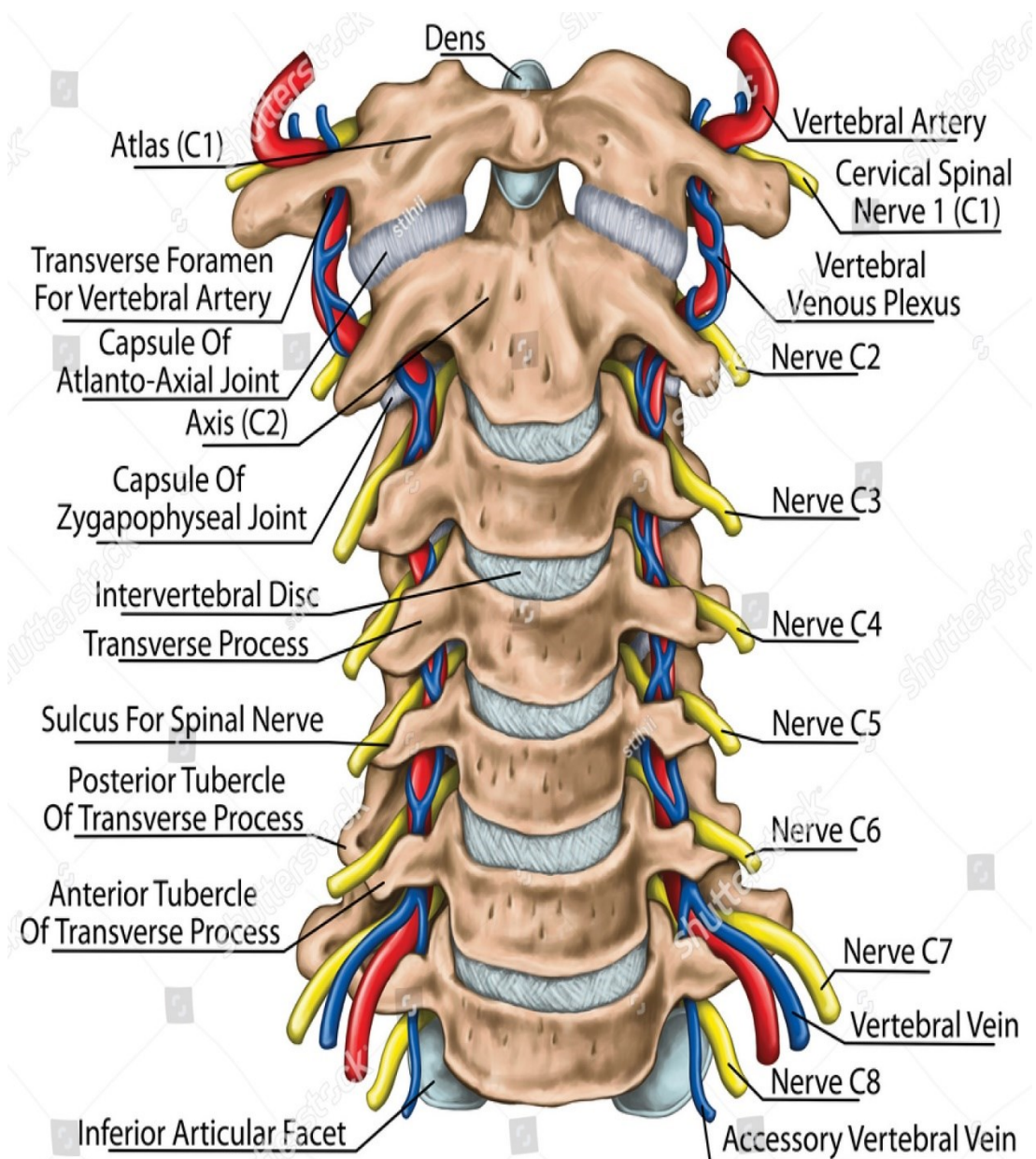
1 INTRODUCTION

Nowadays there are more and more technological advancements, the ubiquity of smartphones and digital devices has become an important part of our daily life. As individuals increasingly engage in prolonged periods of text messaging, web browsing, and other activities behind the screens, concerns about the potential impact on musculoskeletal health, particularly in the cervical region, have emerged. (Datareportal, 2024) The term "text neck" has been come up with to describe the postural strain associated with the forward head posture and increased flexion of the neck while using handheld devices. (Bhattacharya, S. et al. 2021) This phenomenon has raised questions about its potential association with neck pain, a prevalent and often debilitating condition in adults. As the reliance on digital technology continues to rise, understanding the possible relationship between text neck and neck pain becomes important information. (Phoneless Phobia Infographics, n.d.) This narrative literature review aims to synthesize and critically evaluate existing research to clarify the complex interaction between these factors, and to also shed light on the conclusion for physiotherapy practice interventions.

