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Ergonomic infant care for parents

Primary prevention guidebook for parents during infant care from ages 0-1.

DEGREE PROGRAMME IN PHYSIOTHERAPY
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ABSTRACT

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Ergonomic infant care is a broad topic. Infant care isn't regarded as an occupation since it is not a paid occupation. Several hours are put into infant care, burdening the parents and their musculoskeletal system. Little research is provided on this topic, but enough to conclude that parents suffer from musculoskeletal disorders due to this occupation. Several daily tasks are done in awkward positions straining their bodies, resulting in mainly back and neck pains.

The thesis aimed to author a quality guidebook for parents with infants from the ages 0-1. This primary prevention of musculoskeletal disorders guidebook guides parents to acknowledge their bodily posture as they take care of their infants during different daily tasks. This was in cooperation with Olennainen and will be given to their clients.

The objective of this thesis was to research different studies through action research, to find evidence-based knowledge on how to prevent musculoskeletal disorders from occurring during the occupation of infant care.

The databases that were used during this process of finding evidence-based knowledge were PubMed, Finna, and Google Scholar. Which provided studies backing up this topic. Books were used as well to gather the basics of biomechanics and anatomical structures.

During the process of action research, the research question of how we can prevent musculoskeletal disorders from occurring during infant care was answered. Educating parents about their ergonomics was the key to preventing the occurrence of musculoskeletal disorders during infant care from ages 0-1.

Keywords: Infant care, ergonomics, biomechanics, musculoskeletal disorders, Infant care tasks, childcare,

CONTENTS

LIST OF SYMBOLS AND TERMS

MSKD - Musculoskeletal disorders

WMSD – Work-related musculoskeletal disorders

MSK – Musculoskeletal

LBP - Lower back pain

DQD - De Quervains disease

FHP – Forward head posture

Rectus – Parallel to midline

Transverse – Perpendicular to midline

Oblique – Diagonal to midline

Capitis – Latin for head

Anterior – Front side

Posterior – Backside

Inferior – Below

Superior – Above

os – Latin meaning bone

IAP -Intra-abdominal pressure

POP- Pelvic organ prolapse.

WHO - World Health Organization

1 INTRODUCTION

Globally, musculoskeletal disorders (MSKD) are the leading factors burdening the life quality of individuals and healthcare systems (Lewis et al., 2019). Work-related musculoskeletal disorders (WMSD) are the leading factors of health problems and an economic burden (Sultan-Taïeb et al., 2017). Infant care is a demanding job mentally and physically. Requiring parents to work in several awkward positions and without proper education on ergonomics, may contribute to WMSD, such as lower back pain (Sanders & Morse, 2005b; Vanhemmuuden Kaari - Mannerheimin Lastensuojeluliitto, n.d.).

The author's focus is to primary prevent MSKD and improve parent's mental, physical, and social well-being. Performing a physically demanding job requires educating parents to take care of themselves ergonomically. Parents should take into consideration their work environment and be educated wisely with ergonomic solutions. (Fyysinen Kuormitus - Työturvallisuuskeskus, n.d.)

The motive of writing a thesis related to children and families led to cooperation with a private practice clinic called Olennainen. Olennainen was keen on cooperating with this thesis, and so came the idea of creating a guidebook for their clients. A simple guidebook for parents about ergonomics during infant care.

2 AIMS AND OBJECTIVES

This thesis aims to author a quality guidebook for parents with infants from 0-1 year of age for a private practice clinic called Olennainen. The quality guidebook gives their clinics easy and simple access to primary preventative methods during infant care by focusing on their ergonomics.

The objective of this thesis is to find literature with evidence-based knowledge on how we might prevent musculoskeletal problems during infant care with proper ergonomics.

The research question that will be investigated during this thesis is, how can we prevent injuries during the occupation of infant care?

3 INFANT CARE

Raising a child is an occupation that is invisible by economic standards though the occupation itself is loading for the parents (Power, 2020). Taking care of an infant consists of several daily tasks that can be burdensome for the parent's musculoskeletal system. During infant care, there are several tasks consisting of repetitive motions of lifting the child in awkward positions. (Kim et al., 2022) These tasks consist of a lot of forward bending to place their infant into and out of the crib and placing the infant on and off a changing surface during diaper changes or bathing. Feeding times consist of lots of static holds and awkward positions; during breastfeeding, bottle feeding, or on the highchair. Transporting children consists of multiple lifting, either to place the child into the stroller and out or into the car seat. As well as lots of squatting, kneeling, and elevation of arms during; playtime, soothing, and picking up toys from the ground. (Holtermann et al., 2020)

Physical and biomechanical risk factors are static prolonged seating or standing, fast-paced work, repetitive movements, lifts, and lifts with rotation or bending (Tuki- Ja Liikuntaelimistön Sairaudet | Safety and Health at Work EU-OSHA, n.d.). As previously mentioned, the daily tasks of a parent consist of multiple different lifts, static positions, rotations, and bending, winding up with the risk of getting an MSKD.

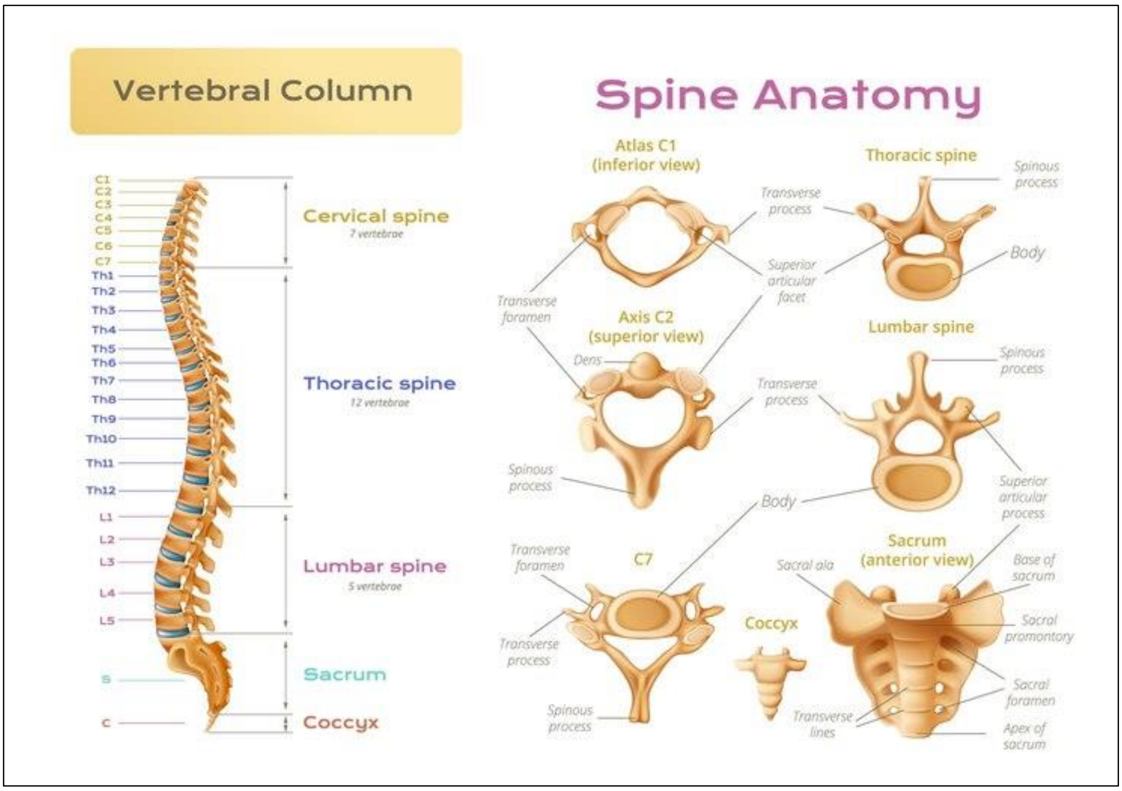
An infant's weight is an external weight on their parents' bodies, as they are being held, transported, and lifted. This affects the parent's center of mass, causing the mechanical load on their bodies. Infants grow at a fast pace during the first few months around 100-200 grams per week. Slowly the infant's weight starts to even out and increase at a slower rate. By the age of 1 year old, the child has doubled or even tripled in size. (Lapsen Ja Nuoren Normaali Kasvu Ja Sen Arviointi - Terveyskirjasto, n.d.; Sandström & Ahonen, 2011)

