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The impact and awareness of mobile touch screen devices usage on posture and its longer effects

Guidebook for physiotherapy students

DEGREE PROGRAMME IN PHYSIOTHERAPY
2023

ABSTRACT

Fazekas, Anna: The impact and awareness of mobile touch screen devices usage on posture and its longer effects, Guidebook for physiotherapy students
Bachelor's thesis
Degree programme in Physiotherapy
December 2023
Number of pages: 39

Mobile touch screen devices (MTSDs) have become an integral part of our daily lives; the time we spend using them is increasing. As children using them from a younger, formative age it might have a greater negative impact on their development. The objective of this thesis is to identify the impact of mobile device usage on school aged children and create a guidebook for physiotherapy students who might do their practice in an elementary school if the possibility opens for them in the future.

After defining a research question, the basis for theory was collected. Focusing on differences between paediatric and adult musculoskeletal systems, changes of physiological growth, atypical development, assessing children's posture, biomechanics of MTSD use and how it affects posture, and how to support healthy development. Relevant studies about the postural effects of MTSD use were found with Google Scholar and PubMed.

Studies found connection between excessive MTSD use and musculoskeletal discomfort or pain in the neck or shoulder area. However, there is a need for further studies in the topic, especially with longitudinal design because there are only a few studies focusing on this age group.

Keywords: children, adolescents, teenagers, posture, guidebook, elementary school physiotherapy, mobile device, ergonomics

CONTENTS

1 INTRODUCTION

Mobile touch screen devices (MTSDs) have become an integral part of our daily lives; the time we spend using them is increasing. Studies on musculoskeletal disorders related to the extensive use of MTSDs have shown that the posture assumed during usage results in the tensing of upper extremities. Which may result the development of musculoskeletal disorders. (Maniva et al., 2013)

Hence the choice for this topic about the effects of MTSDs usage on children's physical development and how to mitigate the potential long-term impact earlier preventatively.

With children now using MTSDs from a younger, formative age it may have a greater negative impact on their development; in comparison with an adult who started using MTSDs later. This could be a larger problem being underreported due to lack of awareness by the users. In elementary school aged children's development, would poor posture whilst using MTSDs have any risk of lasting effects?

The framework of the thesis will include theory on normal and atypical physical development of this age group and how to assess their posture, biomechanics and ergonomics of MTSD use. The guidebook's intended audience is physiotherapy students that might do practice in an elementary school environment. Providing for them contextually relevant guidance material to enhance what they previously learned during their courses.

At this age children are being unknowingly exposed to unhealthy postural behaviour patterns, teaching them about how their habits may affect their health could prevent some problems they might have later in their life.

2 AIM AND OBJECTIVE

The aim of this thesis is to identify the problem of poor posture caused by MTSDs usage among elementary school aged children. To answer the research question, the physical loading related to different postures will be compared. Based on this, guidance will be developed on preventing possible damage caused by spending long time in poor posture and gather evidence-based information to promote healthier habits.

The objective is to create a guidebook in English for physiotherapy students who do their practice in an elementary school. This guidebook would help them find information and improve knowledge on the 7-15 years old's' musculoskeletal development. Providing a source on how to assist them and how to present this information in an age appropriate and understandable way to encourage their wellbeing.

3 DIFFERENCES BETWEEN PAEDIATRIC AND ADULT MUSCULOSKELETAL SYSTEM

Paediatric musculoskeletal systems have distinctive reactions to injuries and recovery that are not present in adults' skeletons. There are different physiological factors to consider, such as increased body mass index on the growing skeleton, neurological development, and changes of growing. (Kocher, 2021, p. 114.)

Young children are relatively more flexible. With time, their joints became stiffer. (Kocher, 2021, p. 121.)

Bones are less dense, less lamellar with lower elastic modulus and increased porosity at birth compared to a mature bone. As a result of this, these bones bend more and in case of getting stressed, absorbing more energy before breaking. Adaptive changes happen while growing which result in the formation of lamellar and osteon bone within the diaphysis. (Kocher, 2021, p. 114.)

The most distinct structural difference between young and mature bone is the presence of physis or growth plate. (Kocher, 2021, p. 123.) Apophysis, which is a growth plate under tension from the insertion of large tendons is also a characteristic of a growing skeleton. These growth plates can be a location of acute injury or chronic irritation. Chronic overuse can lead to clinical inflammation and pain at the insertion of the tendon and not along the tendon itself as it can be seen at adults. (Kocher, 2021, p. 129.)

Contrary to an adult's skeleton, a child's skeleton can remodel and adapt in response to a local stress injury. The reason for this is the growth potential of the physeal plate and the remodelling potential of the periosteum. Even though this typically shows in long bones, it can happen in vertebrae and smaller bones as well. (Kocher, 2021, p. 144.)

The strength of a bone is related to the amount of stress it received, for example if a newly formed bone is subjected to loading, it grows thicker and stronger. In addition, the stress patterns that the bone was subjected to during the remodelling process can change the shape of the bone for fitting support. (Tortora & Derrickson, 2017, p. 158.)

4 PHYSIOLOGICAL GROWTH OF CHILDREN

Development consists of both common and unique experiences. As Santrock (2007) explained:

> Each of us develops partly like all other individuals, partly like some other individuals, and partly like no other individuals. Most of the time our attention is directed to an individual's uniqueness. But as humans we have all travelled some common paths. (Capuzzi, 2016, p. 281.)

Between 6 to 12 years of age, children’s bone structure lengthens and widens. As a result of this, 25-40 % of children experience growing pains, because their muscles and tendons are not growing at the same rate as their bones. (Capuzzi, 2016, p. 281-285)

Growing pains usually occur at night, affecting the lower extremities and can be resolved with local supportive measures. Growing pains do not affect the upper extremities or the spine and in this case a cautious assessment is needed. (Kocher, 2021, p. 148.)