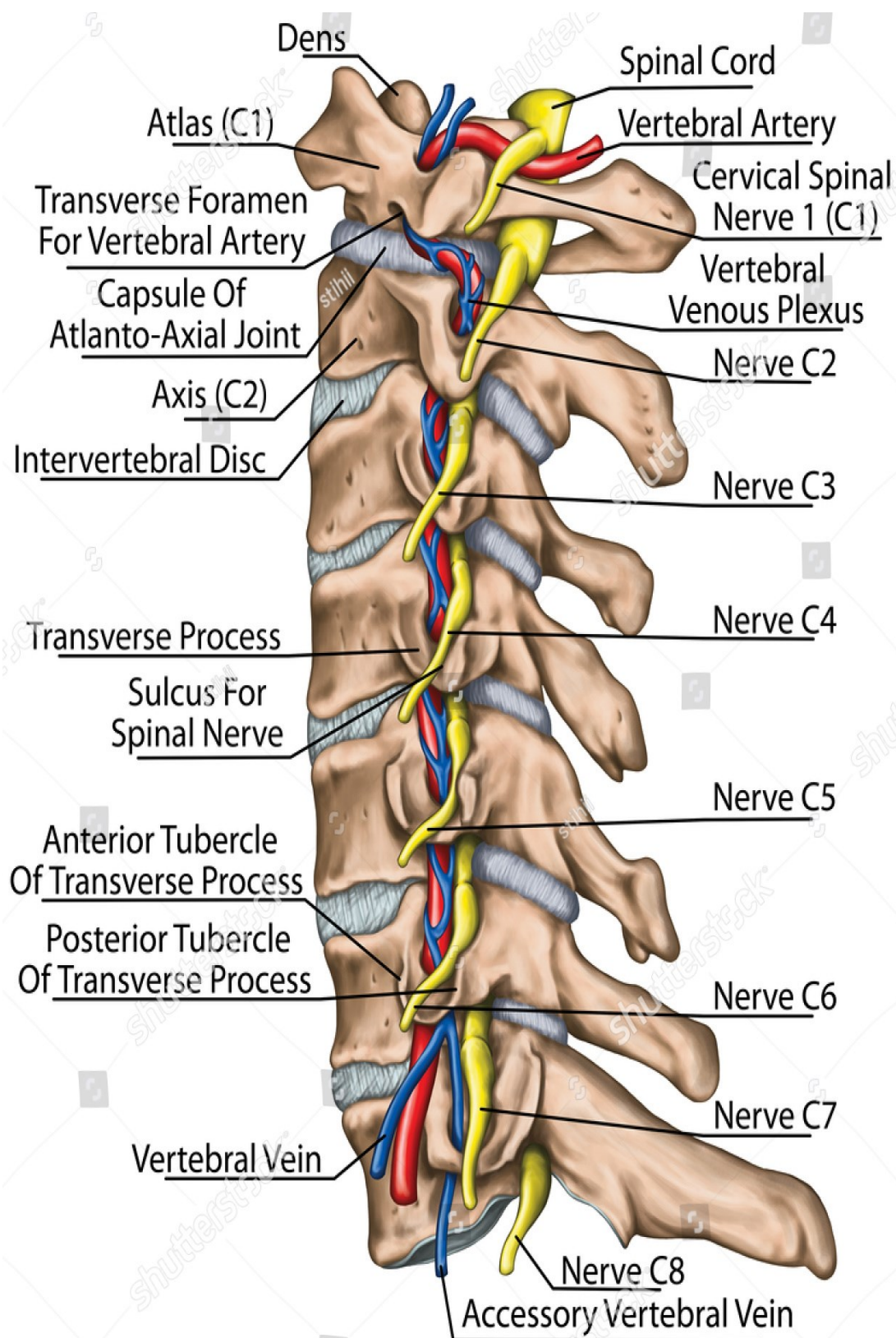
2 NECK ANATOMY

The neck, or cervical spine region, represents anatomical complexity and functional versatility. Comprising seven vertebrae (C1-C7), the cervical spine serves as the primary support for the skull, allowing for a remarkable range of motion essential for daily activities, such as in a rotational way to look over the shoulder or in an extension-flexion way to look up and down. Plenty of ligaments, tendons, and muscles work together to stabilize and facilitate movement within this region. (Picture 3, 4, 5 & Tables 1, 2 & 3) The cervical

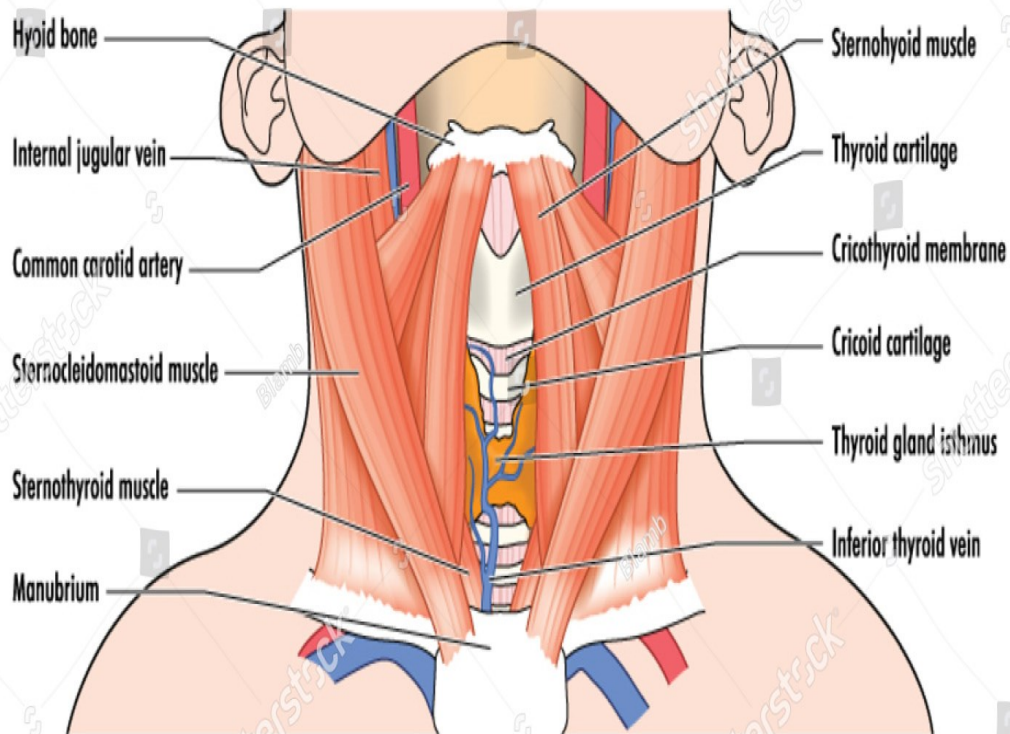
vertebrae encase and protect the spinal cord, forming a vital conduit for nerve signals between the brain and the rest of the body. Noteworthy structures, such as the intervertebral discs, act as shock absorbers and facilitate articulation between adjacent vertebrae. (Physiopedia.com, 2024) Surrounding the spine, an intricate network of blood vessels ensures the vital supply of nutrients and oxygen. (Pictures 1 & 2) Furthermore, the neck is an area for many critical anatomical landmarks, including the trachea, oesophagus, and major blood vessels, highlighting its pivotal role in respiratory, digestive, and circulatory functions. (Garner et al., 2021) The anatomical and physiological knowledge of the neck area is very important in order to understand and logically solve potential sources of discomfort that can appear within this crucial anatomical region. (Sendić, 2022) The anterior neck muscles primarily facilitate neck flexion, stabilization, elevation of hyoid bone and depression of mandible. (Picture 3 & 4, table 1) The lateral neck muscles of the neck primarily facilitate neck flexion, neck lateral flexion, neck rotation, elevation of the first and second rib. (Picture 4 & table 2) The posterior neck muscles mainly facilitate extension, lateral flexion and rotation of head, cervical and thoracic spine and stabilization of the head. (Picture 5 & table 3)