4 MUSCULOSKELETAL SYSTEM

What do we mean when we talk about the musculoskeletal system? The Musculoskeletal (MSK) system consists of, bones, joints, muscles, ligaments, connective tissue, tendons, and cartilage. This system provides shelter, support, and movement. If this system is somehow manipulated by internal or external factors, the system can be impaired causing pain, work incapacity, and functional disability. There are several musculoskeletal system disorders (MSKD) affecting millions of people worldwide. The most common MSKDs are lower back pain, neck pain, osteoarthritis (OA), rheumatoid arthritis (RA), and Gout. (Dreinhöfer & Watfa, 2021)

4.1 Skeletal structure of the vertebrae

The spine consists of multiple regions (picture 1), such as vertebrae cervicales (cervical spine), vertebrae thoracica (thoracic spine), Vertebrae lumbales (lumbar spine), Vertebrae sacrales (sacrum spine), and vertebrae coccygeae (coccyx spine). There are 24 separate vertebras found in the cervical, thoracic, and lumbar regions. 7 vertebrae in the cervical spine, 12 in the thoracic spine, and 5 in the lumbar spine. The Sacrum and coccyx spine are fused, consisting of 5 fused vertebras in the sacrum spine and 4 fused vertebrae in the coccyx spine. (Tortora & Derrickson, 2017)



Picture 1. Spine anatomy (macrovector on Freepik).

In the sagittal plane, normal curvatures of the spine consist of cervical lordosis, thoracic kyphosis, lumbar lordosis, and sacrococcygeal kyphosis. These curves are developed by the age of 10. (Tortora & Derrickson, 2017, p. 217) A normal range in degrees of cervical lordosis is 30-40°, thoracic kyphosis 40°, lumbar lordosis 45°, and 45° at the sacrococcygeal kyphosis region (Kauranen, 2021).

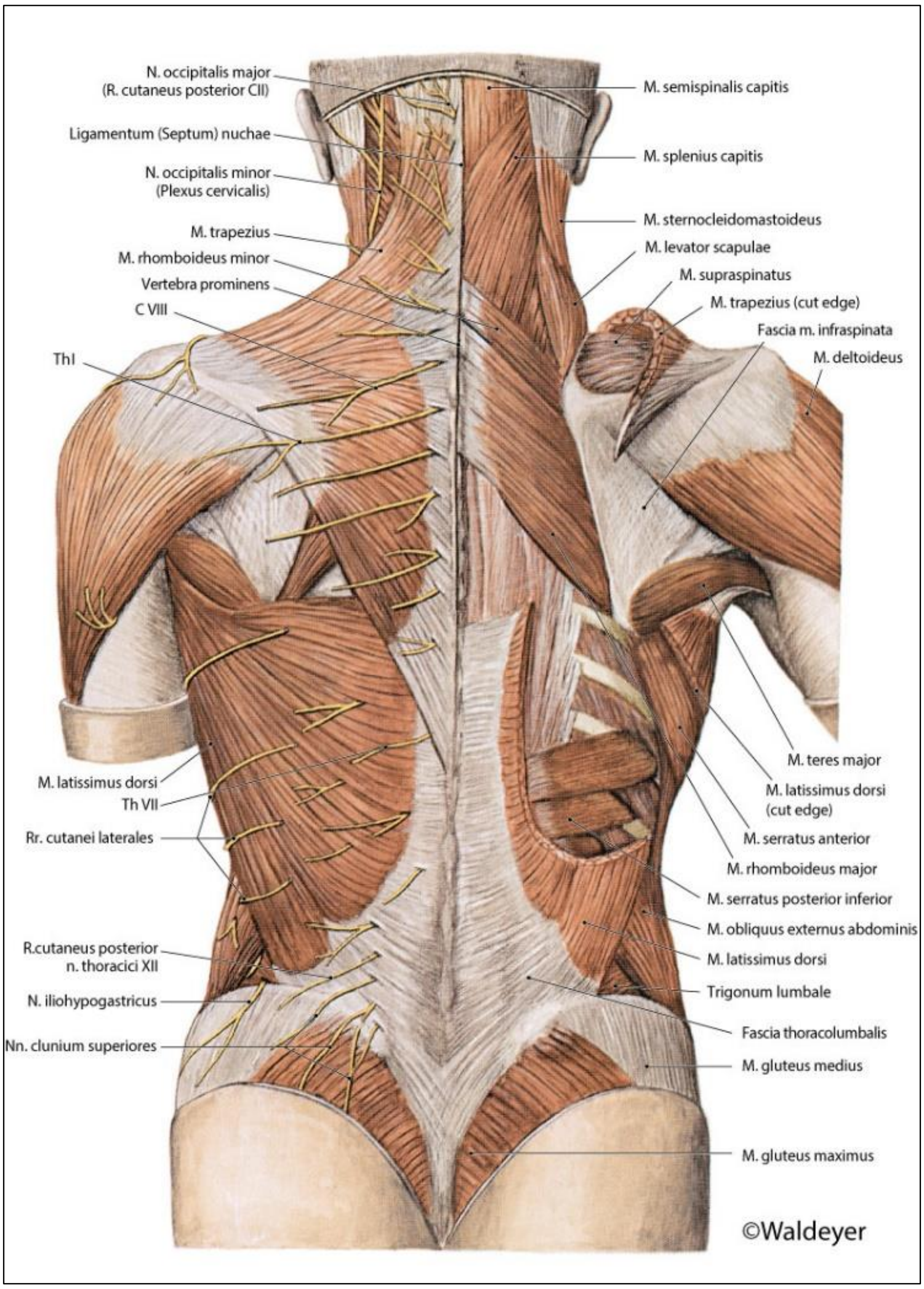
Each vertebra consists of facet joints between each vertebra's articular process, inferior and superior, that facilitate movement. This is the key to allowing the back to move in different directions such as flexion, extension, rotation, and lateral bending. The movement occurring in the cervical spine consists of flexion, extension, lateral flexion, and rotation. The thoracic spine moves in flexion and extension direction. Lastly, the lumbar spine is limited mainly to flexion and extension. (Tortora & Derrickson, 2017, Chapter 7)