There are two periods of rapid spinal growth: one is from birth to 3 years old and the other during adolescence. The growth is linear between these times. For males and females, the spinal pubertal growth spurts happen at different ages. On average, in the case of females, this happens between 8 to 14 years of age and the maximum growth appearing at a mean of 12 years of age. Comparatively, for males this growth spurt occurs in a later time, between ages 11 to 16 years with a maximum growth at age 14. (Campbell, 2012, p. 272)

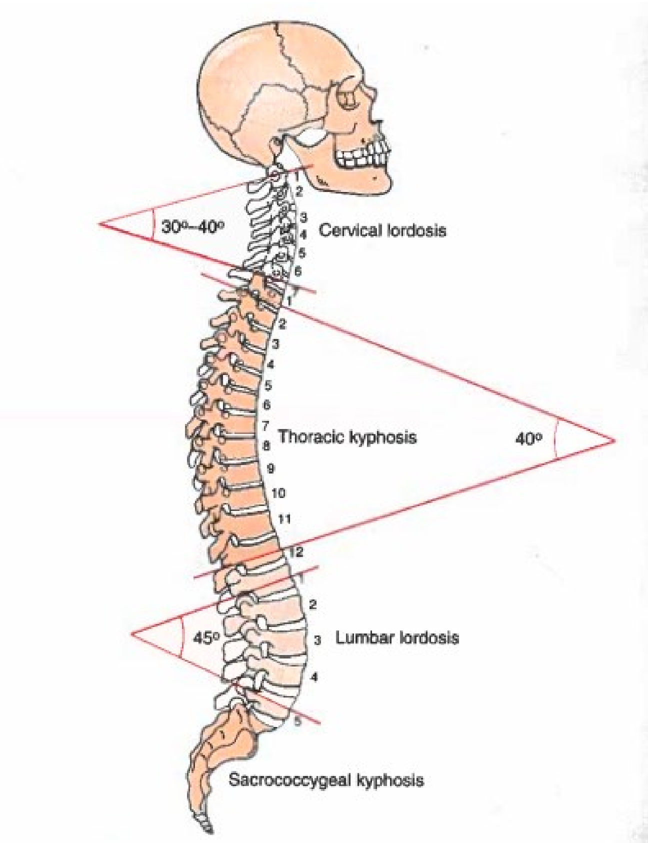
During puberty, the secretion of estrogens (produced by the ovaries) and androgens like testosterone (produced by the testes) has great effect on bone growth. These hormones with the androgens (produced by the adrenal glands for both males and females) are increasing the osteoblast activity, synthesis of the bone extracellular matrix and the growth spurt of this age. The presence of these hormones shut down the growth at epiphyseal (growth) plates, resulting in finishing the elongation of the bones. The lengthwise bone growth usually ends for females earlier, because of their higher levels of estrogens compared to males. (Tortora & Derrickson, 2017, p. 160)

Other factors affecting bone growth and remodelling are the available amounts of minerals such as calcium, phosphorous, magnesium, fluoride and manganese along with the necessary vitamins such as vitamin A (stimulates activity of osteoblast), vitamin C (for collagen synthesis), vitamin D (helps the absorption of calcium from foods in the gastrointestinal tract), and vitamins K and D_{12} (for synthesis of bone proteins). (Tortora & Derrickson, 2017, p. 160)

As a result of the rapid growth spurt, adolescents may seem clumsy. Poor postural habits and changes are more likely to occur at this age. (Magee, 2014, p. 1022)

4.1 Changes in posture

The cross-sectional study by Grabara et al. (2017) about spinal curvatures (Picture 1) of children and adolescents found that the shape of lumbar lordosis is associated with age and gender. With age the lumbar lordosis in male children and adolescents decreases. The most noticeable anterior and posterior curvatures were seen in 10-year-old male and female children. Girls were more lordotic than boys at all ages except 10-year-olds. The study showed links between sagittal curvatures and somatic parameters, but the observed correlations were weak. (Grabara et al., 2017, p. 69-74)



Picture 1: Typical curvatures of the spine (Magee, 2014, p. 152)

4.2 Atypical development

Postural deformities can be functional or structural entities. Functional hyperkyphosis, hyperlordosis and scoliosis need to be identified by a thorough clinical evaluation and overtreatment should be avoided. Though not all curves have a bad prognosis, so treatment should be planned considering the prognosis and any underlying pathology. (Fabry, 2009, p. 1415-1420)

4.2.1 Postural factors

The most frequent postural problem is when a person is sitting or standing for long periods of time and begins to slouch. Avoiding this requires strong and flexible muscles that can easily adapt to environmental changes, as these muscles are harmoniously working against gravity to maintain an upright posture. (Magee, 2014, p. 1022)

In the case of children, rapid growth spurt can also result in poor postural habits. When a child or adolescent wants to avoid being different because of their sudden height, they may start slouching to avoid standing out. Growth spurt might also cause unequal growth in different structures and can lead to unequal posture. For example, muscles and bones might grow with different rhythm. Another reason for poor posture might be muscle imbalance and muscle contracture, an example of this could be tight iliopsoas muscle increasing the lumbar lordosis in the lumbar spine. Poor posture might also be caused by pain, pressure on a nerve root in the lumbar spine can result in scoliosis as the body unconsciously assumes a posture that lessens the pain. In some cases, the posture is negatively affected by respiratory conditions, general weakness, excess weight, loss of proprioception or muscle spasms. Although there are various causes, most of the postural non-structural faults are relatively easy to correct after the reason for the problem was found. The treatment consists of strengthening weak muscles, stretching tight structures, and educating the patient about their own responsibility of maintaining a healthy posture. (Magee, 2014, p. 1022)

4.2.2 Structural factors

Congenital anomalies, developmental problems, disease, or trauma might cause structural deformities that result in alteration of posture. Examples being significant difference in leg length, or an anomaly of the spine. Because structural deformities mainly involve changes in bone, these are not easily correctable without surgery. On the other hand, proper postural care instructions can often ease symptoms.
(Magee, 2014, p. 1022)