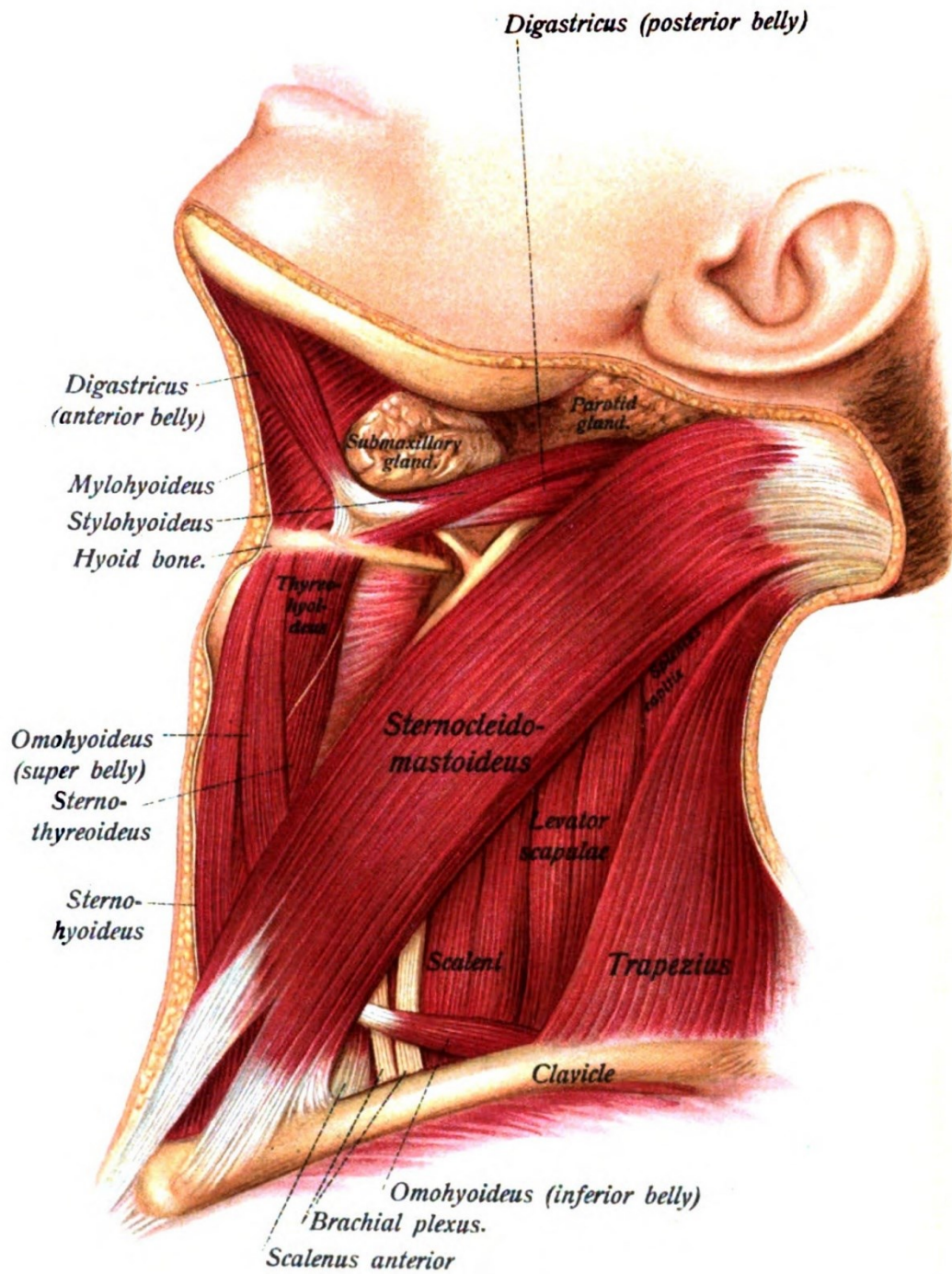
Picture 1: Nerve roots, arteries, veins and vertebrae anterior view (shutterstock.com)



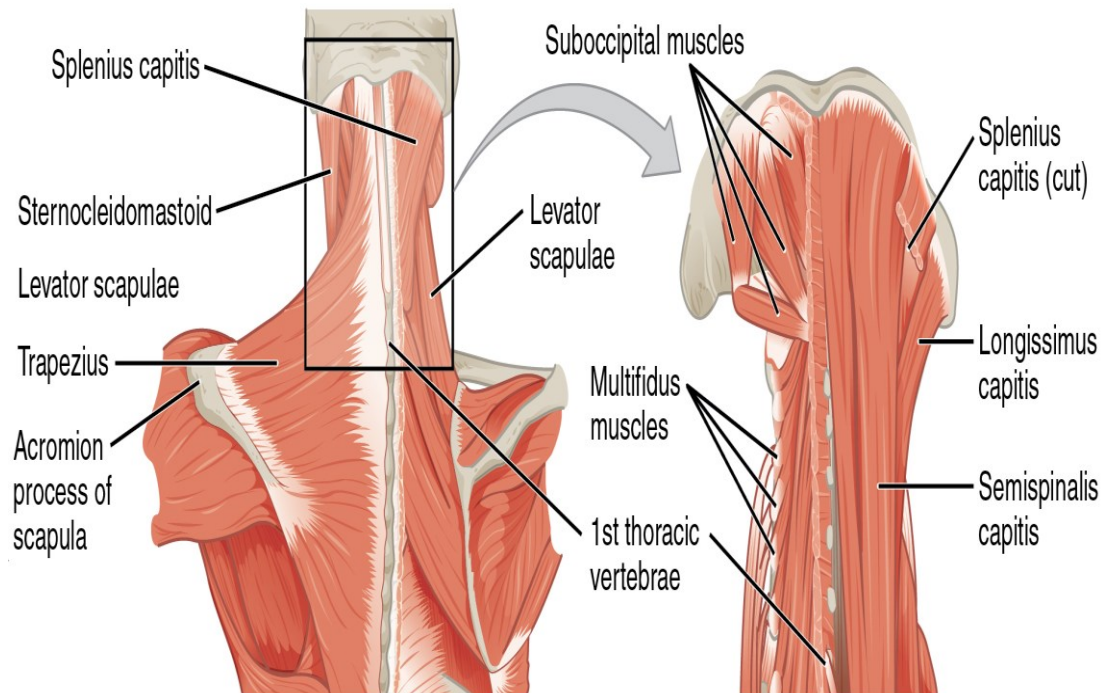
Picture 2: Nerve roots, arteries, veins and vertebrae side view (shutterstock.com)



Picture 3: Labelled drawing to show the anterior muscles of the neck and airway structures, including the trachea, thyroid and cartilages (shutterstock.com)



Picture 4: Side view of the neck muscles (Sobotta, 1909)



Picture 5: Posterior view of the neck muscles (Openstax.org, 2013)

Table 1: Anterior muscles of the neck and their attachment and action (Sendić, 2022):