The vertebrae column is built to protect the spinal cord (that goes through the vertebrae foramen) and nerves, as well as to provide movement and support. Between each vertebra, there is cushioning called intervertebral discs. These intervertebral discs work as shock absorbers consisting of annulus fibrosis and nucleus pulposus. (Tortora & Derrickson, 2017, Chapter 7)

4.1.1 Muscle that moves the vertebrae, neck, and head

Muscles provide movement and stability to the spine together with the thoracolumbar fascia (picture 2). The first layer is the deepest and goes along the vertebrae(spine). Then comes the deep layer, the intermediate layer, and finally the superficial layer. The intermediate layer consists of the erector spinae group consisting of iliocostalis, longissimus, and spinalis muscles. Erector spinae muscles are important to maintain posture as well as extend and laterally flex the spine. Extension is produced by 4 main muscles, Quadratus lumborum, intertransversarii, erector spinae, and multifidus. Lateral flexion is produced by 8 different muscles, quadratus lumborum, intertransversarii, obliquus abdominis externus, obliquus abdominis internus, transversus abdomins, rectus abdomins, erector spinae and multifidus muscles. Rotation is produced by 5 main muscles, obliquus abdominis externus, obliquus abdominis internus, semispinalis, rotatores, and multifidus. Flexion is produced by 6 main muscles, rectus abdomiuis+pyramidalis, psoas minor, psoas major and iliacus, obliquus abdominis externus, and obliquus abdominis internus. (Tortora & Derrickson, 2017, Chapter 11)

The spinalis group consisting of spinalis capitis, spinalis cervicis, and spinalis thoracis, work together to extend the head/neck. The main muscles extending the head and neck are the trapezius, splenius capitis, levator scapulae, splenius cervicis, rectus capitis posterior major & and minor, obliquus capitis superior, and erector spinae. Rotators of the head and neck are semispinalis cervicis, multifiii, scalenus anterior, splenius cervices, sternodcleiodmastoideus, splenius capitis, obliquus capitis inferior and rectus capitis posterior major. The flexors of the neck and head are longus colli, scalen anterior, sternocleidomastoideus, rectus capitis anterior, and longus capitis. Lastly, lateral flexors of the neck and head are all three scalenus muscles(anterior, posterior, and medius), splenius cervices, levator scapulae, splenius capitis, trapezius, erector spinae, rectus capitis lateralis and sternoicleidomastoideus. (Tortora & Derrickson, 2017, Chapter 11)



Picture 2. Posterior view of back muscles (Waldeyer Anatomie des Menschen).

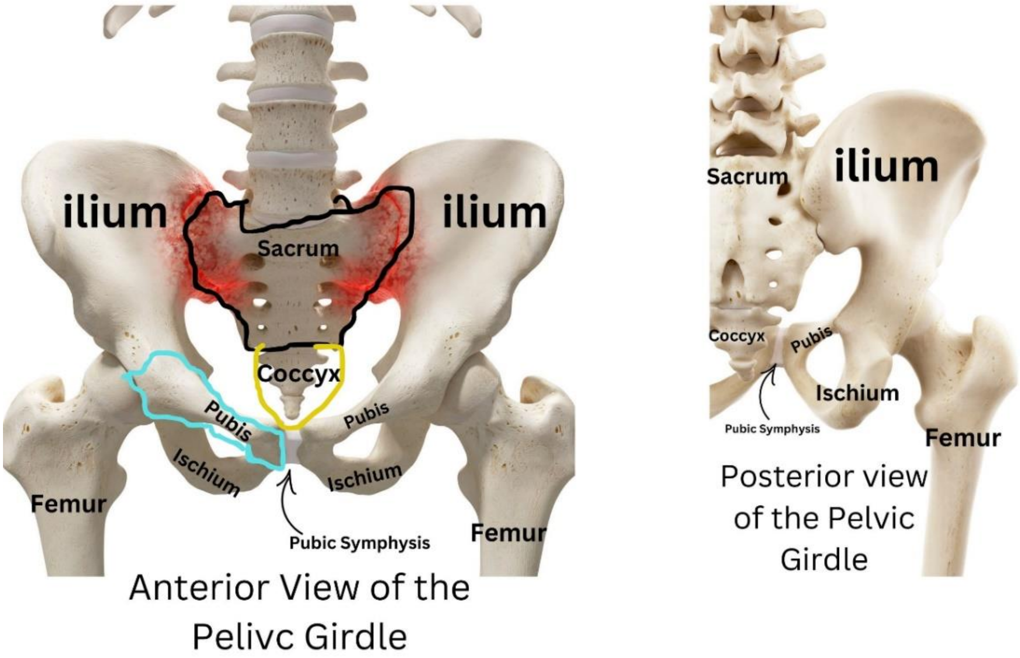
4.2 The Pelvic Girdle

The complex and miss understood part of the human body, is the pelvic girdle. The powerhouse of making homo sapiens an erect being and providing us a bipedal gait. The pelvic girdle consists of the left and right hip bones (os. ilium os. ischium and os. pubis), sacrum, and coccyx. These bony structures are attachment points for ligaments and muscles. The pelvic girdle connects the upper body to the lower limbs to create a dynamic functional body. The pelvic floor muscles within the pelvic girdle can be seen as the floor of the entire body, holding organs with the aid of fascia, muscles, and ligaments. (Heiskanen et al., 2020; Lee, 2011)

4.2.1 Skeletal structure of the pelvic girdle

The pelvic girdle structure differs from person to person. Especially in sex, males tend to have a narrower pelvis than females. This is due to the physiology of females carrying their offspring. Some genetic mutations are possible, like in Currarino Syndrome, where the bone structure is manipulated. (Heiskanen et al., 2020, p. 55; Musielak et al., 2019; Tortora & Derrickson, 2017, p. 213).

As seen in picture 3, the pelvic girdle consists of several parts. The Ischium is located inferiorly in the pelvis, and it is a weight-bearing part of the body as we sit down. It is important to identify where the ischium is when trying to find an ergonomic posture, due to the weight distribution from the upper body to the pelvis while sitting. The ilium is the largest bony structure of the pelvic girdle, which is important for protecting organs, connecting several muscles and ligaments (which aid in movement and flexibility) as well and providing stability and balance to the upper body. The sacrum is a triangular bony structure that consists of five fused vertebras in the posterior part of the pelvic girdle. This triangular structure distributes weight from the upper body to the lower body, as well as connects the left and right hip bones. The pubis is right in front of the pelvic girdle connecting the left and right hip bones with the intercoccygeal joint called the pubic symphysis, which is a thick fibrocartilaginous disc between layers of hyaline cartilage. The pubis forms part of the acetabulum together with the inferior part of the ilium and ischium, which is a part of the hip joint. The hip joint is a synovial joint that consists of the caput femoris (head of the femur) and the acetabulum. Providing movement to the lower limbs such as flexion, extension, abduction, adduction, and rotation. (Heiskanen et al., 2020; Lee, 2011)