4.2.3 Scoliosis

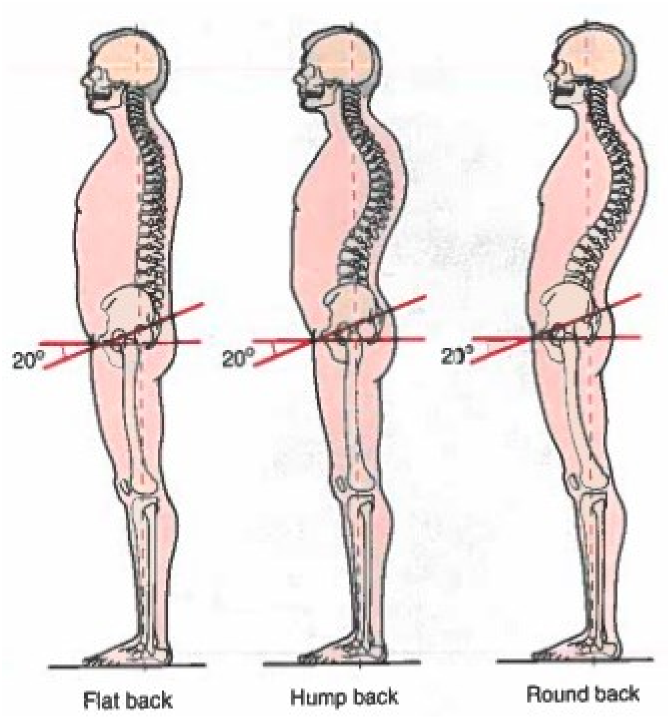
Scoliosis is a lateral curvature of the spine. The curvature in the coronal plane must be greater than 10° with an element of vertebral rotation. Being usually nonprogressive and often caused by a shortened lower extremity on the side of the apex of the curve, it is important to monitor non-structural curves during growth, as they may occasionally develop into structural deformities. On the contrary, structural curve cannot be fully corrected as the rotation of the vertebrae is toward the convexity of the curve. (Campbell, 2012, p. 272-273)

The most common form of scoliosis is idiopathic scoliosis which is of unknown origin. It can be further delineated by age of onset: infantile (from birth to 3 years old), juvenile (3 to 10 years old) and adolescent (older than 10 years). Although not all scoliosis is idiopathic, so congenital and neurologic causes should be ruled out. Structural curves have a rotary component which is visible when the trunk is bent forward, these curves are fixed and do not correct with lateral trunk bending or traction. Non-structural curves correct on lateral trunk bending, and can be caused by pelvic obliquity, limb length discrepancy or medical factors such as a tumour or muscle spasm. (Tecklin, 2015, p. 494)

4.2.4 Kyphosis

Kyphosis (Picture 2) is an abnormal posterior convexity of a spinal segment. It may occur as a result of trauma, congenital condition or Scheuermann's disease. Congenital kyphosis occurs when the anterior part of the vertebra is aplastic or hypoplastic and the posterior elements of the vertebra form normally. (Campbell, 2012, p. 282)

This exaggerated curvature of the thoracic spine most commonly occurs in the area between T10 and L2. The four types of kyphosis are round back, humpback, flatback and dowager's hump. Round back shows as a long, rounded curve with decreased pelvic inclination (<30°) and with thoracolumbar kyphosis, often with forward trunk flexion and decreased lumbar curve. Humpback appears as a localized, sharp posterior angulation of the thoracic spine, which is often a structural deformity caused by a fracture or pathology. Flatback shows with mobile lumbar spine and decreased pelvic inclination (20°). Dowager's hump is generally found in older age groups, usually caused by osteoporosis degeneration in the thoracic vertebral bodies to anterior direction. (Magee, 2014, p. 1024-1025)

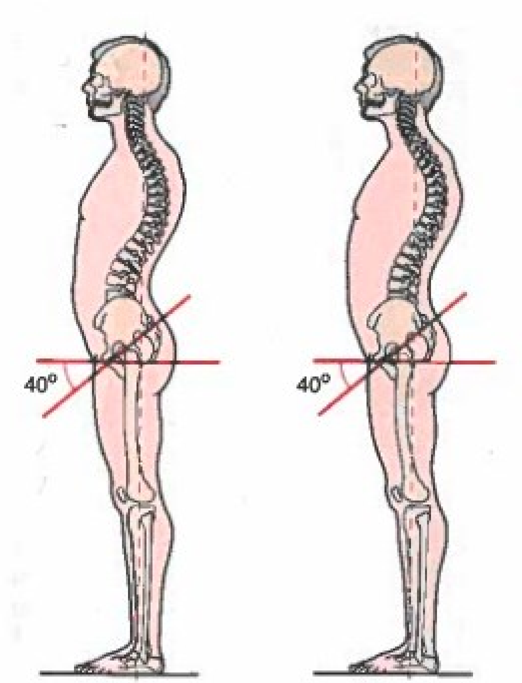


Picture 2: Examples of kyphosis (Magee, 2014, p. 1025)

4.2.5 Lordosis

Lordosis (Picture 3) is an anterior convexity or a posterior concavity of a spinal segment. Congenital lordosis is the result of the lateral posterior failure of segmentation. Both fixed and flexible lordosis can be found in children with a variety of diagnoses. As a compensation for an increased lumbar kyphosis, a lordosis may develop in the thoracic vertebrae. (Campbell, 2012, p. 283)

In a patient with pathological lordosis, sagging shoulders (protracted scapulae and medially rotated arms) and medially rotated lower limbs can be usually observed. Their head can be observed leaning forward as well, to keep it in front of the center of gravity. This posture is adopted to keep the correct visual plane and the center of gravity where it is supposed to be, as a deviation in one part of the body can result in a deviation in another part of the body. Lordosis increases the average pelvic angle from 30° to about 40°, accompanied by mobile spine and anterior pelvic tilt. This condition often shows with weakened deep lumbar extensors, weak abdominals, tight hip flexors and tensor fasciae latae. Swayback deformity similarly causes a near 40° pelvic tilt, but with a kyphosis of the thoracolumbar spine. This deformity causes the spine to bend posteriorly sharply at the lumbosacral angle, shifting the pelvis anteriorly and moving the hips to extension. The thoracic spine flexes on the lumbar spine to keep the center of gravity in its natural position which increases the curves of the thoracic and lumbar spine. This condition might show with tight hip extensors, lower lumbar extensors, upper abdominals, along with weakened hip flexors, lower abdominals and lower thoracic extensors. (Magee, 2014, p. 1023)



Picture 3: Examples of lordosis: exaggerated lordosis (left) and swayback (right) (Magee, 2014, p. 1023)