Muscle name	Muscle origin	Muscle insertion	Muscle action
Musculus platysma	Subcutaneous tissue of infraclavicular and supraclavicular regions	Base of mandible; skin of cheek and lower lip; angle of mouth	Depression of the mandible, tensing the skin of lower face and anterior neck
Musculus sternocleidomastoideus	Clavicular head: the medial third of the clavicle Sternal head: manubrium of sternum	Mastoid process of the temporalis bone	Lateral flexion of the neck and lateral rotation of the head. Flexion of the neck and elevation of the sternum and clavicle

			during forced inspiration.
Musculus digastricus	Anterior belly: digastric fossa of the mandible Posterior belly: Mastoid notch of temporal bone	Intermediate tendon of hyoid bone	Depression of mandible, elevation of hyoid bone
Musculus mylohyoideus	Mylohyoid line of mandible	Body of hyoid bone and median ridge	Hyoid bone elevation, mandible depression, tongue elevation
Musculus geniohyoideus	Inferior mental spine of mandible	Superior border of hyoid bone	Elevation of hyoid bone, depression of mandible, moving the larynx and pharynx anterosuperiorly
Musculus stylohyoideus	Posterior surface of the styloid process of temporal bone	The body of hyoid bone	Elevation of hyoid bone, tongue retraction & keeping the pharynx open during inspiration
Musculus sternohyoideus	Superior part of the manubrium of sternum and posterior surface of the medial end of the clavicle	The inferior border of the body of hyoid bone	Depression of hyoid bone and larynx.
Musculus sternothyroideus	Posterior surface of manubrium of sternum, Costal cartilage of the first rib	Oblique line of thyroid cartilage	Depression of the larynx

Musculus thyrohyoideus	Oblique line of thyroid cartilage	Inferior border of body and greater horn of hyoid bone	Depression of hyoid bone, elevation of larynx
Musculus omohyoideus	Inferior belly: superior border of scapula near the suprascapular notch Superior belly: intermediate tendon	Inferior belly: intermediate tendon Superior belly: body of hyoid bone	Depression and retraction of hyoid bone and larynx. Tensing the carotid sheath.
Musculus rectus capitis anterior	Anterior surface of lateral mass and transverse process of atlas	Inferior surface of basilar part of occipital bone	Atlanto-occipital joint: Head flexion
Musculus rectus capitis lateralis	Superior surface of the transverse process of atlas	Inferior surface of the jugular process of the occipital bone	Stabilization of the atlanto-occipital joint, lateral flexion of the head
Musculus longus capitis	Anterior tubercles of transverse processes of C3-C6	Basilar part of occipital bone	Head flexion, head rotation
Musculus longus colli	Superior part: Anterior tubercles of transverse processes of vertebrae C3-C5 Intermediate part: Anterior surface of bodies of vertebrae C5-T3 Inferior part: Anterior surface of bodies of vertebrae T1-T3	Superior part: Anterior tubercle of vertebra C1 Intermediate part: Anterior surface of bodies of vertebrae C2-C4 Inferior part: Anterior tubercles of transverse processes of vertebrae C5-C6	Neck flexion, neck contralateral rotation, neck lateral flexion

Table 2: Lateral muscles of the neck and their attachment and action (Sendić, 2022):

Muscle name	Muscle origin	Muscle insertion	Muscle action
Musculus scalenus anterior	Anterior tubercle of transverse processes of vertebrae C3-C6	Scalene tubercle of the first rib, superior border of the first rib	Neck flexion, neck lateral flexion, neck rotation, elevation of the first rib
Musculus scalenus medius	From the transverse processes of C1/C2 to C7	Superior border of the first rib	Lateral flexion of the neck, elevation of the first rib
Musculus scalenus posterior	Posterior tubercles of transverse processes of vertebrae C4-C6/C5-C7	External surface of the second rib	Lateral flexion of the neck, elevation of the second rib

Table 3: Posterior muscles of the neck and their attachment and action (Sendić, 2022):

Muscle name	Muscle origin	Muscle insertion	Muscle action
Musculus trapezius	Descending part (superior fibers): medial third of the superior nuchal line, external occipital protuberance, nuchal ligament Transverse part (middle fibers):	Descending part (superior fibers): lateral third of clavicle Transverse part (middle fibers): medial acromial margin, superior crest of spine of scapula	Scapula retraction, rotation of head, extension of head and neck, lateral flexion of head and neck, scapular elevation and depression

	<p>spinous processes and supraspinous ligaments of vertebrae T1-T4 (or C7-T3)</p> <p>Ascending part (inferior fibers): spinous processes and supraspinous ligaments of vertebrae T4-T12</p>	<p>Ascending part (inferior fibers): lateral apex of the medial end of scapular spine</p>	
Musculus splenius capitis	Spinous processes of vertebrae C7-T3, nuchal ligament	Lateral superior nuchal line of occipital bone, mastoid process of temporal bone	Extension of head and neck, lateral flexion and rotation of head
Musculus splenius cervicis	Spinous processes of T3 – T6 vertebrae	Transverse processes of C1 – C3 vertebrae	Lateral flexion and rotation of neck, extension of neck
Musculus semispinalis capitis	Articular processes of vertebrae C4-C7, transverse processes of vertebrae T1-T6	Between superior and inferior nuchal lines of occipital bone	Extension, lateral flexion and rotation of head, cervical and thoracic spine
Musculus semispinalis cervicis	Transverse processes of vertebrae T1-T6	Spinous processes of vertebrae C2-C5	Extension, lateral flexion and rotation of head,

			cervical and thoracic spine
Musculus rectus capitis posterior major	Spinous process of axis	Lateral part of inferior nuchal line of occipital bone	Extension and rotation of the head
Musculus rectus capitis posterior minor	Posterior tubercle of atlas	Medial part of inferior nuchal line of occipital bone	Head extension
Musculus obliquus capitis superior	Transverse process of atlas	Occipital bone between superior and inferior nuchal lines	Head extension and lateral flexion
Musculus obliquus capitis inferior	Spinous process of axis	Transverse process of atlas	Head extension and rotation

3 NECK PAIN

"Pain is an unpleasant sensory and emotional experience associated with, or resembling that associated with, actual or potential tissue damage." This definition of pain by the International Association for the Study of Pain (Raja et al. 2020) encompasses both the sensory aspect of pain (the physical sensation) as well as the emotional and subjective components. It acknowledges that pain can be experienced even in the absence of actual tissue damage and highlights the complex nature of the experience.

Neck pain instead is defined by Merskey & Bogduk (2002) as follows: "Pain perceived as arising from anywhere within the region bounded superiorly by the superior nuchal line, inferiorly by an imaginary transverse line through the tip of the first thoracic spinous process, and laterally by sagittal planes

tangential to the lateral borders of the neck.” It is estimated that around 22%-70% of all people will experience neck area discomfort during their lifetime. (Childs et al., 2008) The majority of neck pain sufferers (50%–85%) in the general population do not fully get rid of their discomfort. (Caroll et al., 2008)

3.1 Possible reasons for neck pain

There are many reasons for neck pain and there can also be non-specific neck pain. Non-specific pain means that it is not possible to identify the culprit of pain symptoms. Some of the known causes for neck pain are introduced in the following paragraphs.

