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INCIDENCE OF SHOULDER PAIN IN PROFESSIONAL AND SEMI-PROFESSIONAL DISC GOLFERS

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The aim of this thesis was to investigate the incidence of shoulder pain in active disc golf players. Prior studies suggested that the proportion of the disc golf players experiencing shoulder pain is high when compared to the normal population. Factors that might contribute to these incidences were researched in this study. These factors were years of playing, skill level of the player determined by the PDGA rating, and throwing techniques. Furthermore, the onset of the pain was investigated. The data for this study was collected through an epidemiological survey, which 63 active disc golf players took part in.

The theory part of this thesis contains background information about the anatomy and the biomechanics of the shoulder joint. Furthermore, the biomechanics of the different disc golf throws are analyzed.

The data of the questionnaire was analyzed using IBM SPSS and Microsoft Excel Add-in provided by SAMK (Tixel). The data revealed that 53,3% of the participants have disc golf related shoulder pain. Additionally, the correlations of incidence of pain to active playing years and player rating were investigated. As were the onset of the pain and the action leading to the onset of the pain.

The obtained data showed that players with a long career were more affected by pain, as well as certain throwing techniques were more prone to the onset of pain.

CONTENTS

1 INTRODUCTION

Musculoskeletal conditions are common among people of all age groups. According to the National Health Interview in 2012, more than one in two American people over the age of 18 reported musculoskeletal conditions (United States Bone and Joint Initiative), thus being "the second largest contributor to disability worldwide" (Website of the World Health Organization, 2018). According to a study carried out in Norway, sick leave due to shoulder and neck disorders are second most common with 20%, the most common reason is low back pain with 33% (Brage, Nygard & Tellnes, 1998).

According to two epidemiological studies carried out in disc golf, shoulder injuries are among the two most common injuries disc golfers sustained. Both studies reported high prevalence of injuries sustained during a disc golf career. (Rahbek & Nielsen, 2016; Nelson, Jones, Runstrom & Hardy, 2015.) The number of registered players by the professional disc golf association increased worldwide by 316% between 2008 and 2017. The growing number of players and the high prevalence of injury is raising the need for further research of this topic and injury prevention. (Website of the Professional Disc Golf Association, 2018.)

For this bachelor thesis an epidemiological study was carried out to investigate the incidence of shoulder pain among professional and semi-professional disc golfers. The study discusses the connection between different throwing techniques and shoulder problems, as well as the effect of playing years on shoulder problems. Furthermore, the onset of pain and the correlation between player rating and prevalence of pain is investigated. The thesis also includes a short introduction to the anatomy of the shoulder, its biomechanics and common shoulder problems.

2 HOW DISC GOLF IS PLAYED

Frisbees were first introduced to the leisure and sports market in the 1950s, and therefore disc golf is a relatively young sport with its first official tournament in 1969. Disc golf is played much like the traditional ball golf. As in ball golf, a hole consists of a tee pad, a fairway with various obstacles such as trees or other vegetation, and a target. In case of disc golf the target is a basket on a pole with chains, that catch the disc when it hits. The player starts throwing from the tee pad and continues from where his disc lands on the fairway until he reaches the basket. The aim is to play every hole with as few throws as possible. (Website of the Professional Disc Golf Association, 2018.)

3 ANATOMY OF THE SHOULDER GIRDLE

The shoulder or pectoral girdle consists of three anatomical joints (glenohumeral, acromioclavicular and sternoclavicular joint) and a physiological joint (scapulothoracic joint) connecting four bony structures (humerus, scapular, clavicle, and sternum). (Tortora & Derrickson, 2013, 232-234).

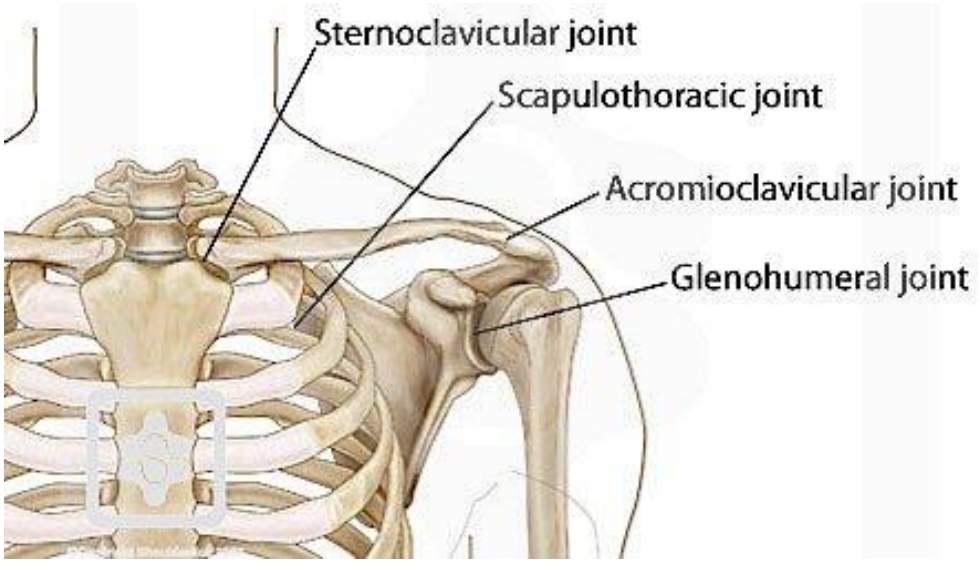

Figure 1: Overview of the joints making up the shoulder (Website of Shoulderdoc)

The glenohumeral joint is a synovial ball-and-socket joint and thus capable of performing movement in three different planes. The sagittal plane in flexion-extension movement, the coronal plane in abduction-adduction and the axial plane in external-internal rotation. (Tortora & Derrickson, 2013, 265-267.) Movement in these planes is generated mainly by the rotator cuff and deltoid muscles, which are supported by the biceps brachii, latissimus dorsi, pectoralis major, teres minor and scapulothoracic muscles (Borstad & Ludewig, 2005). To execute all the movements of the shoulder, the scapula and clavicle, thus for the whole shoulder girdle, mobility is needed, this happens through the sternoclavicular and acromioclavicular joints (Hall, 2015, 180).