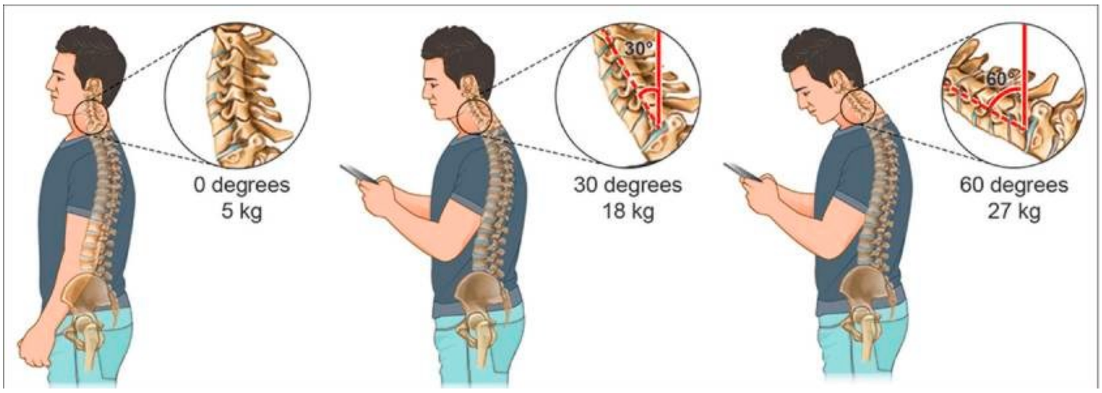
4.3 Assessing children’s posture

Posture is the relative disposition of the body at any one moment, it is also a composite of the positions of different joints of the body at that time. The position of each joint influences the position of the other joints. Correct posture is the position in which minimum stress is applied to each joint. If the upright posture is correct, minimal muscle activity is needed to maintain the position. Faulty posture occurs when static position increases the stress to the joints. If someone has strong, flexible muscles, faulty postures may not affect the joints because they can change position freely, preventing the stress from becoming too much. However, when joints are hypermobile or hypomobile, or when the muscles are shortened, lengthened or weak, it makes altering the posture to correct alignment more difficult. Which may result in some form of pathology. This pathology might be caused by microtrauma, the cumulative effect of re-curring small stress over a longer period of time or by a macrotrauma, of con-stant abnormal stress over a short period of time. The effect of this chronic stress can be similar to problems that are seen when acute stress is applied to the body. This increased stress might cause wearing of the articular surfaces of joints and may weaken soft tissues. Consequently, postural deviations are not initiating symptoms in every case, but over time they might. (Magee, 2014, p. 1017)

When assessing children's posture, the physiotherapist observes skeletal alignment from anterior, posterior, and lateral views. This process should in-clude head, spinal, and both lower extremity alignment, length, and upper ex-tremity positions. The physiotherapist looks for typical upright head, cervical lordosis, thoracic kyphosis, lumbar lordosis, pectis excavatum or carinatum, and anterior or posterior pelvic tilt relative to the age of the child from a lateral view. From the posterior view the physiotherapist visually notes symmetry of the shoulder, scapulae, pelvic height, and lateral rib asymmetries like a rib hump, suggesting a rotational deformity of the spine. An anterior view can help identify symmetries of lateral rib position and pelvic height. (Tecklin, 2015, p.464-465)

5 BIOMECHANICS OF MOBILE TOUCH SCREEN DEVICE USE

The way the head is tilting forward in different degrees can increase the weight and the pressure being put on the spine. A full-grown head weights 4.54 to 5.44 kg in the neutral position. But as the head leans forward, this weight increases to 12.25 kg at 15 °, 18.14 kg at 30 ° and 27.22 kg at 60 ° (Picture 4). This repeated posture over time causes changes in the cervical spine, curvature, supporting ligaments, tendons, musculature as well as the bony segments. Often resulting in pain felt in the neck and associated areas as well as adaptive change in posture. (Hansraj, 2014)



Picture 4 illustrating how different angles change the weight load on the neck. The angle is measured between the global vertical and the vector pointing from C7 to the occipitocervical joint. (Fares et al., 2017)

A study (Vahedi et al. , 2020) observed neck kinematics with a motion analysis system while completing tasks involving reading, watching a video, and typing on their smartphones. The participant’s head forward flexion, lateral bending angle, and viewing distance while doing their tasks in sitting/standing postures and one-handed/two-handed grips were recorded. The participants filled out a questionnaire before and after the completion of their tasks. Their results showed an increase in neck and upper limb pain after finishing. Both sitting and standing postures were related to greater head forward flexion while watching and viewing distance for two-handed typing. They measured higher left lateral bending values for one-handed watching and reading tasks in standing posture. In general, completing their tasks while sitting resulted in more head forward flexion, with higher discomfort and lower lateral bending angles in all tasks and grip types. (Vahedi et al., 2020, p. 837-846)

The laboratory-based study by Syamala et al. (2018) found that the increased head-neck flexion, muscle activity in the neck and shoulder region, and gravitational movement while using a MTSDs might increase musculoskeletal pain or injuries in the area. Their results suggest that holding the phone to eye level with the help of arm rests and back support can reduce the biomechanical stress in the neck and upper extremities. (Syamala et al. 2018, p. 48-54)

The study by Tapanya et al. (2021) compared the effects of four different neck flexion angles (0°, 15°, 30° and 45°) on neck gravitational movement and muscle activity in standing while participants used smartphones. The neck gravitational moment, cervical erector spinae (CES) and upper trapezius (UT) activity of the participants were examined. The results showed that with the neck flexion angle increasing, the gravitational moment of the neck and the muscle activity of CES increased significantly, however that of UT decreased. The lowest gravitational moment of the neck at 0° flexion was consistent with the lowest CES muscle activity and the lowest neck discomfort score. Therefore, they recommend avoiding neck flexion of over 30° and rather recommend a neutral position of 0° flexion when texting on a smartphone. (Tapanya, 2021, p. 900-911)

Another study by Tapanya et al. (2021) focused on different shoulder postures of smartphone users. The participants performed texting tasks for 3 minutes at shoulder flexion angles of 15°, 30°, 45°, and 60°, while maintaining a neck posture in the neutral, 0° neck flexion angle position. Measuring their neck and shoulder muscle activity showed that the activity of their anterior deltoid and lower trapezius increased with the increase of the shoulder flexion angle. Meanwhile the activity of cervical erector spinae and upper trapezius decreased. Based on these results, a recommended 30° shoulder flexion was identified because this angle provided the best compromise between the activation levels of the studied muscles and caused the lowest level of discomfort. (Tapanya, 2021)

6 THE IMPACT OF MOBILE TOUCH SCREEN DEVICE USAGE ON POSTURE

The systematic review by Yakout et al. focused on how the use of MTSDs effect children's upper body posture. They found the increased head and neck flexion, and rounded shoulders posture in lying, sitting, or standing affecting children negatively. The damage being correlated with the time children spent using the devices. Their study also pointed out the need for further studies in the topic. (Yakout et al. 2022, p. 2591-2600)

The systematic review by Sarikaya et al. (2023) had similar results, finding limited evidence of the postural effect of MTSD use negatively affecting spinal posture, depending on the duration of use. They also highlight the need for longitudinal studies that focus on MTSD use in natural environments. (Sarikaya et al. 2023)