3.1.1 Cervical radiculopathy

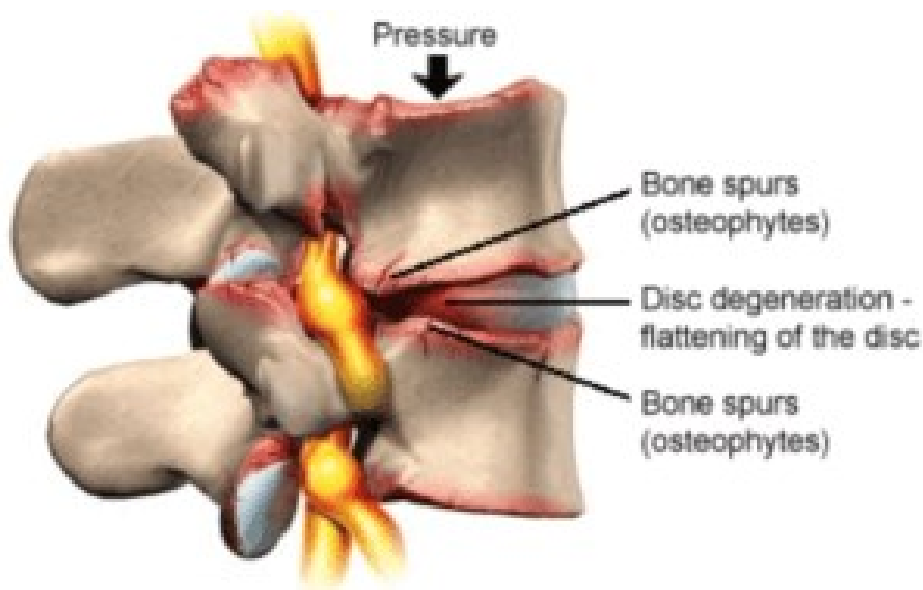
Neck pain can radiate to the upper limbs coupled with sensory, motor, and reflex changes in the affected limb. (Blanpied et al., 2017) Those are symptoms that are taken into consideration in the diagnostic process of a condition called cervical radiculopathy where a nerve in the cervical spine is compressed or irritated where it branches away from the spinal cord. The spinal nerve root can be compressed by a bone spur, a tumor, or a herniated disc. (Cervical Radiculopathy - OrthoInfo - AAOS, n.d.)

3.1.2 Spinal fracture

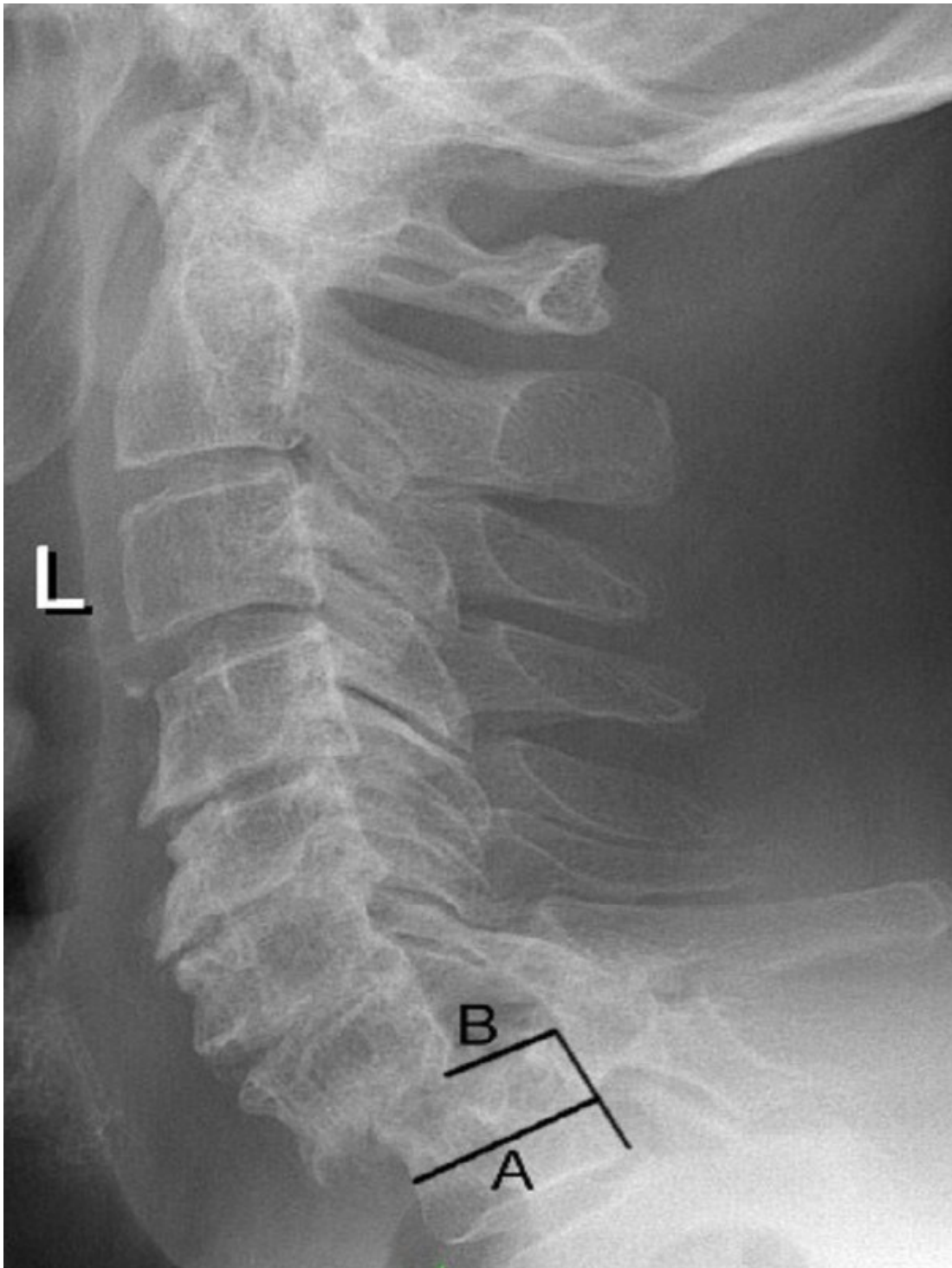
A cervical spine fracture can also be a cause of neck pain. Mechanosensitive nerve fibers that innervate bone undergo mechanical distortion right after a fracture. As a result, these nerve fibers quickly alert the brain to the first intense pain associated with a fracture. If the bone is unable to heal, it may lead to chronic pain. (Mitchell et al., 2018)

