

Match analysis on no-gi Brazilian jiu-jitsu

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<p>Gi and no-gi Brazilian jiu-jitsu are fast growing sports. The aim of this thesis is to conclude a match analysis on no-gi Brazilian jiu-jitsu. Match analysis is used to identify the most used techniques in no-gi Brazilian jiu-jitsu. There is no sport analysis done for either gi or no-gi Brazilian jiu-jitsu, therefore the match analysis and its results can be utilized later as a base for sport analysis.</p> <p>The goal of this study is to find out the match duration, the type of match ending, the most common submissions and the point scoring positions of no-gi Brazilian jiu-jitsu. Previously they have carried out a match analysis on gi Brazilian Jiu-Jitsu World Championships. One purpose of the study is also to compare findings between gi and no-gi Brazilian jiu-jitsu.</p> <p>Matches (subjects) analyzed are from No-Gi Brazilian Jiu-Jitsu World Championships 2015. All of the black belt matches from each weight category both men and women are analyzed. Observations were gathered on Excel spreadsheet and results were analyzed by statistical analysis program SPSS. The literature review is done on the history of the sport, the rules of Brazilian Jiu-Jitsu, match analysis and statistical analysis.</p> <p>On average a black belt no-gi Brazilian jiu-jitsu match lasts approximately slightly over seven minutes. Matches in men categories are longer while in women category the average match duration is approximately five minutes.</p> <p>The most usual type of match ending in no-gi Brazilian jiu-jitsu is a submission (47,7%). Victory via points (33,6%) and advantages (12,5%) are also common. A submission rate in women category is remarkably higher than in men categories.</p> <p>An arnbar and a rear naked choke are the most common submissions in no-gi Brazilian jiu-jitsu. Chokeholds altogether are the most popular submissions followed by leg locks and arm locks.</p> <p>Two point scoring positions are the most usual ones. Three and four points scoring positions occur more rarely. In men categories there are more advantages given to competitors than in women category. In addition, there were no penalties given in women categories.</p> <p>In no-gi Brazilian jiu-jitsu more matches end via submission than in gi Brazilian jiu-jitsu. Victories via points and advantages are more common in gi. There are a similar proportion submissions via chokeholds in no-gi and gi. In no-gi there are more finishes via leg locks and in gi there are more finishes via arm locks.</p>	
Keywords Brazilian jiu-jitsu, combat sports, martial arts, match analysis	

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1 Introduction

Brazilian jiu-jitsu both gi and no-gi are growing sports. Formed from judo in the early 20th century Brazilian jiu-jitsu has gained worldwide recognition in recent years. The fighting style in Brazilian jiu-jitsu which is focused on ground combat is a significant part in another currently popular combat sport, mixed martial arts.

No sport analysis has been done on Brazilian jiu-jitsu or no-gi Brazilian jiu-jitsu. In order to professionalize training and coaching of the sport it is necessary to carry out a match analysis. One of the foundations of a proper sport analysis is a match analysis. No match analysis either has been done on no-gi Brazilian jiu-jitsu. There is a match analysis done on gi Brazilian jiu-jitsu. Considering the different characteristics of the two styles it is important to conduct a match analysis on no-gi Brazilian jiu-jitsu.

A match analysis provides data based on which an athlete and a coach can plan the training of the athlete. There are quite a few match analyses done in combat sports. According to research a notational system with followed data decided in advance can be a good option for combat sports.

The subscriber of the thesis is the Finnish Brazilian Jiu-Jitsu Federation (FBJJF). FBJJF is the governing body of Brazilian Jiu-Jitsu in Finland. FBJJF wants to professionalize the sport and therefore the match analysis is important. The organization provides the material of past No-Gi Brazilian Jiu-Jitsu World Championships.

The statistics of the match analysis of the matches are carried out by using Microsoft Excel spreadsheets and a statistical analysis program SPSS. Statistics from duration, rendering decisions, submissions types, point scoring positions, advantages and warnings are gathered. Based on the gathered data a match analysis on no-gi Brazilian jiu-jitsu is conducted and it is compared to the match analysis on Brazilian jiu-jitsu with gi done in 2016.

The aim of the study is to conduct a match analysis on no-gi Brazilian jiu-jitsu. The subjects of this study are all the adult black belt matches from 2015 International Brazilian Jiu-Jitsu Federation (IBJJF) No-Gi Worlds Championships. Both men and women black belt matches from the competition are analyzed including the open weight categories.