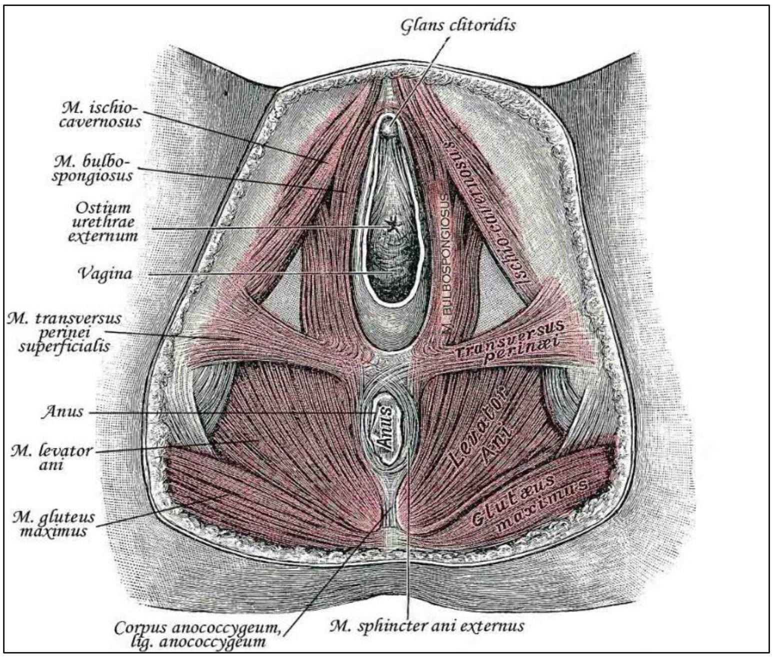
Picture 3. The Pelvic girdle (Adapted from Canva, 2023).

4.2.2 Muscles of the pelvic girdle

The pelvic girdle has larger and more powerful muscles compared to the upper limbs. This is due to the function of the lower limbs. The muscles of the lower limbs are important to maintain posture and create locomotion, and stability. Most of the lower limb muscles originate on the pelvic girdle and are inserted into the femur, tibia, or fibula. (Tortora & Derrickson, 2017, Chapter 11)

Muscles that extend the hip joint are gluteus maximus and the hamstring muscles. The hamstring muscles consist of semitendinosus, semimembranosus, and bicep femoris. The gluteus muscles consist of gluteus maximus, gluteus minimus and gluteus medius. Muscles that abduct the hip joint consist of the gluteus muscles, obturator internus, orburator externus, piriformis, gemellus superior, gemellus inferior and tensor fascia lata. Muscles that adduct the hip joint are adductor magnus, adductor longs, adductor brevis, gracilis and pectineus. Muscles that flex the hip joint consist of psoas major, iliacus, rectus femoris, sartorius and pectineus. (Tortora & Derrickson, 2017, Chapter 11)

In literature psoas major and iliacus muscles are known as the iliopsoas muscle. Muscles that medially rotate the hip joint are the iliopsoas muscle, tensor fascia lata, and the anterior part of gluteus medius and gluteus minimus. Muscles that laterally rotate the hip joint consist of the gluteus maximus, piriformis, obturator internus, gemellus superior, gemellus inferior, quadratus femoris and obturator externus. (Tortora & Derrickson, 2017, Chapter 11)



Picture 4. Muscles of the pelvic floor (female) (Henry Gray ja Henry Vandyke Carter).

There are 3 more layers of muscles found within the pelvic girdle. These muscles are responsible for, holding internal organs, fecal continence, urinary continence, support, and aiding sexual reproductive organs (picture 4). The first layer is the deepest consisting of m. pubococcygeus pars pubica, m.

puborectalis, and m. iliococcygeus pars iliaca. These 3 muscles also known as the levator ani muscle, aid fecal continence, resist the increase in intraabdominal pressure, and aid in defecation. (Heiskanen et al., 2020, p. 61; Tortora & Derrickson, 2017, Chapter 11)

The middle layer of the pelvic floor muscles consists of the deep perineum muscles. These are m. transverse perinei profundus, m. sphincter urethrovaginalis (for females), and m. compressor urethrae (for females). The superficial perineum muscles consist of m. transversus perinei superficialis, m. sphincter urthrae externus, m. ischiocavernosus, m. bulbospongiosus for males and females m. bulbocavernosus. The deep perineal muscles aid in urination and ejaculation in males and aid females with urination and compression of the vagina. The muscle that controls the anal canal and anal canal is called m.sphinter ani externus. (Heiskanen et al., 2020, p. 61; Tortora & Derrickson, 2017, Chapter 11)

5 BRIEF UNDERSTANDING OF BIOMECHANICS

Biomechanics comes from the Greek word Bios = life and mekhanike = mechanics. Mechanics can be divided into 3 groups. Kinematics (the study of motion without taking into account forces), 2. Kinetics (the study of systems where motion and forces are considered) and 3. Statics (the study of the equilibrium states of systems that are at rest or moving at a constant velocity) (Kauranen & Nurkka, 2010). Biomechanics considers many different aspects of living beings. These parts are physics, chemistry, and biology (anatomy and physiology). Biomechanics is used to solve problems related to the structure of the body and understand the function of living organisms. (Hall, 2019)

5.1 Biomechanics and everyday life in infant care

Understanding the complex body and how forces are reacting to it, is an important factor when talking about ergonomics. The aim is to prevent injuries by performing optimally. Caring for an infant is a parent's job and involves repetitive lifting from different heights and static positions such as holding the child either during breastfeeding, soothing, or transporting. It affects the muscles, joints, fascia, and ligaments that are working against gravity to be able to move in different directions. (Sandström & Ahonen, 2011)

Standing in an erect position is like building blocks, staked up on top of each other, the head being the top block and the feet being the bottom part of the building block. In an optimal erect position, the ear, shoulder, hip, and ankle are aligned, this distributes the body's weight evenly. As discussed in the previous chapter, the human spine has its natural curves when in optimal position. Muscles are working hard contracting and relaxing to uphold the center of mass. If the center of mass is not in the optimal posture position, this increases strain on the vertebrae and the stability of the spine decreases. For example, when lifting something off the ground, the body’s center of mass shifts and joins the center of mass of the object, creating torque to the vertebrae. This is why it is important to have the object as close to the body as possible when lifting. (Sandström & Ahonen, 2011)

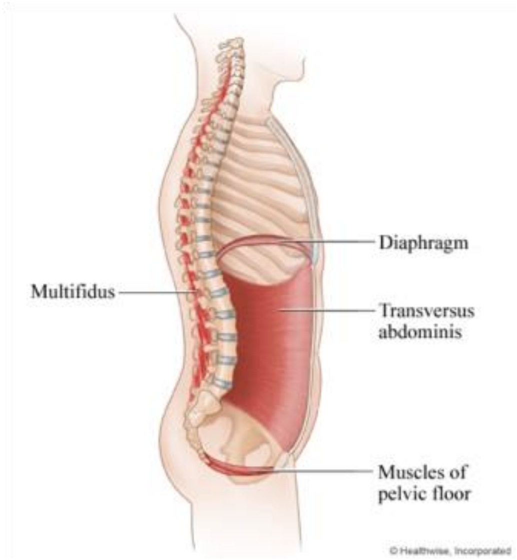
An infant's weight changes the center of mass anteriorly of the caregiver when being held, lifted, or transported. This anterior load can cause pressure on the thoracolumbar spine. Bruno et al., (2017), investigated the thoracolumbar regions of the spine and risk factors during daily activities. They concluded that the highest compressive loads on the thoracolumbar spine occurred when the anterior load was applied and trunk flexion occurred, for example carrying an infant.