3.1.3 Spinal osteoarthritis

Spinal osteoarthritis, spondylosis, and degenerative disc disease all signify the same thing (picture 6). The vertebral disc starts to weaken and flatten which allows the vertebral bones above and below the disc to move out of place which can lead to vertebral slippage (spondylolisthesis, picture 7). People with osteoarthritis and spondylolisthesis can experience radiculopathical or myelopathical symptoms such as decreased reflexes, shooting pain, muscle atrophy, weakness, tingling (paresthesia) and coordination problems. (Johns Hopkins Medicine, 2019; Woo & Choi, 2021) All joints cannot be prevented from wearing and tearing. Wearing may occur in the joints as a result of pressure on the vertebral discs, and frequent use. In actuality, the alterations in our spine's joints and disks are normal and do not correspond to an illness like rheumatoid arthritis. The rate at which joint degeneration occurs can be accelerated by risk factors. (Physiopedia, 2013)



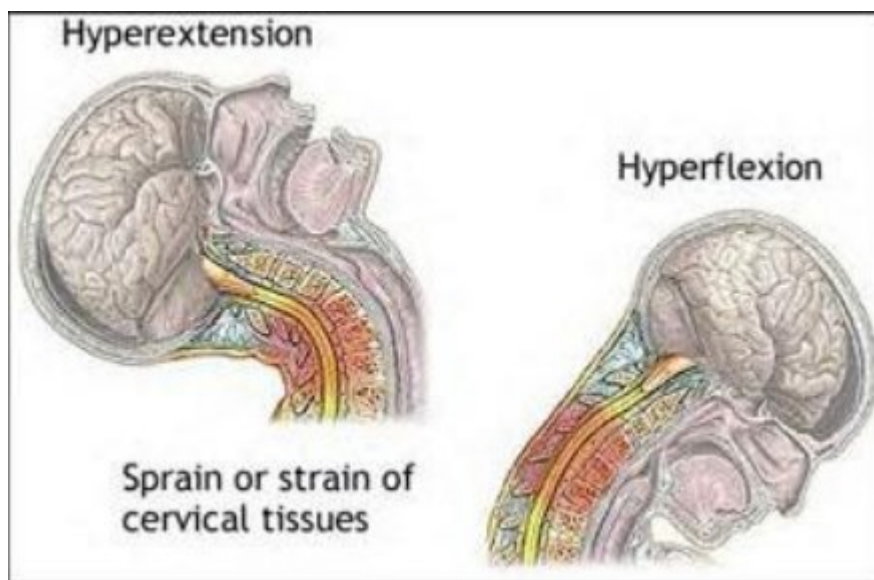
Picture 6: Cervical spine disc degeneration (researchgate.net)



Picture 7: Lateral radiograph of the cervical spine shows a spondylolisthesis at C7-T1 (preoperative); the sagittal diameter of T1 (A) was 22.6 mm and the horizontal displacement (B) between C7 and T1 was 13 mm. (Zwingenberger et al., 2012)

3.1.4 Musculoskeletal strains

Sprains and acute strains or contusion of the neck muscles and soft tissue are likely the most common injuries to the neck that occur to athletes in a tackling situation. When a muscle is stretched too much, it can cause whiplash (picture 8), which results in the tear of muscle fibers. While whiplash from a fall is possible, car crashes are more likely to cause it. These injuries are the consequence of the collision from every angle. This movement has the potential to harm the esophagus, blood vessels, muscles, facet joints, ligaments, nerves, bone, and numerous intervertebral discs, among other parts of the neck structure. Muscle damage occurs in almost all cases of cervical spine injuries. (Naser et al., 2016)



Picture 8: Sprain or strain of cervical tissues during hyperextension and hyperflexion (Researchgate.net)

3.1.5 Scoliosis

Scoliosis can cause neck pain also. It is a condition where the human spine has an abnormal lateral curvature, rotated and/or kyphotic outlook. Idiopathic scoliosis is hereditary, and it is the most common type of scoliosis. The word idiopathic refers to an unknown cause. The second type is congenital scoliosis, which is caused by rare and abnormal formation of the vertebrae during

embryotic development. It can be confirmed when the child is born. The third type is neuromuscular scoliosis is caused by abnormalities in the nerves and muscles that support the spine. A fourth type is adult-onset scoliosis, typically at the age of 50-70, which is caused by degeneration of intervertebral discs and ligaments, and it can be accompanied by decreased bone density also called osteoporosis (Columbia University Irving Medical Center, 2023). While scoliosis primarily affects the thoracic or lumbar spine, the compensatory changes in spinal alignment such as muscle imbalances and asymmetrical loading of the spine can also impact the cervical spine area, causing symptoms to the person such as movement and pulmonary function restrictions, and discomfort. (American Association of Neurological Surgeons, 2019)

3.2 Physiotherapeutic treatment of neck pain

There is evidence for thoracic spine manipulation in the treatment of neck pain. A Cochrane literature review by Gross et al. (2015) found that in the short-term follow-up, manipulation helped participants with acute and subacute neck pain feel better, and it also helped those with chronic and acute neck pain function better.

Treating the patient from the mental aspect is very important also since a worse prognosis of the condition was linked to poor psychological health and worrying, becoming upset, or being frustrated in reaction to neck pain. A better prognosis was linked to more optimism, self-assured coping, and a decreased need for social interaction. (Carroll et al., 2008; Sullivan et al., 2011; Buitenhuis et al., 2008)

Therapeutic exercise planning is a very important intervention of delivering help to neck pain patients. It can be stretching, aerobic exercise, strength training, ergonomic or postural changes. A systematic review and meta-analysis (Bertozzi et al., 2013) from Physical therapy academic journal concluded the data from 7 different studies regarding therapeutic exercise in neck pain patients. It showed that doing exercise ranging from 5 minutes to 50 minutes per

session multiple times a week done for an extended period resulted in better outcomes regarding neck pain in adults aged 18 years or older.