3.1 Static stabilizers

The freedom of movement of the joint of causes a need for structures to ensure its stability. There are several structures to ensure the stability of the joint. Like all synovial joints the glenohumeral joint has a synovial cavity (glenoid cavity) and is united by the connective tissue of an articular capsule (Tortora & Derrickson, 2013, 259). It is supported by a labrum extending from the edge of the glenohumeral cavity. This fibrocartilaginous structure deepens the joint socket thus increasing the area of contact between the glenohumeral head and the joint socket (Tortora & Derrickson, 2013, 263). Additional stability is given by the ligaments of the shoulder joint (Superior glenohumeral ligament, middle glenohumeral ligament, inferior glenohumeral ligament, coraco-acromial ligament, coraco-clavicular ligaments, transverse humeral ligament) (Agur & Dalley, 2012, 540-541).

3.2 Dynamic stabilizers

Muscles of the thorax, shoulder and arm are involved in executing the movements of the shoulder and give dynamic stability. The deepest layer of these dynamic stabilizers are the rotator cuff muscles (Supraspinatus, infraspinatus, subscapularis, teres minor), they are called like this because they form a musculotendinous cuff around the glenohumeral joint. (Agur & Dalley, 2012, 524.) Through combined activation the rotator cuff muscles support the glenohumeral joint in abduction by compressing the humeral

head into the glenoid cavity, thus allowing the deltoid muscle to abduct the arm (Harryman, Sidles, Clark, et al., 1990). Due to antagonistic forces of the subscapularis in anterior direction and the teres minor and infraspinatus in posterior direction the glenohumeral head is stabilized through compression in anterior-posterior translation (Gasbarro, Bondow & Debski, 2017). The supraspinatus also contributes to resist inferior translation caused by the weight of the arm (Ackland & Pandy, 2009). While performing overhead movements the infraspinatus and teres minor externally rotate the humerus to increase the space between the acromion and the humeral head, thus decreasing the chance of subacromial impingement (Phadke, Camargo & Ludewig, 2009). Anteriorly the glenohumeral joint is stabilized by the subscapularis muscle. This muscle also facilitates abduction and internal rotation of the humerus (Borstad & Ludewig, 2009).

A secondary role in glenohumeral stability is played by the biceps brachii and triceps brachii. The main role of the biceps brachii is the supination of the forearm and it has a contributing factor in elbow flexion (Gasbarro, Bondow & Debski, 2017). The triceps muscles main action is the extension of the elbow. During abduction these two muscles have a contributing factor to the stability of the glenohumeral joint. The long head of the biceps brachii helps to stabilize the shoulder while the long head of the triceps steadies the head of the humerus. (Agur & Dalley, 2012, 528.) During load the long head of the biceps brachii is limiting the anterior translation of the humeral head (Bain, Itoi, Di Giacomo, et al., 2015).

The periscapular muscles act as anchors of the scapula during movement and thus contributing to the overall stability of the glenohumeral joint. Pectoralis minor, serratus anterior, latissimus dorsi, trapezius, levator scapulae, rhomboideus minor and major are forming this muscle group. (Escamilla, Yamashiro, Paulos, et al. 2009.)

The deltoid muscle covers the glenohumeral joint, thus providing some protection to the underlying structures and giving the shoulder its rounded shape. Movement of the arm is largely created by the three parts of the deltoid muscle, which originate at different points of the scapula. (Tortora & Derrickson, 2014, 362-263; Agur & Dally, 2012, 521.)

Table 1. Primary stabilizers (Agur & Dalley, 2012, 525)

Muscle	Main Action
Supraspinatus	Initiates Abduction
Infraspinatus	Lateral rotation of the shoulder joint
Teres minor	
Subscapularis	Medial rotation of the shoulder joint and abduction

Table 2. Secondary stabilizers (Agur & Dalley, 2012, 528)

Muscle	Main Action
Biceps brachii	Supination of the forearm; flexion of the elbow joint; stabilization of glenohumeral joint during abduction
Triceps brachii	Extension of the elbow joint; steadying of the humerus during abduction

Table 3. Scapular stabilizers (Agur & Dalley, 2012, 507;521)

Muscle	Main Action
Pectoralis minor	Stabilization of the scapula by anteriorly and inferiorly drawing it to the thoracic wall
Serratus anterior	Protraction of the scapula and fixation against thoracic wall; rotation of the scapula
Latissimus dorsi	Extension, adduction, and medial rotation of the shoulder joint
Trapezius	Elevation, retraction, and rotation of the scapula
Levator scapulae	Elevation of the scapula; tilting glenoid cavity inferiorly by rotation of the scapula
Rhomboideus minor and major	Retraction of the scapula; Rotation of the scapula to depress glenoid cavity; Fixation of the scapula to the thoracic wall
Teres major	Medial rotation and adduction of the shoulder joint

4 BIOMECHANICS OF THE SHOULDER GIRDLE

The four joints of the shoulder girdle act together to obtain a greater mobility than they could individually. The lack of bony support that makes this complex so moveable results in instability. A range of ligaments and muscles are responsible for providing the necessary support. (Nordin & Frankel, 2012, 319.)

4.1 Movements of the shoulder girdle

Flexion of the shoulder is executed by the muscles crossing the glenohumeral joint anteriorly, lifting the arm upwards in front of the body. The main flexors are the anterior part of the deltoid muscle and the clavicular head of the pectoralis major. Assisting in flexion are the short head of the biceps brachii and the coracobrachialis. (Hall, 2015, 188.) As long as the elbow and forearm are not participating in the movement the long head of the biceps brachii is not active although it crosses the glenohumeral joint anteriorly (Nagami, Morohoshi, Higuchi, et al, 2011).

Extension of the shoulder joint is the opposite movement to shoulder flexion and restores the arm back to its anatomical position after flexion (Tortora & Derickson, 2014, 265). In case of the shoulder joint, gravitation is the main moving factor when the movement is unresisted. If resistance is present or the arm is moved beyond the anatomical position into hyperextension, the movement is executed by the muscles crossing the glenohumeral joint posteriorly. The main extensors are the latissimus dorsi and teres major, assisted by the posterior part of the deltoid, particularly when the humerus is in external rotation. When the elbow is flexed the long head of the triceps brachii is assisting the movement as well. (Hall, 2015, 188; Tortora & Derickson, 2014, 265.)