The literature review by Domoff et al. found hardly any studies focusing on the effects of MTSD use and aspects of the physical health of children, such as musculoskeletal problems, pain, neurological and ocular concerns. Even though research made with adults suggest that these physical health areas may be impacted by excessive MTSD use, few studies have observed these associations in children. They also found no investigations using longitudinal design. They see a need for expanding the scale of investigations to include MTSD related health concerns so far identified in adults. (Domoff et al. 2019)

6.1 Possible longer effects

Evidence shows that children, especially adolescents who report persistent pain, are at an increased risk of chronic pain as adults. On the contrary, this increased risk is rarely occurring and report of multiple symptoms in childhood are uncommon. Additionally, many musculoskeletal illnesses follow a long-term pattern of recurring aggravations and remissions. (Jones et al., 2007)

In a longitudinal study published by Brattberg (2004), 335 children participated at ages 8, 11 and 14, first studied in 1989 and were later followed up on two occasions in 1991 and 2002. Participants responded to surveys on their pain. Based on the results, a connection was found between pain reports recorded during the participants childhood, early adolescence, and early adulthood. This highlights the need for more attention when managing health related issues in this vulnerable group. (Brattberg, 2004, p. 187-199)

Studies found connection between early exposure to MTSDs and musculoskeletal problems later in life. However, experimental studies are needed regarding the topic to confirm the direct cause and effect of the question. As most research was focused on young adults, more research relating children and adolescents are needed. They also mentioned the need for better classroom furniture, along with a need for guidelines to educate people on how to use MTSDs in neutral postures and about the importance of exercising more. (Warda et al., 2023; David et al., 2021)

A systemic review by Toh et al. (2017) showed limited evidence that MSTD use and different aspects of use (such as amount of time spent, tasks or positions) associated with musculoskeletal symptoms and exposures. They concluded that this is because of mostly low quality experimental and case-control studies with few cross-sectional and no longitudinal studies. For this reason, further research is necessary for developing guidelines for healthy use of MTSDs. (Toh et al., 2017)

7 SUPPORTING HEALTHY DEVELOPMENT

The systematic review by Yakout et al. (2022) recommends parents, teachers, or other caretakers of children to prevent excessive screen time for children. Not only limiting it to 1-2 hours daily, but also encouraging children to move, take breaks and help them choose a different activity. They advise against using the phone in lying position and recommended keeping it away from the child's bedroom. Exercise activities that promote relaxation of the shoulders and neutral neck and back posture should be encouraged. They recommend having at least an hour of physical activity daily. Parents of younger children should be provided with knowledge of safer postures. For example, using a tablet with a stand on a table, rather than on their lap to prevent the risk of musculoskeletal pain and reduce neck muscle activity by providing a neutral posture. It was also suggested to ensure suitable traditional toy play with its connected physical activity benefits. (Yakout et al. 2022, p. 2591-2600)

7.1 Health literacy

The concept of health literacy is relatively new. It is defined as a combination of motivation, confidence, physical competence, knowledge with an understanding to value and take responsibility for commitment in being physically active throughout life. (Kämppi et al. 2022, p.36) The Health Behaviour in School aged Children study found that Finnish adolescents generally have a good understanding of health literacy, without difference among boys and girls. (Paakkari et al. 2021. P 136-138)

The community in schools, family and friends have an important role in supporting the involvement in physical activity. As children and adolescents are spending lot of time in educational institutes, the attitude towards physical activity there can influence them as they are learning a more active or passive lifestyle. These learned habits will likely impact their wellbeing in adulthood. (Kämppi et al. 2022, p.38)

7.2 Physical activity

Play is an important part of socialization and human behaviour. It was found that play benefits peer relations, boost self-esteem, influence attitude and releases tension. As it is being a key part of growth, it influences development. The time spent with play and sport activities during childhood and adolescence provide opportunities for improving cognitive, physical, and motor development. (Gabbard, 2022, p. 375-394)

The World Health Organization (2022) recommends for children and adolescents aged 5-17 years to have a minimum of 60 minutes per day of moderate-to-vigorous intensity, mostly aerobic, physical activity throughout the week. It was also suggested to have at least 3 times per week some vigorous-intensity aerobic activities, as well as those that strengthen muscle and bone. In addition to this, the amount of time spent being sedentary, especially the amount of recreational screen time should be limited.

The length of sedentary time (waking time spent in a physically passive way) has connection to poorer health. In case of school aged children, the amount of sedentary time and screen time increases with age. Research found no specific time amount to define from when sedentary time becomes harmful. However, it is recommended to substitute some of the individual sedentary time with moderate-to-vigorous physical activity as evidence shows it being beneficial for mental and physical health. (Kämppi et al. 2022, p.26.)

The study by Jussila et al. (2022) focused on measuring sedentary behaviour, physical activity levels and patterns with accelerometer among Finnish children and adolescents. In total 3274 (3^{rd}, 5^{th}, $7^{th,}$ and 9^{th} grader) participants were involved from 176 schools. The participants daily activity was measured with hip-worn triaxial accelerometer for a week during waking hours. Using the mean amplitude deviation of the acceleration data, the intensity of the participants' activity was converted into metabolic equivalents so it could be divided into light, moderate and vigorous categories. For measuring sedentary behaviour and standing, the angle of posture estimation was used. Their results included:

> The majority of participants' PA consisted of light PA, and they were sedentary for more than half of their waking hours. Children were more active than adolescents, and boys were more active than girls. Participants took, on average, 9890 steps daily, and one third met the PA

recommendation. The participants were divided into tertiles based on daily steps to investigate the variation in PA patterns. Compared to the least active tertile, the most active tertile took twice as many steps on weekdays and nearly three times as many steps on the weekend. Conclusions: The majority of the participants were not active enough, and there was a great variation in PA levels and patterns, especially among the adolescents and on weekends. (Jussila et al., 2022)

7.3 Ergonomics while using mobile touch screen devices

To prevent musculoskeletal symptoms, Gustafsson recommends supporting the forearms, using both thumbs and avoiding sitting with the head bent forward while texting. (Gustafsson, 2012, p. 5705-5706.)

Instead of holding the phone at stomach level, raising it to chest level with the arms bent can help keeping the neck in a more comfortable, neutral position. (Gustafsson et al., 2016, p. 208-214.)