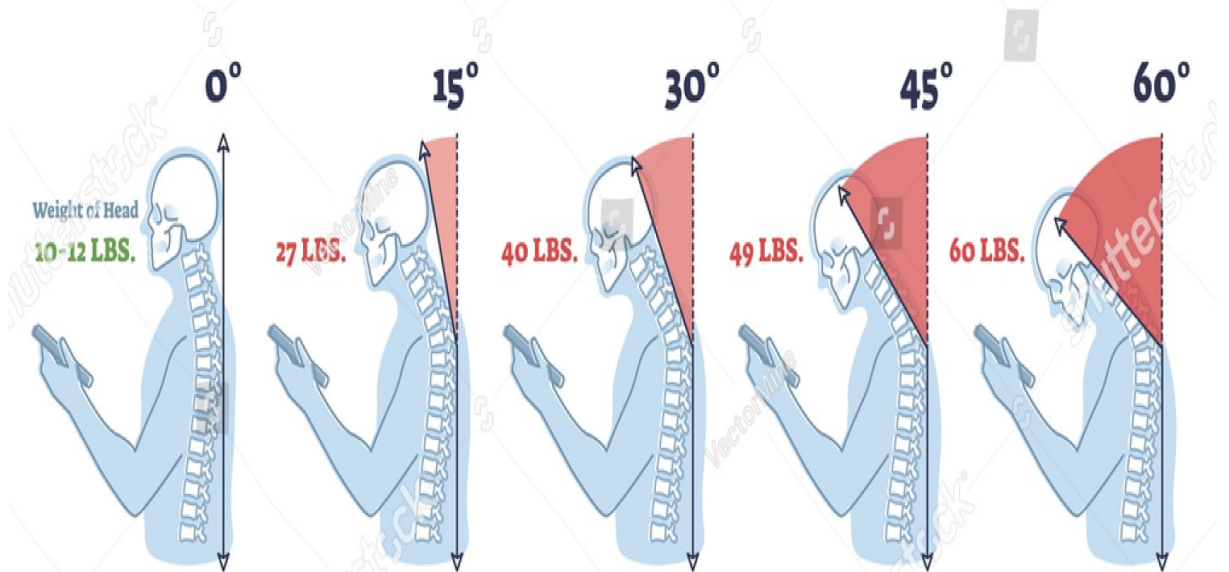
A systematic review and meta-analysis by Lew et. al. (2020) studied the effectiveness of dry needling and trigger point manual therapy on myofascial neck and upper-back syndrome. Neck disability index (NDI) and visual analogue scale (VAS) were used to gather information about the pain and disability of the individuals. The conclusion is that dry needling and trigger point manual therapy both improve pain and function in the short-to-medium term. Neither treatment was greatly better than the other.

4 TEXT NECK

The definition of text neck goes as follows according to the Text Neck Institute: “overuse syndrome involving the head, neck, and shoulders, usually resulting from excessive strain on the spine from looking in a forward and downward position at any handheld mobile device, i.e., mobile phone, video game unit, computer, mp3 player, e-reader. This can cause headaches, neck pain, shoulder, and arm pain, breathing compromise, and much more.” The term was first used by a Chiropractic physician called Dr. Dean L. Fishman. (Bhattacharya, S. et al. 2021)

A study published in the Surgical technology international 2014 publication concluded that the normal weight of an adult person’s head is 10-12 pounds (4,54kg - 5,44kg) and with the increase of the cervical spine flexion angle in a forward head posture, the load on the neck drastically increases respectively. The following visualization (picture 9) is demonstrating the phenomenon:

PHONE POSTURE



Picture 9: Head weight in relation to cervical spine angle (shutterstock.com)

A study by Guan et al. (2016) was conducted to research the head and cervical spine angle differences between males and females while using technical devices such as a mobile phone or a computer. The study was conducted for 219 males and 210 females. The study did find a difference so that males had a greater head and cervical spine flexion angles than females. It was associated with the amount of computer usage.

5 AIM AND OBJECTIVE

The aim of my thesis is to provide information about whether neck pain is related to text neck for people that have the condition or know someone with it. The objective of my thesis is to find available research from different databases and form a narrative literature review out of it.

The research question was:

- How are neck pain and text neck related in adults?

6 THESIS PROCESS AND METHODS

6.1 Narrative literature review

This thesis uses a narrative literature review approach, offering a summary and comparison of existing knowledge and research on the topic of text neck. The aim is to explain current findings on the causes, symptoms, and impacts of text neck, as well as the effectiveness of various prevention and treatment strategies.