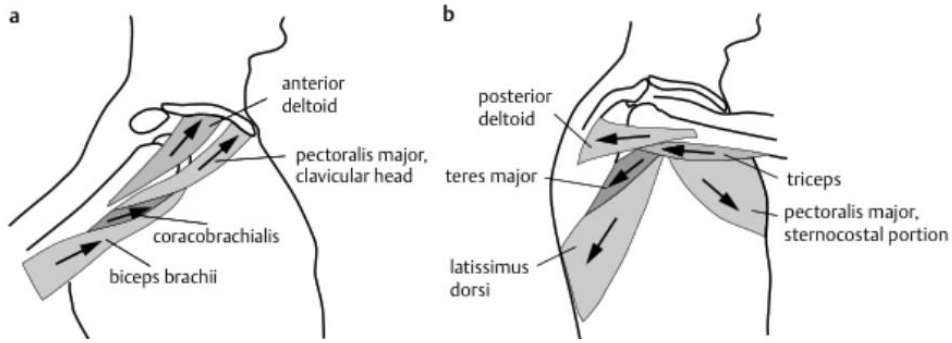

Figure 2. a Muscles flexing the shoulder joint; b: muscles extending the shoulder joint (Brinckmann, Frobin & Leivseth, 2016, 366)

Abduction is the motion of moving the arm laterally at the glenohumeral joint and is executed by the muscles superior to the humerus, the middle part of the deltoid and the supraspinatus. This movement is executed along the frontal plane. The supraspinatus is initiating the movement and is active until about 110° abduction. Whereas the deltoid is active from about 90° to 180°. To stabilize the glenohumeral joint and keeping the humeral head centralized, the subscapularis, teres minor and infraspinatus neutralize the force created by the middle part of the deltoid. (Hall, 2015, 188; Tortora & Derickson, 2014, 266.)

Adduction is the opposite movement to abduction and describes the movement of the arm towards the midline. As in extension the gravitation is the main moving factor when the movement is unresisted. When resisted the muscles inferior to the glenohumeral joint are the main adductors, including teres major, latissimus dorsi and the sternocostal part of the pectoralis major. (Hall, 2015, 188; Tortora & Derickson, 2014, 266.)

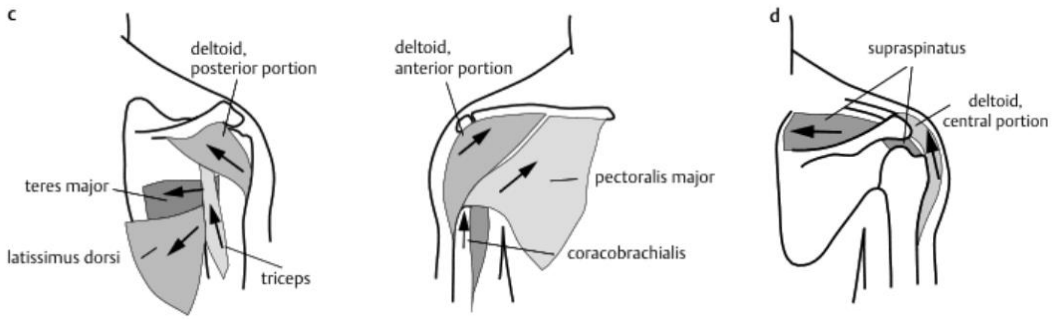

Figure 3. c: muscles adducting the shoulder joint (left posterior view, right anterior view) d: muscles abducting the shoulder joint (Brinckmann, Frobin & Leivseth, 2016, 366)

An important role in the sport of disc golf and other throwing and bat/racket sports is played by the horizontal abduction and adduction. Horizontal adduction of the glenohumeral joint describes the movement of the arm on the transverse plane from a lateral to an anterior position and is executed by the muscles which are anterior to the glenohumeral joint, such as the pectoralis major, the anterior part of the deltoid and the coracobrachialis. Horizontal abduction is describing the movement in the opposite direction, from an anterior to a lateral position which is executed by the muscles posteriorly to the glenohumeral joint, the middle and posterior part of the deltoid, teres minor, and infraspinatus. (Hall, 2015, 188-189; Kent, 2016.)

Rotation, medial as well as lateral, describes the movement of the humerus around its longitudinal axis. Medial, or also internal rotation, is mainly executed by the muscles attaching anteriorly to the humerus, the subscapularis and teres major. The movement is assisted by the anterior part of the deltoid, the pectoralis major, the latissimus dorsi and by the short head of the biceps brachii. In the opposite direction, the lateral, or external, rotation, the movement is mainly created by the muscles attaching to the posterior aspect of the humerus, with the main actors being the infraspinatus and teres minor and assisting muscle being the posterior part of the deltoid. (Hall, 2015, 188; Tortora & Derickson, 2014, 266-267; Brinckmann, Frobin & Leivseth, 2016, 366.)

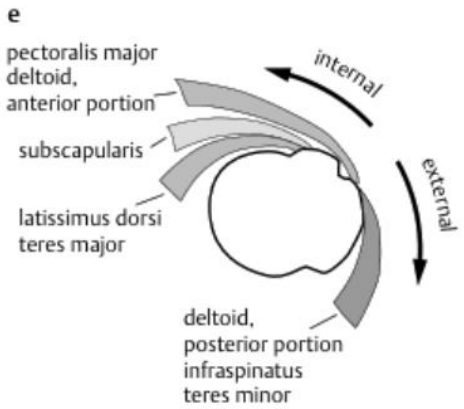

Figure 4. e: Muscles externally and internally rotating the humerus (Brinckmann, Frobin & Leivseth, 2016, 366)

4.2 Loads on the shoulder

Because the different components of the shoulder joint are connected to each other, they are working together to carry the loads and absorbing shocks. The biggest part is carried by the glenohumeral joint due to its direct connection to the arm. As the whole body itself each extremity has its individual center of gravity. (Hall; 2015; 191.) Even though the arm makes up just about five percent of the body weight, the forces created by the lever of the arm while extended creates a large torque that needs to be stabilized by the shoulder muscles. The contraction of these muscles compresses the gleno-humeral joint in a way that it needs to sustain an equal of about 50% of the body weight. (Chollet, Hue, Auclair, Millet & Chatard; 2000.) As shown in Figure 5, the load increases the further the center of mass is moved away from the body, with the maximum of force acting on the shoulder at 90° flexion and abduction (Hall, 2015, 191).