Rohlmann et al., (2014) studied the activities of everyday life that impact high spinal loads. This study investigated resultant force on the spine while lifting a weight off the ground, forward elevation with weight in the arms, changing body position, staircase walking, tying shoes, upper body flexion, standing up / sitting down, washing face, walking, and moving a weight laterally in front of the body. In this study, the highest resultant force was seen when lifting a weight of 10.8kg off the ground. Other movements that showed high resultant force on the spine were seen in the forward elevation of straight upper limbs with holding a weight at around 9.2kgs, moving an object of 10.8kg laterally in front of the body, and changing positions from sitting to standing. Concluding that "The activities with the highest resultant force have in common that the center of mass of the upper body (and a carried weight) was shifted anteriorly".

Another study conducted by Kim et al., (2022) investigated the maximum joint moment during infant lifting-up motion. In this study, they used dummies to produce mechanical load on the musculoskeletal system. These dummies weighed around the same as a 1 -,6- and 12-month-old infant would.
Each participant was told to lift the dummy to shoulder height from the squat position. During the lift, each joint moment was calculated in an inverse dynamic simulation. These joint moments were in the lumbar, hip, knee, ankle, and shoulder. The main joint moment was seen in the lumbar, hip, and shoulder joints. Knee and ankle joints did not have a significant effect. The heavier the dummy got the more the lumbar, hip, and shoulder joint moment. The

greatest joint moment was seen in the lumbar joint, indicating that the lumbar extension moment plays an important role when lifting an infant and may be the reason lower back pain occurrence during infant care is high. “These results could contribute to the prevention of musculoskeletal diseases due to infant care activities by developing an effective lifting strategy and an assisting device to reduce loads on lumbar and hip joints”.

5.2 Intra-abdominal pressure



Picture 5. Intra-abdominal pressure (Healthwise incorporate).

Intra-abdominal pressure (IAP) is concealed within the abdominal cavity, consisting of muscles that keep the pressure regulated. This is important for respiration, coughing, vomiting, sneezing, going to the bathroom to urinate/defecate, childbirth, heavy lifts, jumps, landing, and maintaining posture. (Emerich Gordon & Reed, 2020; Sandström & Ahonen, 2011, p. 249; Tortora & Derrickson, 2017, p. 757)

Muscles needed for IAP include the diaphragm, the abdominals, spinal stabilizers, and the pelvic floor muscles (picture 5). The pelvic floor muscles work as the floor of the abdominal cavity and the diaphragm muscle as the roof. When we inhale the diaphragm contracts, flattens, and expands like when opening an umbrella, it spreads and makes space for inhaled oxygen to enter the body. Simultaneously the pelvic floor muscles relax and stretch. When exhaling the diaphragm relaxes and rises, while the pelvic floor muscles contract and rise. (Emerich Gordon & Reed, 2020; Sandström & Ahonen, 2011, p. 249; Tortora & Derrickson, 2017, p. 757)

Hsu et al., (2018) studied different variables affecting IAP during lifts on postpartum mothers. The lifting consisted of carrying a 12.5 kg car seat. This study was conducted to understand the risk factors for developing pelvic organ prolapse (POP) and lifting. After vaginal birth, the risk of getting POP is 1 in 5 women. Occupations that include a lot of heavy lifting increase the risk of POP as well, due to the high pressure involved during the lift on the pelvic floor, aka IAP. During infant care is it unavoidable to lift and transport your infant. Parents must carry and transport their infant on various occasions, which raises the IAP and strains the pelvic floor muscles. Unfortunately, this study did not find ways to decrease IAP towards the pelvic floor while lifting.

IAP influences unloading forces off the spine and optimizes shear force when flexing forward. IAP works as a corset, muscles contract to support the spine and increase the pressure in the abdominal cavity to reduce muscle forces, intradiscal pressure, and disc loads. This biomechanical method protects the spine by producing an extensor torque and increases stability to reduce the risk of injury to the spine. (Bojairami & Driscoll, 2022; Liu et al., 2019; Stokes et al., 2010)

6 MUSCULOSKELETAL DISORDERS DURING INFANT CARE

During the year 2021, Finland’s top disabilities pensions went to mental health and behavioural disorders and diseases of the musculoskeletal (MSK) system and connective tissue (Kela, 2022). The MSK system pains are one of the leading reasons to receive professional help from a doctor and get proscribed sick leave in working-age adults, disabling the workforce, and increasing the loss of the country to around 1.5 billion euros. Most common MSKD occurs in the back, upper extremities, and neck as well as osteoarthritis. Lower back pain is one of the most reported MSKDs worldwide. (Dreinhöfer & Watfa, 2021) 41 % of Finnish women experienced back pain compared to 35% of men within the past month in the year 2022 (Oppaat Ja Esitteet Päättäjille – Tuki- Ja Liikuntaelinliitto Tule Ry, n.d.).

6.1 Infant care-related MSKD

According to one study by Sanders & Morse, (2005) performed on 88 parents 66% of them indicated to have MSKD related to infant care. 48% reported lower back pain, 44% reported neck-upper back/ shoulder pain, and 10% or less reported knee, finger, or wrist pain as well as 10% or less reported hip pain. 21% of the parents had received a diagnosis. In this same study, it was seen parents of infants had more MSKD than those who had kids over the age of 2.

A study conducted in Jordan followed mothers who breastfed their children for 6 months and were experiencing nonspecific MSK pain. This study concluded that these women were not educated properly about their ergonomics to prevent these MSKDs. (Aburub et al., 2022) Another study suggested that further studies are needed, but there are several risk factors for musculoskeletal disorders to be present while lifting a child at home (Vincent & Hocking, 2013).

During the year 2022, there were 44,951 children born in Finland. As a result, undoubtedly increasing the occupation of parenthood during infant care is statically large. Around 23,101 wedlock parents take care of their child at home, increasing the risk factor for MSKD to be present during daily activities. (Live Births by Year and Information. PxWeb, n.d.)