After evaluating trapezius muscle activity, Tang et al. (2021) found that keeping a static posture while texting was more fatiguing with higher level of discomfort compared to dynamic posture. Supporting the forearm while texting resulted in reduced muscle activity, less fatigue and discomfort. For these reasons they suggest avoiding texting with forearm floating while keeping a static posture (especially sitting) for a long time. (Tang et al., 2021.)

8 INTRODUCTION OF GUIDEBOOK

With the possibility of physiotherapy students doing a practice placement in an elementary school with a school physiotherapist; this guidebook is to provide them with relevant information to expand their knowledge from their previous courses. The guidebook was made with the intention to give something easily readable and understandable for the physiotherapy students who are interested in this topic. As back problems are common and affecting many people, it is important to learn about prevention. Learning how to take care of our bodies from a young age might help to avoid or delay some musculoskeletal complications as a result of poor posture from MTSDs use.

The author decided to use Canva, an online graphic design tool to make the guidebook. The reason to choose this tool was to make an eye-catching layout to motivate the reader to read it. The applicable points from the Content style guide of NHS (2022) Standard for creating health content was used in the process of creating the guidebook to help the author create functional structure and content.

The language of the 12-page guidebook is English. It consists of ergonomics recommendation for safer MTSD use and some examples of preventative exercises. The exercises were chosen from Physiotools. The illustrations were drawn by the author to make the guidebook look consistent.

9 METHODOLOGY AND THESIS PROCESS

The thesis is a practical thesis including a guidebook for physiotherapy students which is based action research method. Consisting of a theory part, covering the development of 7-15 years old’s, what to look out for when assessing their posture, postural biomechanics while holding a MTSD and if poor posture while using MTSDs can have a lasting effect on them. The literature used for this thesis sources found in SAMK Finna, PubMed and Google Scholar. The initial criteria was to include sources from 2018 to 2023, although some relevant sources were included from earlier years.
The thesis process was supported by teacher feedback.

The presentation of the thesis plan was on 26.01.2023. Most of the theory part was written during the autumn semester.
The thesis was planned to be finished in November 2023.

10 DISCUSSION

The limited number of studies about whether the posture of someone while using MTSD will have a lasting effect on them made answering the research question of this thesis difficult. Studies seemed to agree about negative effects and the need for further research in the topic, as the lack of validated tools to evaluate pain levels or outcomes makes it difficult to compare the results. The commonly used questionnaires are making it challenging to evaluate the results as environmental, cultural, and personal factors need to be considered.

This thesis scope was limited to focus on postural changes. However, studies expressed the risk of headache, visual fatigue or eyestrain, disturbed sleeping patterns, mental health problems and psychological aspects that also related to excessive MTSD use, regardless of age.

Finding studies to include in the thesis was challenging, as many studies focused on computer, TV, tablet, and mobile use together, summing it all as screentime, even though the posture while using these devices can be varying from laying down, to sitting or standing. Another reason that excluded many search results was that the participants of the studies not belonging in the 7-15 years old age group, as most studies focused on students in higher education or working adults. Additionally, studies that did fucus on the 7-15 years old age group, were mostly in the topic of mental health and cognitive development being affected by extended screentime.

While searching for relevant sources for the topic, the author of this thesis fond studies about how using a MTSDs while walking affects the gait. This topic could be added to broaden the scope. However, it seemed too diverting to include in this thesis.

Even though there are mostly negative influences connected to MTSD use, the author of this thesis feels needed to add that serious games (games with educational qualities) or gamification (having game like elements) in apps focusing on health promotion can be helpful and easily accessible to people. The key is moderation and learning how to use it to our benefit with reducing harmful impacts.

REFERENCES

Brattberg, G. (2004). Do pain problems in young school children persist into early adulthood? A 13-year follow-up. European Journal of Pain, Volume 8, Issue 3,187-199. https://doi.org/10.1016/j.ejpain.2003.08.001.

Campbell, S. K., Palisano, R. J., & Orlin, M. N. (2012). Physical therapy for children (4th ed.). Saunders Elsevier. 272. 273. 282.

Capuzzi, D., & Stauffer, M. D. (2016). Human growth and development across the lifespan: Applications for counselors. Wiley. https://ebookcentral.proquest.com/lib/samk/reader.action?docID=4405838

David, D., Giannini, C., Chiarelli, F., & Mohn, A. (2021). Text Neck Syndrome in Children and Adolescents. International journal of environmental research and public health, 18(4), 1565. https://doi.org/10.3390/ijerph18041565

Domoff, S.E., Borgen, A.L., Foley, R.P.& Maffett, A. (2019). Excessive use of mobile devices and children's physical health. Human Behaviour & Emerging Technologies. 1: 169–175. https://doi.org/10.1002/hbe2.145

Fabry, G. (2009). Clinical practice: The spine from birth to adolescence. European Journal of Pediatrics 168, 1415–1420. https://doi.org/10.1007/s00431-009-0998-9

Fares J, Fares M.Y, Fares Y. (2017). Musculoskeletal neck pain in children and adolescents: Risk factors and complications. Surgical Neurology International. 2017 May 10;8:72. doi: 10.4103/sni.sni_445_16

Gabbard, C. P. (2022). Lifelong motor development. Wolters Kluwer. 375-394.

Grabara,M.,Bieniec,A. & Nawrocka,A.(2017).Spinal curvatures of children and adolescents – a cross-sectional study. Biomedical Human Kinetics,9(1) 69-74. https://doi.org/10.1515/bhk-2017-0011

Gustafsson, E. (2012). Ergonomic Recommendations When Texting on Mobile Phones. IEA 2012: 18th World congress on Ergonomics - Designing a sustainable future. 5705 – 5706. DOI: 10.3233/WOR-2012-0925-5705

Gustafsson, E., Thomée, S., Grimby-Ekman, A.,& Hagberg, M.(2017), Texting on mobile phones and musculoskeletal disorders in young adults: A five-year cohort study. Applied Ergonomics. Volume 58, 208-214. ISSN 0003-6870. https://doi.org/10.1016/j.apergo.2016.06.012.