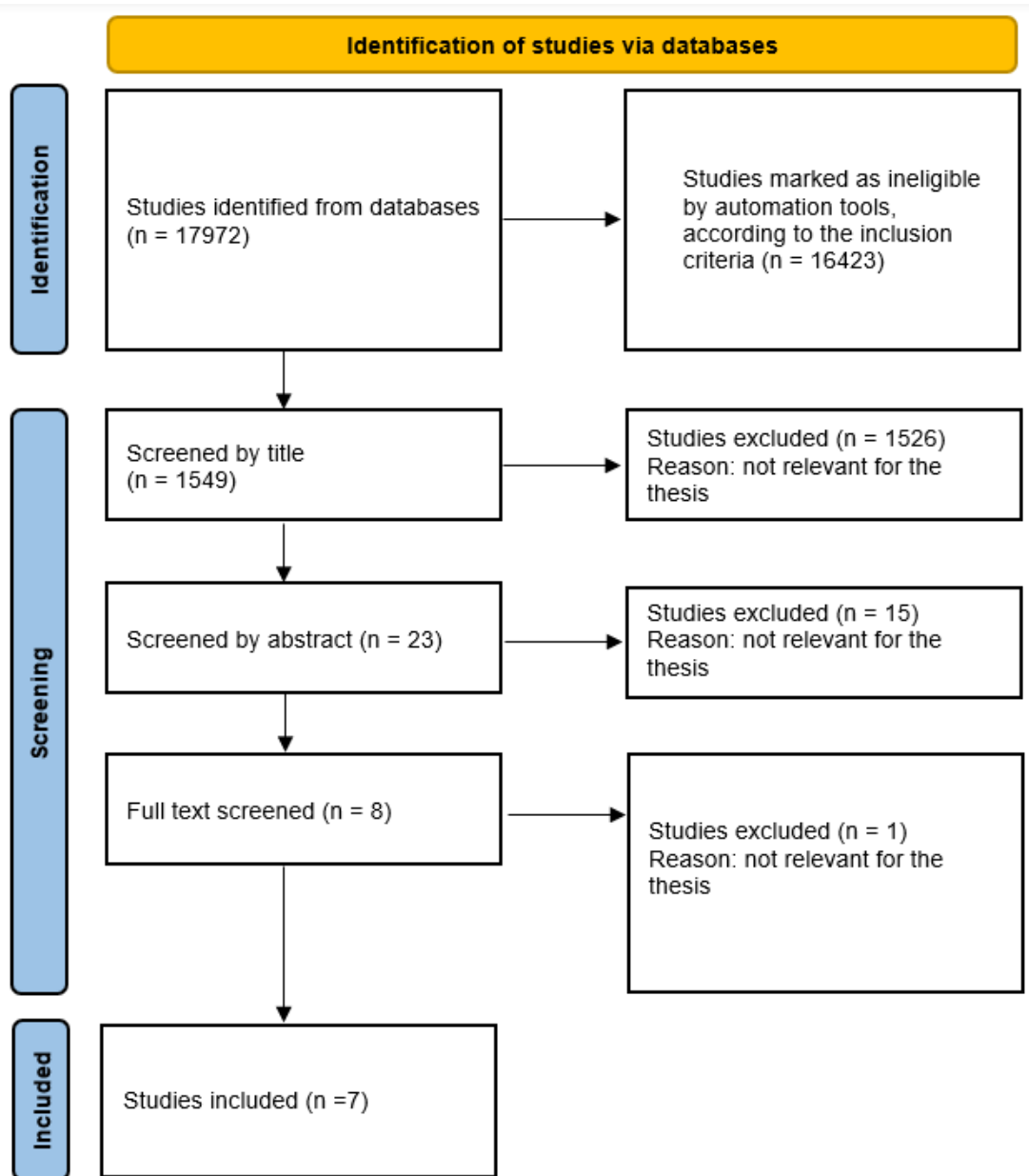
6.2 Data collection process

This narrative literature review consists of peer-reviewed studies written in English. For this thesis, relevant studies were sourced from several reputable databases, including PubMed, PEDro, Google Scholar, and SAMK Finna. PubMed provided access to a wide range of medical and health-related research. PEDro is an evidence-based research platform for physiotherapy related topics. Google Scholar is a broad tool to find diverse academic articles and publications, further enriching the research. Additionally, SAMK Finna, a research resource from the Satakunta University of Applied Sciences was also used. By using these research platforms, a versatile set of studies was gathered for this narrative literature review. In tables 4 and 5 inclusion and exclusion criteria there are listed and also the process of excluding studies during the data collection process.

Table 4: Inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
The study is relevant to the thesis subject	The study is not relevant to the thesis subject
Full-text available	Full-text not available
Written in English	Written in any other language
Less than 15 years old	More than 15 years old
Participants over 18	Participants under 18

Table 5: Prisma flow chart visualizing the identification of studies via databases.



6.3 Thesis schedule

This thesis of my bachelor's degree studies in Physiotherapy was started in the end of 2023 with planning the theoretical framework for my thesis. Research process started in the beginning of 2024 and it continued until the beginning of 2025. The final presentation of the thesis takes place during the spring of 2025.

7 RESULTS

Research including 101 research participants, conducted by Nejati et al. (2014), delves into the significant correlation between forward head posture, and neck pain among Iranian office workers. The identified relationship between specific postural deviations and neck pain emphasizes the importance of ergonomics and posture awareness in the workplace to mitigate the prevalence of occupational-related neck discomfort. The conclusion of the study is that forward head posture was associated with neck pain.

A study titled "Association Between Text Neck and Neck Pain in Adults," conducted by Correia et al. (2021), investigated the association between "text neck" and neck pain in adults. They conducted a comprehensive investigation for 582 volunteers aged between 18 and 65 years. The researchers used Cervical range of motion device (CROM) to measure the flexion of the cervical spine region. Both the standing and sitting posture were measured. A self-reported questionnaire was used to assess the sociodemographic, anthropometrics, lifestyle, psychosocial, NP, and smartphone use of the research participants. The study's findings, published in the Spine journal, concluded that text neck was not associated with prevalence, frequency, or maximum neck pain intensity in adults.

A Swedish study (Gustafsson et al., 2017) including 7092 young adults aged from 20-24 years old that took part in a questionnaire that asked about their technological device usage, neck pain, occupation, physical activity, education, general health and stress. The results show that text messaging is associated with temporary pain symptoms in the neck/upper back area.

Another Swedish study (Gustafsson et al., 2011) measured young adults' texting posture manually using a goniometer. 60 people were included which of 45 had existing musculoskeletal symptoms in the neck/upper extremity. The study shows that the participants who had no symptoms were texting with a not so flexed cervical spine.

A study from the European Spine Journal (Derakhshanrad et al., 2020) included 1602 office workers researching smartphone overuse in regards to neck pain. The study concluded that people that have smartphone overuse according to the SAS-SV (evaluation scale) are 6 times more likely to experience neck pain than people who aren't overusing their smartphones.

A systematic review and meta-analysis (Sadegh Mazaheri-Tehrani et al., 2023) released in the Preventive Medicine journal describes that computer and smartphone use is a considerable risk factor for neck pain. It is also worth mentioning that sitting time showed an insignificant relation with neck pain occurrence.

A study from the Kingdom of Saudi Arabia (Sirajudeen et al., 2022) included 313 university students aged over 18 years old. Data on the frequency of text neck posture, smartphone addiction/overuse, neck disorders, and physical activity level were gathered using a self-administered questionnaire. During the 12-month period, 46 percent of the students experienced neck pain. It was concluded that smartphone addiction is significantly associated with neck pain.

8 CONCLUSION

Most of the studies ended up with results showing that text neck is a risk factor for neck pain. However, not all research draws a direct link between text neck and chronic neck pain. For example, Correia et al. (2021) did not find a strong association between text neck and the intensity or prevalence of neck pain. While smartphone overuse and poor posture are found to be risk factors, the relationship between text neck and neck pain may vary based on individual factors such as posture habits, frequency of device use, and pre-existing conditions such as injuries, diseases, genetic structural problems etc. In summary,

while there's evidence suggesting that text neck can contribute to neck discomfort, it doesn't necessarily lead to chronic or severe pain in all individuals.

9 DISCUSSION

Healthcare monetary costs and personnel resources that are being used due to preventable neck pain patients are something that could be lowered via direct education for example in schools since that is when people get their phones for the first time. In the future, children could get them even earlier. But for the working age adults, companies could offer wellbeing information regarding their posture during work with technological devices. We can't forget about the older generation because smartphone and computer usage is common even in the elderly age groups. The need for ergonomic wellbeing assistance in older age groups is bigger because they are more likely to have done more physical work and overall have more years of strain on their neck behind them. Active participation in physical activities, social events, and sports during spare time would reduce the amount of smartphone use and its effects on neck pain in people of all ages. Others receive help to their neck pain problems by just taking into account their technological device ergonomics while others don't. As healthcare professionals, providing a variety of methods for neck pain is a good idea. But of course, the patients wishes must be respected.

This thesis aimed to research a very important topic and that would need to be researched even more. For example, in future studies, using larger sample sizes would improve the representation of the general population, leading to more reliable and generalizable results. Additionally, ensuring stricter inclusion criteria by excluding individuals with a history of diseases, injuries, medication use, genetic structural abnormalities, mental health conditions, prior surgeries, and drug use would help reduce potential factors that affect the experience of neck pain. Of course, the participating individuals should be in groups by gender, age, activity levels. Ethics have to be considered during the making of the

study. All personal information gathered from the individuals must be kept confidential and the data has to be stored securely. While stricter inclusion criteria may improve the reliability of the results, the researchers must ensure that exclusions do not lead to unfair discrimination.

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