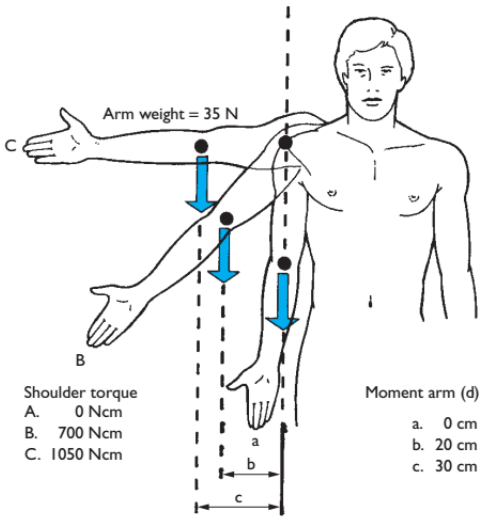

Figure 5. (Hall; Basic Biomechanics; 191)

This load can be reduced by flexing the elbow, but the rotational torque when flexion happens on the horizontal plane (figure 6) requires the activation of additional muscles. With a flexed elbow, the center of mass of the upper arm is moving in direction of the frontal plane F_1, and the center of mass of the elbow in direction of the sagittal plane F_2, resulting in a diagonal force F_r on the shoulder. (Hall, 2015; 192.)

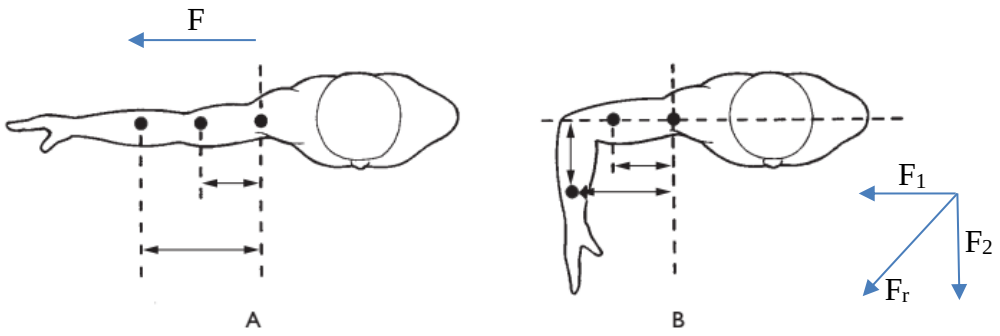

Figure 6. A: Force acting on the frontal plane on the shoulder with extended elbow. B: Forces acting on the frontal and sagittal plane with flexed elbow. (Hall, Basic Biomechanics;192)

4.3 Throwing Techniques and biomechanics

There are three general throws in Disc golf, backhand, sidearm and overhead. Through angle of the disc and variation of the general throwing movement several different throws can be performed, like hyzer, anhyzer or roller. In each style the player has to master different components of the throw, such as stands, windup, release and follow through. Furthermore, the player has to pay attention to the grip and angle of the disc. To gain more distance, a runup can be added prior to the throw. (Website of the Professional Disc Golf Association, 2018.) Unfortunately, the terminology of throwing phases is not consistently, therefore the most common terms will be used.

4.3.1 Backhand throw

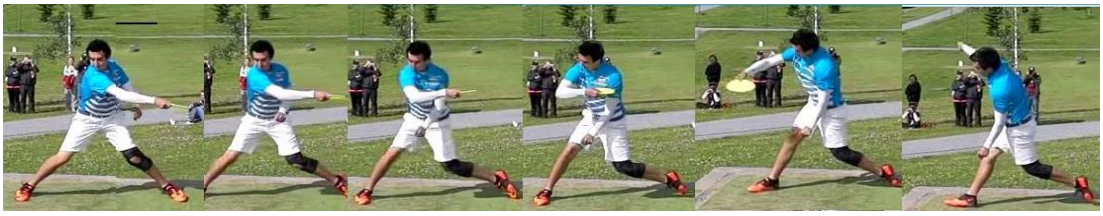

Figure 7. Different Phases of a backhand throw executed by Paul McBeth (heavydisc, 2015)

The backhand throw is the most common throw used in disc golf. Because of its similar movement it is named after the backhand tennis stroke. The backhand throw consists of different upper and lower body phases. The upper body phases are reach back, pull through, release and follow through. The lower body phases are the plant phase, hip turn and foot spin. The disc is held in the hand on the same side as the leading foot/front foot with the wrist in neutral or slight supinated position. At the plant phase the reach back is at its widest range away from the body with the arm fully extended. In case a run up was performed, the energy of the run up is used to create rotational acceleration in the torso, the plant phase is used as the pivot point. At this time the weight is mainly on the rear leg. The hip and upper body are rotating simultaneously and the weight is shifted to the front leg, increasing the speed of the arm during the hip turn and pull through phase. The disc should reach peak speed at the release point with an out-stretched arm. Ideally the disc maintains to travel in a straight line from reach back to release point. The shoulders need to rotate to allow the disc to stay on the line. At the moment of release the foot spin and follow through phases start to keep balance and gradually decrease the speed of the rotation. To further promote balance the rear leg is lifted and slightly turned in the opposite direction of movement. (Feldberg, 2011; Greenway, 2003; Witmer & Sandström, 2013.)

4.3.2 Sidearm throw

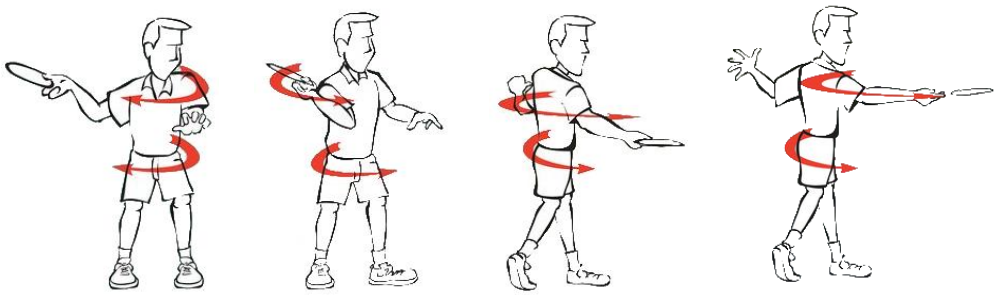

Figure 8. Different phases of a sidearm throw (discsunlimited, Innova Champion Disc Inc. 2003)

The sidearm or forehand is as the backhand similar in technique to the tennis forehand stroke. The lower and upper body phases are named the same as in the backhand throw but are performed differently. The disc is held in the opposite side of the leading leg.