Hansraj, K.K. (2014) Assessment of stresses in the cervical spine caused by posture and position of the head. Surgical Technology International, 2014 Nov;25:277-9. https://pingeprii.ee/wp-content/uploads/2016/09/Hansray-K.K.-Assessment-of-Stresses-in-the-Cervical-Spine-Caused-by-Posture-and-Position-of-the-Head.pdf

Jones, G.T., Silman, A.J., Power, C., & Macfarlane, G.J. (2007), Are common symptoms in childhood associated with chronic widespread body pain in adulthood?: Results from the 1958 British birth cohort study. Arthritis & Rheumatism, 56: 1669-1675. https://doi.org/10.1002/art.22587

Jussila, A.M., Husu, P., Vähä-Ypyä, H., Tokola, K., Kokko, S., Sievänen, H., & Vasankari, T., (2022) Accelerometer-Measured Physical Activity Levels and Patterns Vary in an Age- and Sex-Dependent Fashion among Finnish Children and Adolescents. International Journal of Environmental Research and Public Health. 19(11):6950. https://doi.org/10.3390/ijerph19116950

Kocher, M. S., & Noonan, K. (2021). Pediatric musculoskeletal physical diagnosis: A video-enhanced guide. Wolters Kluwer. 114.

Kämppi, K., Asunta, P., & Tammelin, T. (2022). Finland's Report Card 2022 on Physical Activity for Children and Youth. 2022. LIKES Research Reports on Physical Activity and Health 407. JAMK University of Applied Sciences.

Magee, D. J. k. (2014). Orthopedic physical assessment (6th edition.). Elsevier.

Maniwa, H., Kotani, K., Suzuki, S.,& Asao, T. (2013). Changes in Posture of the Upper Extremity Through the Use of Various Sizes of Tablets and Characters. In: Yamamoto, S. (eds) Human Interface and the Management of Information. Information and Interaction Design. HIMI 2013. Lecture Notes in Computer Science, vol 8016. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-39209-2_11

NHS. (2022, July). Standard for creating health content. NHS Digital service manual. Retrieved November 24, 2023, from https://service-manual.nhs.uk/content/standard-for-creating-health-content

Paakkari, L., Paakkari, O., Tynjälä. J. & Kokko, S. (2021) Terveyden lukutaito, liikunta-aktiivisuus ja urheiluseuratoimintaan osallistuminen. [in Finnish] In S. Kokko, R. Hämylä & L. Martin (eds.) Nuorten liikuntakäyttäytyminen Suomessa. LIITU-tutkimuksen tuloksia 2020. Publications of the National Sports Council 2021:1, 136–138.

Sarıkaya, M. , Avcı, P. , Satılmış, N. , Kılınçarslan, G. , Bayraktar, I. & Bayrakdar, A. (2023). The Effect of Digital Gaming Duration on Musculoskeletal System Symptoms: A Systematic Study . International Journal of Disabilities Sports and Health Sciences , 6 (3) , 564-573 . DOI: 10.33438/ijdshs.1332626

Syamala, K.R., Ailneni, R.C., Kim J.H. & Hwang, J. (2018) Armrests and back support reduced biomechanical loading in the neck and upper extremities during mobile phone use, Applied Ergonomics, Volume 73, 48-54, ISSN 0003-6870, https://doi.org/10.1016/j.apergo.2018.06.003.

Tang, Z., Jin, X., Wu, Y., Ma, J., Xia, D., Dong, Y., & Yang, C. (2021) Ergonomic evaluation of the effects of forearm conditions and body postures on trapezius muscle activity during smartphone texting, International Journal of

Industrial Ergonomics, Volume 82, 103085, ISSN 0169-8141, https://doi.org/10.1016/j.ergon.2021.103085.

Tapanya, W., Puntumetakul, R., Neubert, M.S. & Boucaut , R. (2021) Influence of neck flexion angle on gravitational moment and neck muscle activity when using a smartphone while standing, Ergonomics, 64:7, 900-911, DOI: 10.1080/00140139.2021.1873423

Tapanya, W., Neubert M.S., Puntumetakul, R. & Boucaut, R. (2021) The effects of shoulder posture on neck and shoulder musculoskeletal loading and discomfort during smartphone usage, International Journal of Industrial Ergonomics, Volume 85, 103175, ISSN 0169-8141, https://doi.org/10.1016/j.ergon.2021.103175.

Tecklin, J. S. (2015). Pediatric physical therapy (5th ed.). Lippincott Williams & Wilkins, a Wolters Kluwer business. 464-465. 494.

Toh, S.H., Coenen, P., Howie, E.K.& Straker, L.M. (2017). The associations of mobile touch screen device use with musculoskeletal symptoms and exposures: A systematic review. PLoS ONE 12(8): e0181220. https://doi.org/10.1371/journal.pone.0181220

Tortora, G. J. & Derrickson, B. H. (2017). Tortora's principles of anatomy & physiology: Study guide (15th edition.). John Wiley & Sons.

Vahedi, Z., Mazloumi, A., Sharifnezhad, A., Kazemi, Z. & Garosi, E. (2020). Head Forward Flexion, Lateral Bending and Viewing Distance in Smartphone Users: A Comparison Between Sitting and Standing Postures. 837 – 846. doi: 10.3233/WOR-203303

Warda, D.G., Nwakibu, U. & Nourbakhsh A., (2022, October 5). Neck and Upper Extremity Musculoskeletal Symptoms Secondary to Maladaptive Postures Caused by Cell Phones and Backpacks in School-Aged Children and Adolescents. Healthcare. 2023; 11(6):819. https://doi.org/10.3390/healthcare11060819

World Health Organization. Physical activity. https://www.who.int/news-room/fact-sheets/detail/physical-activity

Yakout, A, Refaat, M.S. & Abdelazeim, F.H., (2022). Effect of Modern Technology on Upper-Body Posture in Normal Developed Children: Systematic Review. The Medical Journal of Cairo University, 90(12), 2591-2600. doi: 10.21608/mjcu.2022.295336

APPENDIX 1: GUIDEBOOK

THE IMPACT AND AWARENESS OF MOBILE TOUCH SCREEN DEVICES USAGE ON POSTURE AND ITS LONGER EFFECTS

Guidebook for physiotherapy students

Contents

Introduction

The content of this guidebook is based on a thesis, with the objective to provide information for physiotherapy students.

Studies found the increased head and neck flexion with rounded shoulders posture in lying, sitting, or standing affecting children negatively, although defining the long term effects requires further research. The damage being correlated with the time children spent using the devices.