6.2 Mommy/Daddy/Baby wrists

Mommy wrist also known as baby wrist is a term used when talking about De Quervain’s tenosynovitis / De Quervain's disease (DQD). Known as an overuse reaction to the tendons in the wrist and hand. It may also be called “Daddy's wrist”, affecting the father’s wrists, or any male infant care provider. This aspect of DQD is seen in the perspective regarding infant care where the overuse injury comes from repetitively lifting and grasping the infant with flexion and extension of the wrist and abduction of the thumb. Other occupations where there is a lot of keyboard use, knitting, gardening, playing sports, and piano playing may lead to DQD. (Corvino et al., 2023; Fakoya et al., 2023)

De Quervains disease (DQD) symptoms involve pain in the lateral side of the wrist. Pain is induced due to inflammation of the tendon sheath (defined as stenosing tenosynovitis). Usually, the tendon affected is the abductor pollicis longus and the extensor pollicis brevis are found in the hands first radio-dorsal compartment. These tendons go through a narrow carpel tunnel under the flexor retinaculum. DQD affects mostly women from ages 30 to 50 but does occur in men and women of all ages, due to the repetitive hand and wrist movement in their daily activities. (Fakoya et al., 2023) One correlation of DQD occurring more in women than men was found that the estrogen receptor-β was associated with the severity of DQD (Shen et al., 2015).

6.3 Forward head posture and upper limb discomfort.

Normal head posture starts during the phase we learn how to sit, and stand known as the secondary spinal curves. The posture of each person is an individual feature. Genetics, mental state, and pathological conditions affect one’s posture. When the cervical spine is aligned with the rest of the spinal curves the forces applied on the cervical spine are more sustainable and reduce risks to the spine when aligned. In forward head posture (FHP) the cervical spine is not aligned stressing the cervical spine and muscles supporting this position. (Hall, 2019, p. 267)

An average adult head weighs in a neutral position (0 degrees tilt forward) around 4,5 to 5,5 kgs. As the head tilts forward the strain on the neck increases gradually. At 15 degrees the forces exert already 12.2kg and at 45 degrees it’s at 27.2kg. Good posture is observed in sagittal view as the ear is aligned with the shoulder, hip, and ankle. Poor posture affects the distribution of forces as mentioned above the spinal alignment. As the head flexes forward the thoracic spine and shoulder girdle follow, causing protraction of shoulders and kyphotic thoracic spine. (Hansraj, n.d.)

In FHP the muscles supporting the neck and head are either stretched or shortened, affecting the muscles' capacity to work optimally. For muscles to work optimally the alignment should be in a neutral position. In a study regarding neutral and forward head posture, the displacement of the cervical spine vs neutral position was calculated. In their results, it was seen that the C0 (occiput)-C2 extended to a significant degree and C2-C7 flexed into a significant degree with P values of <0.05 and <0.01. This correlates to muscle lengthening and shortening of the occipital extensors, occipital flexor, cervical extensors, and cervical flexors. (Khayatzadeh et al., 2017)

During breastfeeding situations, mothers observe their infants with a constant forward head posture, their cervical spine in a flexed position, and slight rotation to follow their gaze toward their infant. As well overall sitting posture is poor. This may bring aches and pain to the neck and upper extremities. (Ojukwu et al., 2022) Emmanuel Mbada et al., (2013) created a cross-sectional study related to mothers' breastfeeding posture and its link to MSKD. 383 mothers answered their questionnaire related to their preferred breastfeeding position and what MSK pains they felt. Sitting on a chair was the most common breastfeeding posture among these mothers, 62.4% used this position. While 16.2% sat on the side of the bed, 12.3% breastfed in a side-lying position and just 9.8% sat on a mat while breastfeeding. The top three MSK pains reported were neck, neck and shoulder, and back and neck. The highest percentage (20.5%) of women in this study answered their neck was the affected part of the body. 16.6% answered neck and shoulder and 12.6% answered back and neck. Concluding that sitting on the side of the bed and mat while breastfeeding was predisposed to MSK pains.

In 1979 Dr. Vladimir Janda opened the concept of the upper cross syndrome, which has developed into many different names such as Forward head posture, Slouched posture, Protracted shoulders, and many more that affect the upper part of the spinal alignment. Usually, during poor sitting postures, these areas are affected, such as in breastfeeding postures. Poor sitting posture affects the scapula kinematics and muscular imbalances. As mentioned above, supporting muscles of the cervical spine become imbalanced, which is found to cause aches and pains. As the FHP brings the head forward the thoracic spine tries to follow the mass of the head and balance it out by bringing the thoracic spine into an increased kyphotic curve and bringing the shoulders into a protracted position. (Shafeeq et al., 2023)

In a study conducted by Shafeeq et al., (2023), they had a sample size of 141 lactating women. In this study, it was seen that 53.2% suffered from severe pain, 41.8% moderate pain, and only 5% experienced mild neck pain. This study concluded that most of their patients were not educated properly about ergonomic breastfeeding positions and suffered from various musculoskeletal problems, mainly in the neck. As well as there is an interrelation between upper crossed syndrome and neck pain.

6.4 Lower back pain

Lower back pain (LBP) is one of the leading musculoskeletal disorders in Europe. Estimated to be around 66 million Europeans suffer from lower back pains, which has been seen to be more prevalent in women than men. (Dreinhöfer & Watfa, 2021) In 2019 there were 625 100 adults in Finland suffering from back pain and the numbers are growing (Tuki- Ja Liikuntaelinsairaudet Suomessa | Työterveyslaitos, n.d.).

The lower back consists of the lumbar spine between the lowest part of the ribs (thoracic vertebrae) to the top part of the sacrum. It consists of L1, L2, L3, L4 and L5. In a natural standing position, it has a slight lordosis called lumbar lordosis. Anatomically the lumbar spine consists of the largest vertebrae in the whole spine. This is due to providing stability and distribution of the weight of the upper body towards the lower extremities. When the structure is manipulated in any way, such as having anterior weight by lifting heavy objects, stooping to pick up objects off the floor, or any flexed position forward, it causes stress to the lower back. Most MSKD occurs due to the imbalance of weight distribution affects the biomechanics of the spine. (Kuo et al., 2010; Understanding Lower Back Anatomy | Spine-Health, n.d.)

Considering the anatomy of the spine, facet joints and intradiscal pressure are affected by different postures of the spine. A study conducted by Kuo et al., (2010), concluded that intradiscal pressure increased noticeably with flexion than with axial rotation or extension of the lumbar spine.

Sanders & Morse, (2005) explored ergonomics during infant care and received data on the body parts that were most affected. The biggest percentage of musculoskeletal pain was seen in the lower back of the parents. 48% of 130 parents (92% being mothers) reported lower back pain.

Vincent & Hocking, (2013) built up their study regarding MSKD from the original study of Sanders and Morse (2005). In this study, 25 mothers were observed at their homes taking care of one or two infants. The main idea of the study was the way they lifted their infants. Observed movements were lifting the child out of the cot, static lifting (in a forward bent position) when bathing or washing the infant in the sink, bending over while carrying the infant, placing the infant into or out of the car seat, nappy changing positions, and playtime. The most reported MSKD in this study was lower back pain. 64% out of the 25 mothers reported lower back pain. 32% reported neck/shoulder and upper back pain. Where 40% of reports related to some lower limb pain (20% knees, 16% hips/thighs, and ankles/feet 4%).

Koch et al., (2015) created a cross-sectional study regarding musculoskeletal symptoms and the risk of burnout among childcare workers. The main idea of this study was to investigate how psychosocial factors influence the MSK system. During this study, lower back pain was the most reported MSKD. From 230 participants, (86.4 % women) 46 % reported lower back pain. Others reported neck pain (31%), and upper limb pain (shoulder) 17%.