The disc is held with a supinated wrist, the palm facing upwards. Optional a runup can be performed prior to the throw. The basic stands in this technique is perpendicular to the throwing direction, with the weight on the rear leg. During the plant phase, the reach back is at its widest range with the arm externally rotated and the elbow slightly flexed to allow maximum forward motion during the pull through phase. In the pull through phase the weight is transferred to the front leg, with the foot now turning towards the target. The hip is leading the rotation of the body, followed by the shoulder which pulls the bend arm forward. The body rotation will continue with the arm extending to the release point. To keep balance and gradually decrease speed, the rear leg will lift off and the body continues the rotation in the follow through phase. (Feldberg, 2011; Innova Champion Disc Inc. 2003; Witmer & Sandström, 2013.)

4.3.3 Overhead throw

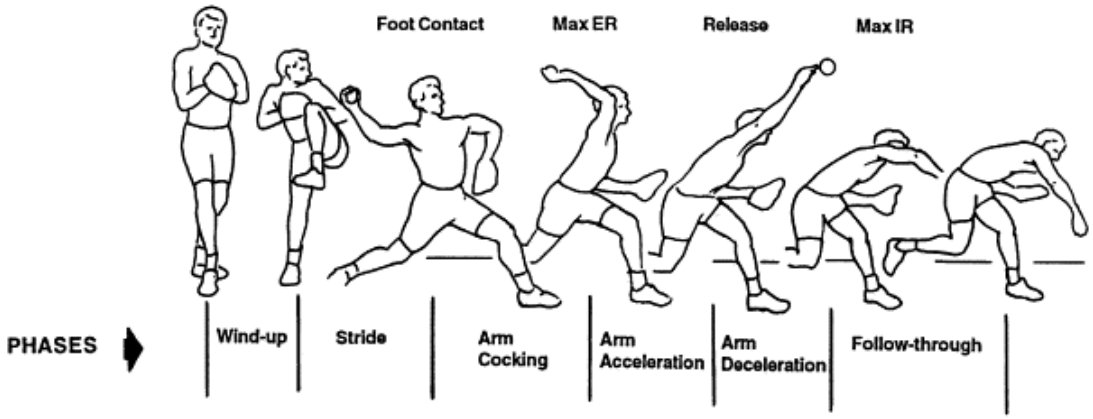

Figure 9. Phases of overhead throwing (Fleisig, Barrentine, Zheng, Escamilla, & Andrews, 1999)

The arm motion of the overhead throw is executed much like a throw done by a baseball pitcher as shown in figure 9, although the phases are named consistently to the other throwing techniques, the footwork is similar to the sidearm throw to ensure the accuracy of the throw. As in the sidearm throw the disc is held in the opposite hand to the leading leg and the stance is perpendicular to the target. During the reach back the weight is mostly on the rear leg and the shoulder is abducted and externally rotated. Much like in the other throwing techniques the reach back is at its widest range at the moment of the plant phase to generate maximum forward motion. The hip initiates the

forward motion and the front leg is turned in direction of the target. During the pull through phase the shoulder externally rotates. In the late pull through phase the body continues to rotate towards the target and the arm horizontally adducts, at this moment the elbow is still bend. In the last phase of the pull through the arm straightens, accelerating the disc maximally until the release point. In the overhead throw a follow through is performed by continuing the rotation of the body to decelerate. (Seroyer, Nho, Bach, Bush-Joseph, Nicholson and Romeo, 2010; Witmer & Sandström, 2013; Papa, Bennett and Koz, 2008.)

5 COMMON SHOULDER PROBLEMS OF THROWING ATLETES

Shoulder pain is with 15-20% one of the most common musculoskeletal pains, following low back pain and neck pain (Website of International Association for the Study of Pain: 2009-2010). Due to its wide range of motion it is vulnerable to overuse as well as traumatic injuries (Hall, 2015, 194). Especially with throwing and overhead sports chronic degenerative changes with damage of the rotator cuff are common (Gerhardt & Scheibel, 2016). In 77% of the cases of a study done by Ostor et al. two shoulder problems were found at the same time (Ostor, Richards, Prevost, Speed, Hazleman 2005). This chapter will discuss the most common shoulder injuries of throwing and overhead athletes, which include SLAP lesions and rotator cuff injuries.

5.1 SLAP lesion

The glenoid labrum, a tissue in the glenohumeral joint similar to the menisci in the knee, can be torn or detached from the glenoid cavity due to trauma or overuse. In 1990 Snyder described 4 classifications for SLAP lesions, (SLAP = Superior Labral tear Anterior to Posterior), which were later expanded to seven classifications by Maffet et al. (Wang, Yalizis, Hoy & Ek, 2018.)

5.2 Rotator cuff injuries

According to a study by Ostor et al. in 2005, 85% of patients with shoulder pain were found to have rotator cuff tendinopathy, therefore being the most common cause for shoulder pain between the age of 35 and 75 (Ostor, Richards, Prevost, Speed, Hazleman 2005). This condition can be caused by repetitive movements, especially above shoulder level, like in throwing or due to heavy lifting (Mitchell, Adebajo, Hay & Carr, 2005).

Rotator cuff tears occur due to trauma in young age or due to overuse in elderly population (Mitchell, Adebajo, Hay & Carr, 2005). According to a study of Connor et al. 40% of overhead athletes were found to have rotator cuff tears (Connor, Banks, Tyson, Coumas & D'Alessandro, 2003).

Extrinsic shoulder impingement can occur due to narrowed space between the acromion and the humerus that causes mechanical wear to the rotator cuff muscles. The narrowing of the suprahumeral space can be caused by anatomical or biomechanical factors, such as repetitive elevation activities. Primary impingement describes compression due to structural variations in the acromion or degenerative changes that decrease the suprahumeral space, whereas secondary impingement describes compression due to instability or hypermobility of the glenohumeral joint and increased translation of the humeral head. (Kisner & Colby, 2012, 562-563.) Ultimately an impingement can result in biceps or rotator cuff tendonitis and subacromial bursitis (Chorley, Eccles & Scurfield, 2017).

6 AIM AND OBJECTIVES OF THE THESIS

The aim of this thesis is to investigate the incident of shoulder pain in professional and semiprofessional disc golf players. Furthermore, the connection of shoulder pain to throwing technique, playing years and player rating will be investigated.