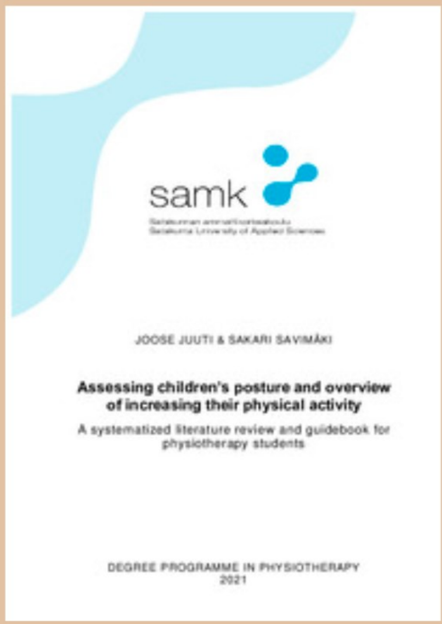
The included examples of exercises promoting relaxation of the upper limbs, and neutral neck and back posture to counteract the forward rounding neck and shoulders while using a mobile device for a longer period of time.
The number of repetitions and length of time to hold each stretch should be adjusted considering the individual.

About posture

For guidebook about children's posture and promoting physical activity:

The thesis by Juuti, Joose & Savimäki, Sakari (2021)

Assessing children's posture and overview of increasing their physical activity : a systematized literature review and guidebook for physiotherapy students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JOOSE JUUTI & SAKARI SAVIMÄKI

Assessing children's posture and overview of increasing their physical activity

A systematized literature review and guidebook for physiotherapy students

DEGREE PROGRAMME IN PHYSIOTHERAPY
2021

Growing

Young children are relatively more flexible. With time, their joints became stiffer.

The most distinct structural difference between young and mature bone is the presence of physis or growth plate. This is why a child's skeleton can remodel and adapt in response to a local stress injury. Even though this typically shows in long bones, it can happen in vertebrae and smaller bones as well.

The strength of a bone is related to the amount of stress it received, for example if a newly formed bone is subjected to loading, it grows thicker and stronger. These stress patterns can change the shape of the bone for fitting support.

As their muscles and tendons are not growing at the same rate as their bones, 25-40 % of children experience growing pains between 6 to 12 years of age. Growing pains usually occur at night, affecting the lower extremities and can be resolved with local supportive measures.

Apart from the times of growth spurts, the growth is linear. The first period of rapid spinal growth is from birth to 3 years old and the other during adolescence. The second rapid spinal growth happens in the case of females, between 8 to 14 years of age and the maximum growth appearing at a mean of 12 years of age. Comparatively, for males this growth spurt occurs in a later time, between ages 11 to 16 years with a maximum growth at age 14.

During puberty, the secretion of estrogens (produced by the ovaries) and androgens like testosterone (produced by the testes) has great effect on bone growth. These hormones with the androgens (produced by the adrenal glands for both males and females) are increasing the osteoblast activity, synthesis of the bone extracellular matrix and the growth spurt of this age. The presence of these hormones shut down the growth at epiphyseal (growth) plates, resulting in finishing the elongation of the bones. The lengthwise bone growth usually ends for females earlier, because of their higher levels of estrogens compared to males. Bone growth and remodelling are affected by the available amounts of minerals and the necessary vitamins.

The rapid growth spurt may cause adolescents to seem clumsy. Poor postural habits and changes are more likely to occur at this age.

Ergonomics

The way the head is tilting forward in different degrees can increase the weight and the pressure being put on the spine. Holding a phone closer to eye level or raising a tablet with a stand on a table, rather than on the lap can help prevent the risk of musculoskeletal pain and reduce neck muscle activity by providing a neutral posture.

Supporting the forearms, using both thumbs and hands can also be helpful. Instead of holding the phone at stomach level, raising it to chest level with the arms bent can help keeping the neck in a more comfortable, neutral position.

Avoiding texting with forearm floating results in reduced muscle activity of the upper limbs, with less fatigue and discomfort.

It is recommended to avoid sitting for extended time.

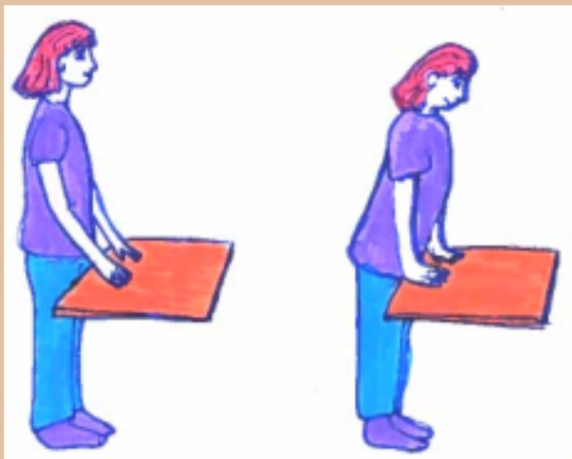
Wrist exercises

Wrist Flexors Stretch

Clasp hands by interlocking fingers and lift arms horizontally in front of you.

Alternately turn palms inwards and outwards.

Hold for _ seconds and repeat _ times.



Weightbearing on hands and stretching the fingers

Stand at a table.
Lean forward to support yourself on both hands. Keep your fingers straight and pointing forward. Feel the weight of your body on both hands and a stretch in your fingers.

Hold for _ seconds.
Repeat _ times.

Neck exercises

Neck extension

Sit or stand with good posture and place hands behind head as shown.

Press head backwards into hands, without letting either head or hands move

Hold _ seconds and repeat _times.

Upper Neck Extension

Sitting tall, bend your head backwards as far as is comfortable.

Hold _ seconds and repeat _times.

Assisted cervical spine retraction

Sitting straight-backed, pulling your chin in.

At the end position take hold of your chin with your hands. Push your chin carefully further backwards.

Hold for a moment and feel the stretch in your neck.

Repeat _times.

Shoulder and core exercises

Active Chest Opening (Shoulder Horizontal Adduction)

Sit on a chair or a stool with your hands on your thighs.

Open your chest by bringing your arms out to the side with turning your palms facing upwards.

Hold and then relax to the starting position.

Repeat _times.

Side Bending Stretch

Sit on a chair with arms by your side.

Hold your hands and turn your palms facing forwards. Lift your arms over your head so that your palms face towards the ceiling.

Slowly bend to the side by lengthening through your arms. Hold while breathing evenly. Return to the starting position.

Repeat _times.

Coordination and mobility

Leg Swings

Sideways

Start by standing and lift one leg off the floor.

Start swinging the leg in front of the other leg back and forth from one side towards the other side. Keep the movement relaxed.

Change side and repeat _ times.

Forwards and Backwards

Start similarly, but swinging the leg backwards and forwards. Keep the movement relaxed.

Change side and repeat _ times.