7 ERGONOMIC STRATEGIES FOR PARENTS

Ergonomic strategies for parents, provide parents with a safe and more productive workspace. In the previous chapters, several studies concluded that educating parents with proper ergonomics may reduce the incidences of MSKD.(Sanders & Morse, 2005a; Sultan-Taïeb et al., 2017; Vincent & Hocking, 2013) These ergonomic strategies in the following chapter regard different breastfeeding positions, lifting, carrying, and holding the car seat.

7.1 Breastfeeding

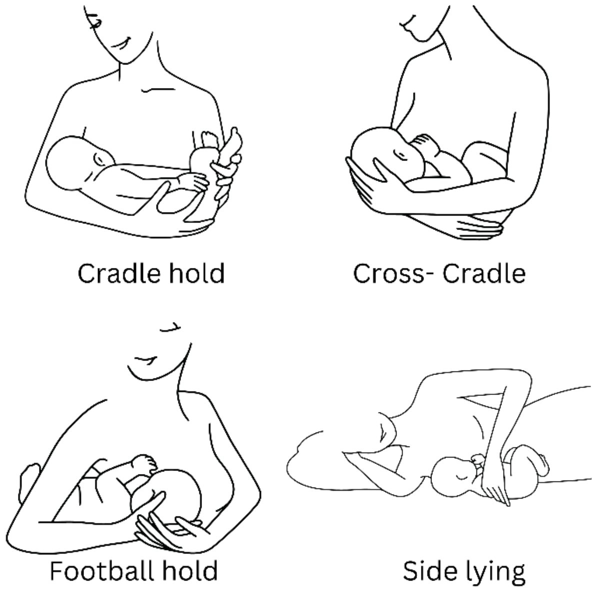
Breastfeeding is the source of an infant's nutrients for the first 6 months of life, if the mother can produce milk and choose to breastfeed. World Health Organization (WHO) suggests breastfeeding alongside supplementary foods till the age of 2 years old. (Infant and Young Child Feeding, n.d.) There are several advantages to breastfeeding for the child and mother. The child's growth is determined by the amount of breastmilk supplied, but that's not the only benefit a child receives from being breastfed. A children's immune system develops, with the anti-infective, anti-inflammatory, and oligosaccharides that breastmilk provides. These benefits may affect the child till adulthood. Studies have shown that being breastfed as an infant lowers the risk of obesity, atopic dermatitis, diabetes, asthma, cardiovascular diseases, and inflammatory bowel syndrome in adulthood. During this period of breastfeeding, it creates a bond between the mother and child. Giving the child the ability to have an intimate relationship with their caregiver. (Robert & Brown, 2023, Chapter 1)

Mothers benefit from breastfeeding their children. By breastfeeding they create a bond with their child, get psychological advantages, and may decrease risks of cancers such as breast-, ovarian-, endometrial-, and thyroid cancers and decrease the risks of type two diabetes, cholesterol, and blood pressure problems and may aid in postpartum weight loss. By breastfeeding mothers release stress hormones and increase oxytocin, aiding their psychological well-being. Some studies have shown that some mothers may lose some postpartum weight by breastfeeding, but this is very individual. Studies have shown the longer the mother breastfeeds the more benefits of risk mitigation. (Lambrinou et al., 2019; Robert & Brown, 2023; Sharma & Sharma, 2020)

7.1.1 Ergonomic position for the child and mother during breastfeeding

The prevalence of musculoskeletal pains during breastfeeding is due to poor breastfeeding mechanics. Mothers have reported lower back, neck, shoulder, upper limb, and thigh pain during breastfeeding sessions. Poor breastfeeding mechanics contribute to MSKD and nipple discomfort. Therefore an ergonomic breastfeeding position may reduce the incidences of MSKD. (Afshariani et al., 2019)

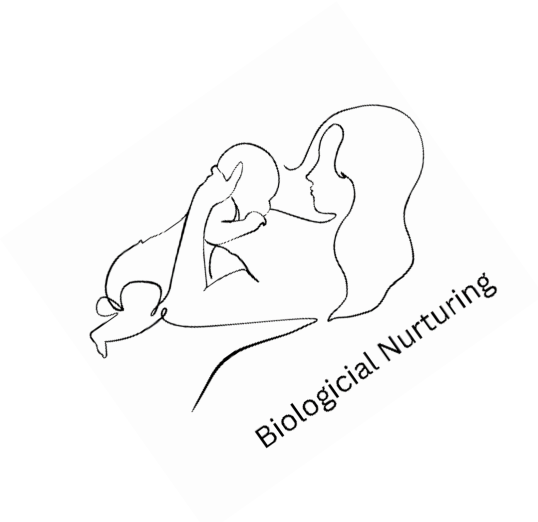
There are multiple different positions a mother can breastfeed their child. The most common positions are cradle, cross-cradle, football, and side-lying (picture 6). In the cradled position the infant’s body is aligned horizontally against the mother so that the nose of the infant is at the point of the mother’s nipple and their belly buttons are aligned. The mother’s forearm supports the infant's head and spine as the infant latches onto the breast. In the cross-cradle position, the infant is aligned the same way as in the cradle position, but the mother supports the head of the infant with their palms. During a football hold the infant is held under the mother’s armpit and the infant’s body is alongside the mother’s rib, this position is considered mechanically efficient. These three holds are done upright in a seated position. Side-lying position can be done on the sofa or bed, as the mother lays down on her side and places the infant in a side-lying position, nose aligned with nipple and belly button facing the mother's belly button. (Deufel & Montonen, 2010; Imetysasennot – Imetyksen Tuki Ry, n.d.)



Picture 6. Four different breastfeeding positions (Canva2023).

There are several other positions an infant could be breastfed, but these 4 are the most common ones used worldwide. Mothers hold their infants in a static position during breastfeeding times, straining their upper limbs, neck, and wrists. During these static holds, the strain on the body increases, and the risk of injury increases. Poor sitting posture with no support on the back or upper limbs, increase the development of MSKD. In a randomized control trial, they accessed the influence of ergonomics training on the growth of the infant also the effectiveness of this training on MSKD in mothers. They concluded in this study that educating the mothers reduced the incidence of MSKD. (Afshariani et al., 2019)

Seating in a static flexed position increases muscle strain and pressure on the discs between the vertebrae, fatiguing the muscles and causing discomfort. To avoid this situation from occurring, good lumbar support is advised. A small thin pillow at the lumbar part of the spine, around 3-11cm in thickness. The thickness of the lumbar support depends on the person. A study on Thai breastfeeding mothers concluded that having at least some kind of lumbar support increased their comfort levels and decreased muscle voluntary contraction. By adding some kind of lumbar support, muscle strain decreased and the occurrence of lower back pain decreased. (Klinpikul et al., 2010)



Picture 7. Biological nurturing position (Canva,2023)

Biological nurturing also known as laid-back position is performed as the mom lying down in a semi-inclined position, and the infant longitudinally lays on top of the mother (picture 7). This gives the infant body skin-to-skin contact with the mother. Biological nurturing aided the primitive neonatal reflexes of infants with their locomotion that led them to find the nipple and latch on. For the mother this position supports the mother's trunk and relaxes the pelvic area, shifting the weight of the ischial tuberosities and onto the sacrum and coccyx. In a laid-back position, the gravitational forces applied to the cranial area, neck, upper limbs, and spine sink into the base where the mother lies, for example, a sofa, reducing forces on the muscles and keeping the musculoskeletal system relaxed. (Colson, n.d.; Articles for Mothers - Biological Nurturing, n.d.)