Objectives of the thesis:

1. During what throwing technique does pain occur?
2. Does the pain occur during or after throwing?
3. Do years of playing affect occurrence of pain?
4. Is there a correlation between player rating and prevalence of pain?

7 METHODOLOGY

The study was designed as an epidemiological study in cooperation with the German frisbee sport association. In epidemiological studies the incidence or distribution of diseases or other health related events are investigated through different methods like observation or descriptive studies. (Website of the World Health Organization, 2019.) The data for this study was collected through an online questionnaire set up with the tool (APPENDIX 2) provided by SAMK (eLomake). It was distributed to amateur and pro licensed disc golf players through the German frisbee sport association. The questionnaire includes demographic information, playing habits (weekly practice time, favored technique, participation in competitions, etc.) and shoulder pain specific questions.

Prior to the main distribution, the questionnaire was piloted by professional disc golf players, consisting of 2 female and 3 male participants, to obtain feedback and identify possible flaws. In general, the feedback was positive. Minor layout improvements were done to make the answering process clearer and an additional question was added to clarify the specific location of the shoulder pain.

The survey was published on the website of the German disc golf association, a subgroup of the frisbee sport association, and stayed open for a total of 3 weeks from 15th of October until 4th of November 2018. Because it was published on a public website it cannot be determined how many people saw the questionnaire and how many of those who saw it replied. An introduction letter (APPENDIX 1 and 3) clarified the

purpose of the survey and participants consent was given by voluntarily completing the survey. Participants had to be 18 years old to be included in the study.

The timeline of the thesis process is displayed in Table 5. The thesis process started in October 2017 with the decision of the thesis topic and establishing contacts to possible partners. In November 2017 the thesis plan was presented, and the research questions were determined. In February 2018 the thesis agreement was signed with the German frisbee sport association. After that the questionnaire was designed in cooperation with the thesis partner. The questionnaire was then piloted and adjusted according to the feedback. Before the questionnaire was published to the public, research on the theoretical background of the topic was done and was continued for about seven months. The questionnaire was distributed from October to November 2018 and the obtained data was analyzed from February to March 2019. The finished thesis was presented in April 2019.

Table 5. Timeline of the research process

Timeline	
October 2017:	Deciding topic of the thesis and contacting possible partners.
November 2017:	Presentation of the thesis plan.
February 2018:	Signing thesis agreement.
February-March 2018:	Designing the questionnaire.
May-June 2018:	Pilot study and review of the questionnaire.
Sep. 2018-March 2019:	Writing theory.
Oct.- Nov. 2018:	Distributing the questionnaire.
Feb-March 2019:	Analyzing data obtained by questionnaire.
March-April 2019:	Finishing written part of the thesis.
April 2019	Completion and presentation of the thesis.

8 RESULTS

Out of the 63 responses three had to be excluded, one due to being under age and two for not entering a valid value for the PDGA rating. The majority of the participants were in the age group of 25-45 years old. The wide range of the participants (Table 4) is due to one participant being significantly older than the rest of the study group. 42(70%) of the participants were registered with an amateur license and 18(30%) with a professional license. Out of the 60 included replies 37(65%) reported that they experienced some sort of shoulder pain, 32(53,3%) reported it to be related to disc golf.

Table 4. Demographic data of the participants

Demography item		Frequency (%)
Sex	Male	53 (88,3)
	Female	7 (11,7)
Age (yr)	Mean (range)	38.48 (23 -70)
	Median	37
License	Am	42 (70)
	Pro	18 (30)
Total		60 (100)

8.1 Occurrence of pain during different throwing techniques

The most common throwing technique was the backhand throw with 45 participants stating to primarily use this throwing technique, sidearm was used primarily by two participants, and 13 participants stated to use both techniques about equally. The distribution of occurrence of pain is shown in Figure 10. The highest occurrence of pain was reported during the overhead throw (59%) closely followed by the sidearm throw (56%). 15% of the participants stated to have pain during sidearm as well as the overhead throw, which makes it the most common combination. Other combinations were solely individual cases.

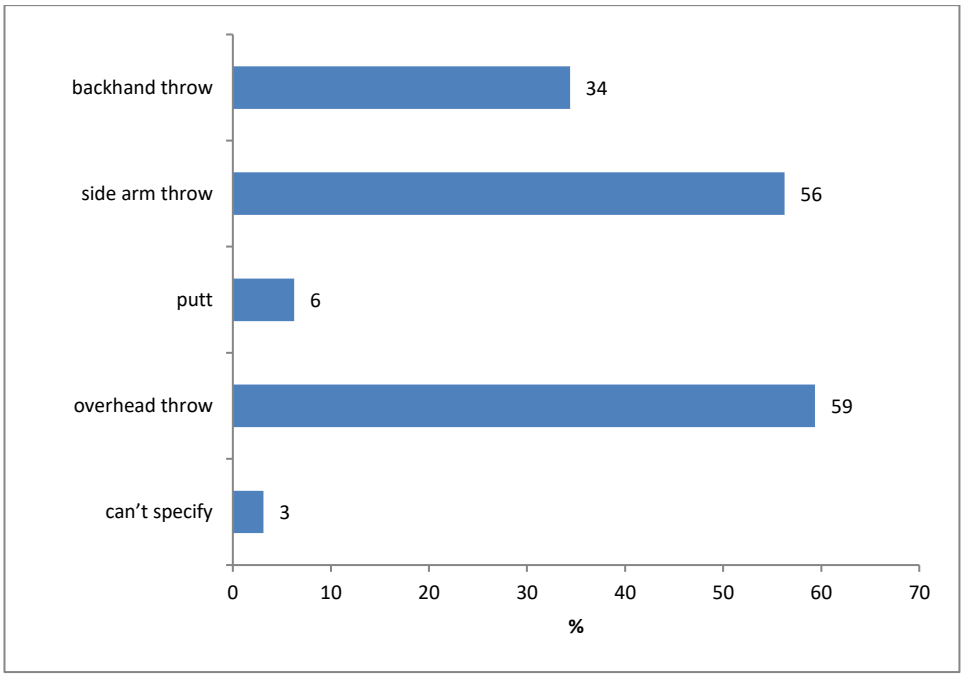

Figure 10. Occurrence of pain during different throwing techniques

8.2 Onset of pain

In figure 11 the onset of pain is graphically displayed, again, this was a multiresponse question. No clear pattern of combinations could be found. Most common onset was during the throw (44%), followed by an onset of pain directly after the throw (38%). Just 3% of the participants could not specify when the pain set in.

The location of the pain (Figure12) was most commonly described to be inside of the shoulder (44%) or in the front of the shoulder (38%). A pattern of combinations could not be found here either.

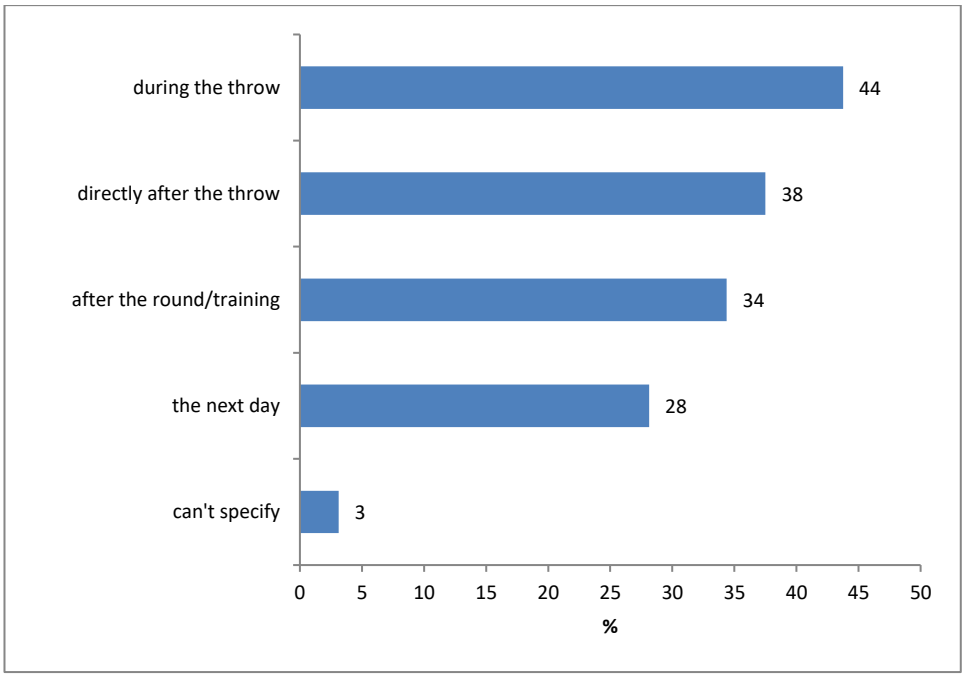

Figure 11. Onset of pain

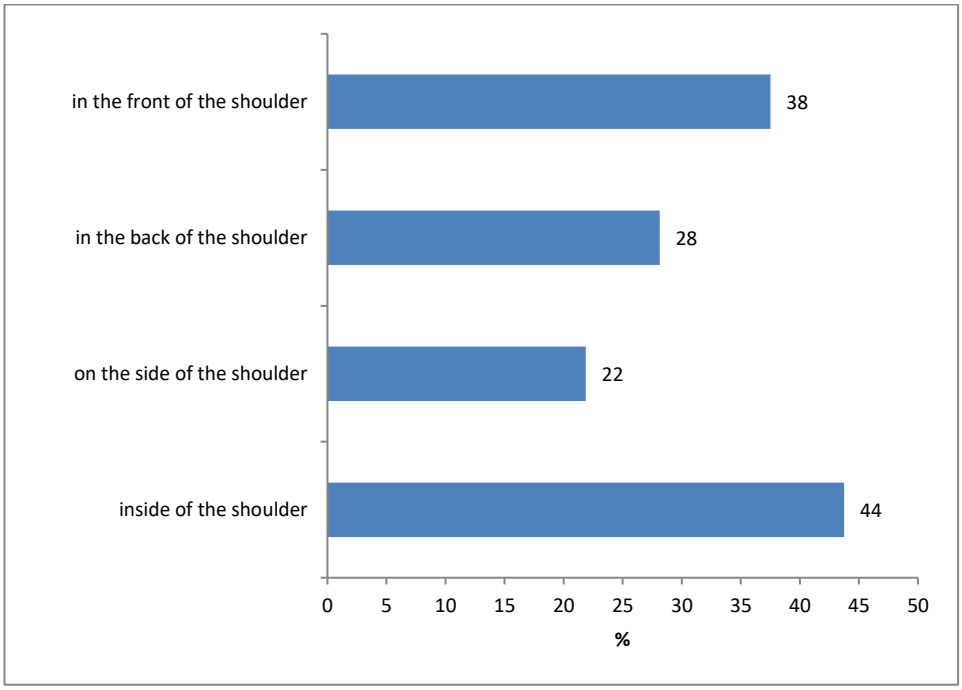

Figure 12. Location of pain

8.3 Effect of playing years on occurrence of pain

The years of playing disc golf ranged between two and 35 years, and the years of playing tournaments ranged between one and 30 years. In Table 6 the years of playing disc golf were compared to the occurrence of disc golf related shoulder pain. Here it can be seen that the longer a person is playing disc golf, the greater the likelihood of eventually developing shoulder pain. The actual age of the participants did not show to have an effect of the prevalence of pain. As seen in Table 7 the years of playing tournaments paint a similar picture, although the results were not as significant as in the total amount of playing years. The number of played tournaments per year did not show to have a significant impact on the prevalence of pain, neither did different training habits.

Table 6. Comparison years of playing disc golf and pain

	Yes	*No*	*Total*
Average	10.6	5.9	8.4
Standard Deviation	8.7	2.9	7.0
Freq.	32	28	60
Confidence Int.	7.4	4.7	6.5
95%	13.7	7.0	10.2

F = 7,41 Degrees of Freedom: 1 and 58
p = 0,00857 Statistically significant

Table 7. Comparison years of playing tournaments and pain

	Yes	*no*	*Total*
Average	8.2	4.6	6.5
Standard Deviation	8.2	2.9	6.5
Freq.	32	28	60
Confidence Int.	5.2	3.5	4.8
95%	11.1	5.7	8.2

F = 4.74 Degrees of Freedom: 1 and 58
p = 0.0336 Statistically almost significant

8.4 Correlation between PDGA rating and prevalence of pain

The results show that there is no correlation between PDGA rating and the prevalence of pain. The average PDGA rating of participants experiencing disc golf related shoulder pain and those not experiencing such pain is close to the overall average of the participants. This means that neither participants with a higher or lower rating were especially affected by experiencing pain.