Multiple breastfeeding positions are good to use diversely. Changing positions with the use of support in different parts of the body during the breastfeeding session is advised to decrease the load on the musculoskeletal system. Adding pillows under the elbow/ arms gives support to the upper limbs and decreases the weight of the body on the mother as she holds the infant. However, pillows may be used to be placed behind the back, under the baby (to lift the baby closer to the mother's nipple), and between knees (in a side-lying position). Using a pillow as an assistive tool to optimize an ergonomic posture. (Afshariani et al., 2019)

7.1.2 Sitting ergonomics while breastfeeding

Sitting ergonomics is important to consider since studies have shown that most mothers like to sit and breastfeed their child and other studies have shown that prolonged sitting is straining on the spine. It is important while sitting to take mini breaks to activate the metabolism and blood circulation. As well as when sitting, sit on the ischium part of the pelvic girdle, so that the pelvic girdle is in a neutral position and the hip joint at 90 degrees, as shown in picture 8. (Sandström & Ahonen, 2011, pp. 197–202)

Picture 8. Sitting position while breastfeeding (Anni Levonen,2023).

7.2 Carrying and lifting an infant ergonomically

The average weight of a newborn child, born at week 40 in Finland is 3766g for a boy baby and 3624 for a girl baby (Makrosomian Määritelmä, n.d.). When the child turns one year old their weight increases three times their birth weight Putting three times the load on the parents during infant care within the first year of birth. (Vauvan Fyysinen Kehitys - Mannerheimin Lastensuojeluliitto, n.d.)

7.2.1 Carrying and lifting an infant

Carrying an infant anteriorly has been shown to increase lumbar lordosis which can be the cause of lower back pain in parents. Biomechanical stress has been studied via electromyography and motion capture cameras. (Schmid et al., 2019) Schmid et al.'s (2019) study viewed different types of sling-based infant-carrying methods vs no sling used. Sling-based infant-carrying methods may reduce MSD by eliminating paraspinal muscle hyperactivation and excessive lumbar lordosis. In this study anterior carrying caused lumbar lordosis and side carrying caused thoracic kyphosis as well as lateral bending to the side to compensate for the weight that they carried the dummy on the preferred side.

Another study by Havens et al., (2020) investigated baby-carrying methods and their impact on the caregiver’s posture loading, during gait and item retrieval. Each movement was performed with load and without load. As an Item was being retrieved, the motion was first performed without any baby carrier anteriorly and the second measurements were with an infant carrier and dummy. ‘It was seen that when retrieving an object off the floor, the person was able to squat and maintain torso upright, but as soon as they added the carrier anteriorly, there came limitations on how much the person can stoop due to not wanting to invert the baby’s body. Hence, one must bend in an awkward position to retrace an object, causing back extension. During unloaded gait, there was less ground reaction force and impulse and braking force.

As discussed in the biomechanics chapter, as an external object is being lifted or carried the center of mass of the body changes. The longer the lever of the arm when lifting or carrying an object, the larger the torque in the spine. This is why when lifting/kneeling/stooping/bending down, you must keep the external weight as close to your body as possible and minimize the lever of your arm (picture 9). Then use the lower extremities to generate force to push up (picture 9). So, when going down, do not let the pelvis move posteriorly so that the back does not round, bend the knees/kneel, breathe in, keep the spine neutral, contract scapulae, and lift the infant off the ground. As you go up, breathe out (increasing IAP), and generate most of the force with your legs, keeping the spine in a neutral position and the infant close to you. When in an erect position, remember the alignment, ears, shoulder, hip, knee, and ankle aligned (picture 9). (Sandström & Ahonen, 2011)

Picture 9. Ergonomic carrying and lifting of an infant (Anni Levonen,2023).

When carrying an infant in their car seat it is important not to carry the car seat like it is a handbag. Keep a good posture and divide the weight using both upper extremities with good stability at the scapula area (picture 10). Another way is by wrapping your arm around the car seat and holding it laterally next to the body (picture 11). Remember to keep the shoulders relaxed and not elevated. The pictures below show two different ways an infant can be carried when in the car seat. (How to Carry a Car Seat (Without Compromising Your Back), n.d.)

Picture 10. Holding the car seat with the support of both arms (Anni Levonen,2023).

Picture 11. Holding the car seat on the side with one arm wrapped around it (Anni Levonen,2023).

8 METHODOLOGY

The author started planning at the beginning of 2023. The topic of the thesis was still in question for the author, but they concluded that ergonomic infant care for parents would be the topic to start exploring. In the spring of 2023, the author started the process of action research. During this time several studies were being read and encountered through several databases.

The databases that the author used were PubMed, Google Scholar, and Finna. Each research study used in the thesis was different. Authors of studies used several different research designs, but primarily mixed methods. Primarily the author limited the publication date within these databases from 2013-2023, not to exceed 10-year-old studies. Within some studies, references were used from original studies that exceeded 10 years but were seen as useful and reliable information for the author.

The author of the thesis began the journey of an action research approach as soon as planning started at the beginning of 2023 to create a quality guidebook for clients in a private practice clinic.

The research question of the author was “How can we prevent injuries during the occupation of infant care?”. To find answers to the research question through previously mentioned databases, keywords were used. During the research, the keywords used were “infant care”, “ergonomics for parents”, “biomechanics”, “childcare”, and “parents and musculoskeletal disorders”.

The author gathered theoretical knowledge through evidence-based knowledge. The author composed a guidebook that consists of ergonomic methods of infant lifting, carrying, transporting, and breastfeeding. Research brought to light that these were the main tasks of infant care that caused most parents musculoskeletal pains. Most research also concluded that parents need to be educated about their ergonomics during infant care.

9 DISCUSSION

Ergonomic infant care is something no one discusses when you become a mother, father, parent, sister, brother, or any person taking care of an infant. There is a lot of discussion about how to take care of an infant and public health care has several appointments regarding the wellbeing of the infant medically. However, without the well-being of the caregiver, there are limitations to how optimal the care for the infant can be. Work-related musculoskeletal disorders are already affecting the workforce and economics worldwide. Ergonomic solutions are starting to emerge in workplaces, to take care of their workers' well-being. When does child health care expand its resources to consider the work-related musculoskeletal disorders in parents' occupation of taking care of their infants?

After several clinical practices, the author observed the surroundings of public care and came to realize that primary preventative measures are not considered when it comes to the human musculoskeletal system. Especially parents. This brought light to the cooperation with a private practice clinic Olennainen, to create a primary preventative ergonomic guidebook for their clients.

The author had trouble finding specific studies regarding this topic. But thankfully some studies have been made. Although the author was able to use other studies to understand the biomechanical aspect of the human body and alter it into this specific topic of ergonomic infant care. This aided the author in answering the question “How can we prevent injuries during the occupation of infant care”.

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