Table 7. Comparison PDGA rating and pain

	Yes	*No*	*Total*
Average	898.1	879.3	889.3
Standard Deviation	52.9	76.8	65.3
Freq.	32	28	60
Confidence Int.	879.0	849.5	872.5
95%	917.2	909.0	906.2

F = 1,25 Degrees of Freedom: 1 and 58
p = 0,26744 Statistically not significant

9 CONCLUSION

The number of participants was quite suitable for the scope of this thesis, but since the distribution of participants in aspect of age and PDGA rating was not a normal distribution, the results need to be evaluated with caution. Because of this the results may not be applicable to the whole population of disc golf players.

The study revealed that years of playing disc golf significantly increase the prevalence of shoulder pain, whereas age does not seem to have an impact. The affected players could clearly distinguish during which throwing technique or techniques they experienced their pain. More than half of the participants experienced pain in overhead (59%) and sidearm throw (56%), which makes those the techniques most prone for experiencing pain. Almost half of the participants stated that the onset of the pain is during

the throw (44%) or directly after the throw (38%), just 3% of the participants stated that they could not specify when the pain set in.

The players skill level, in this study evaluated through the PDGA rating, did not show to have an influence on the prevalence of pain. Neither did the trainings habits and training frequency of the players.

10 DISCUSSION

The questionnaire used to obtain the data was suitable for the scope of this thesis, however it could be optimized. To save time and effort for participants and also the researcher the questionnaire tool should be adjusted to exclude participants immediately if an answer does not fit the inclusion criteria. Content wise the questionnaire should also include the offseason training of the participants. Disc golf is a seasonal sport mostly played outside, so training habits vary during the year. It should be further investigated if the shoulder pain participants are experiencing is seasonal and if the offseason break is influencing the incidence of pain.

Several limitations affect the generalizability of the study. For one the average PDGA rating of the participants (889, range 671-1010) was lower than in most PDGA rated tournaments, for example the European Championships 2018 had an average rating of 957 (range 784-1036) in the open division. (Website of the Professional disc golf association, 2019.) The player groups should be analysed individually and compared to each other for a thorough examination of the pain patterns and the identification of the mostly affected groups. This is material for further research.

It also needs to be further investigated to what extent pain during disc golf is caused by other underlying conditions. Several participants stated that their pain might be due to poor posture during work or from prior injuries. Furthermore, it needs to be investigated if pain that sets on after the actual activity of playing disc golf still is perceived as related to the sport by the affected person.

The results of this study show that there is a high prevalence of pain the longer a disc golf career lasts. To prevent incidences of shoulder pain the right technique should be taught as early as possible, as a study by Fleising at al. (1999) suggested. In recent years workshops and pro clinics from professional players for beginners got more common in certain areas with a high number of players (Finland, USA), which is a positive development. In other areas players still rely on online material and have no feedback about their technique. A better education of the players through clinics or local clubs might decrease the prevalence of pain. A study investigating and evaluating the injury patterns among disc golfers over a longer period would be useful to design such a targeted prevention program.

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Hey,

I'm a physiotherapy student from Satakunta university of applied science. I wish to carry out a survey as part of my bachelor thesis on disc golf related shoulder injuries, because shoulder problems are among the most common in this sport. I'm doing a study on the frequency of different shoulder pain with in competing players. For this purpose, I am collecting data through this survey.

Participation is completely voluntary, and the data is handled confidentially. The collected data is solely used for this study. In the end of the study there is some free space for comments. It takes less than 5 minutes to answer the questions.

Thank you for your reply!

Shoulder pain in disc golf

Background information

Question 1: Age

	Male	Female
Question 2: Gender	○	○

	Am	Pro
Question 3: PDGA license	○	○

Question 4: PDGA rating

	left	right	both equally
Question 5: Dominant throwing arm	○	○	○

Experience and training habits

Question 6: Years of playing disc golf

Question 7: Years of playing tournaments

	0	1 - 5	6 - 10	11 - 15	16 - 20	>20
Question 8 How many tournaments do you play per year?	◉	○	○	○	○	○

Question 9 How often do you train?

	<1 time/month	1-3 times/month	1-2 times/week	3 or more times /week
Driving	○	○	○	○
Putting	○	○	○	○
Playing on the course	○	○	○	○

Question 10 Do you do a specific training except throwing?(more than 1 option possible)

- ☐ Technique/form
- ☐ Targeted strength training

- [ ] Stretching
- [ ] nothing special
- [ ] other

	backhand	sidearm	both about equally
Question 11 What is your preferred throwing technique?	○	○	○

Shoulder Pain

	yes	no
Question 12: Do or did you experience any kind of shoulder pain?	○	○

If yes please continue with question 13, if no continue with the feedback section

	Yes	No
Question 13: Was this shoulder pain related to disc golf?	○	◉

If yes please answer question 14, 15 and 16, if no continue with the feedback section

Question 14: During what kind of movement did you feel pain? (more than 1 option possible)

- [ ] backhand throw
- [ ] sidearm throw
- [ ] putt
- [ ] overhead throw
- [ ] can’t specify

Question 15: When did the pain set in? (more than 1 option possible)

- [ ] during the throw
- [ ] directly after the throw
- [ ] after the round/training
- [ ] the next day
- [ ] can't specify

Question 16: Where is your pain located? (more than 1 option possible)

- [ ] in the front of the shoulder
- [ ] in the back of the shoulder
- [ ] on the side of the shoulder
- [ ] inside of the shoulder

Comments and Feedback

Comments or additional information you want to give about the content of the questionnaire

Hallo,

Ich bin Physiotherapiestudentin an der Stakunta University of Applied Science und führe diese Umfrage als Teil meiner Bachelorarbeit durch. Da Schulterprobleme bei Disc-Golfspielern unter den häufigsten Verletzungen liegen, werde ich die Häufigkeit von Schulterschmerzen bei Spielern mit einer PDGA Lizenz untersuchen. Zu diesem Zweck führe ich diese Umfrage durch.

Die Teilnahme ist freiwillig und die Daten werden vertraulich behandelt. Die gesammelten Daten werden nur für diese Studie verwendet. Am Ende der Studie gibt es einen Feld für Kommentare. Es dauert weniger als 5 Minuten, um alle Fragen zu beantworten. Aus technischen Gründen ist die Umfrage nur auf Englisch verfügbar, Kommentare können gerne in Deutsch verfasst warden.

Danke für Ihre Antwort!