2 Brief history of Brazilian jiu-jitsu

The origins of Brazilian jiu-jitsu are difficult to determine. Similar grappling styles are known to have been used in India, China and Japan hundreds of years ago. One of the best known origins of Brazilian jiu-jitsu style fighting skills are the samurai martial arts practiced by samurai warriors. There is a theory describing that when a samurai warrior lost his weapon on a battlefield different kinds of takedowns, joint locks and strangleholds came effective. At first jiu-jitsu developed alongside with combat skills involving weapons. (Graciemag. 2014)

In the late 19th century and in the beginning of the 20th century judo, a progenitor of Brazilian jiu-jitsu, spread outside of Japan. Mitsuyo Maeda, practitioner of judo, was convinced on the effectiveness of judo. Maeda began to travel the world to introduce the art. In judo the main objective is to throw or take down an opponent from a standing position. Depending on the situation when judokas hit the ground, the combat continues on the ground. In judo while being on the ground the objective is to pin and immobilize the opponent or to make the opponent submit by using different chokeholds and joint locks. (Butcher 2001, 13) Maeda, who was specialized on a ground combat, organized judo demonstrations where he challenged locals into a fight. In these fights against the locals Maeda wanted to demonstrate the superiority of chokeholds and joint locks. (Mixed martial arts rankings. 2009)

In 1914 Maeda arrived in Brazil. In Brazil Maeda continued the judo demonstrations and challenge fights. In 1917, then 14-year-old Carlos Gracie took part in one of the Maeda's demonstrations. Gracie was convinced of the sport and requested Maeda to teach him the art. Carlos Gracie and his brothers became eager students of the sport. Gracies were fascinated especially by the ground techniques of the sport. After being Maeda's students for a few years, Carlos together with his brother Helio founded their own adaptation of Judo focused on ground fighting. Gracies started to call the new martial art Gracie Jiu-jitsu, later known as Brazilian Jiu-jitsu. (Mixed martial arts rankings. 2009)



Picture 1. Carlos Gracie applying armbar (BJJ Heroes 2011)

Brazilian jiu-jitsu started to gain success in Brazil and practitioners of the sport were sent for example to United States to spread the sport. The worldwide popularity of Brazilian jiu-jitsu increased in 1990s when Rorion Gracie, the oldest son of Helio Gracie, founded the Ultimate Fighting Championship (UFC). The UFC is a mixed martial arts organization which presents full-contact matches in which a fighter can use both grappling and striking techniques. Rorion Gracie wanted a representative of Brazilian jiu-jitsu to participate in the first UFC tournament which was held in Denver, Colorado in 1993. Royce Gracie, a son of Helio Gracie, was one of eight fighters in this first UFC tournament and he won the tournament overwhelmingly by using techniques of Brazilian jiu-jitsu. (MMA training tech. 2015)

2.1 Style of fighting

Brazilian jiu-jitsu promotes that with a proper technique a smaller and weaker person can beat a bigger and stronger opponent. By using the levers of a body correctly and utilizing torque and pressure the goal in Brazilian jiu-jitsu is to control and make the opponent submit in a ground combat. (Cartmell. 1998)



Picture 2. Rear naked choke applied in no-gi match (Flograppling 2015)

Like in judo and wrestling, a Brazilian jiu-jitsu match starts in a standing position. The goal is to bring the opponent to the ground. In Brazilian jiu-jitsu, alternatively to a takedown, a fighter can also pull the opponent to the ground. This voluntary decision to take bottom position, also known as pulling guard, is a characteristic move in Brazilian jiu-jitsu. (Cartmell. 1998)

An important position in Brazilian jiu-jitsu is the guard. The guard is a position where the fighter in a bottom position controls the fighter in a top position with both legs or at least one leg. From the guard bottom the fighter can threaten the top fighter with sweeps from bottom to top and with submission holds. It is typical in Brazilian jiu-jitsu to achieve and maintain a dominant position in which a fighter can start to work on a submission. Because the guard is a strong position for the bottom fighter, usually the top fighter tries to pass bottom fighter's legs to maintain a better position. Passing opponents legs from a top position is also known as guard passing. After the top fighter passes the bottom fighter's guard, the fighter usually seeks a dominant position like side control, the mount or back control. (Cartmell. 1998)

Side control is a dominant ground position where the fighter on top lies perpendicularly on top of the bottom fighter. In side control the bottom fighter lies on his/hers back while the fighter on top tries to maintain pressure and control. In the mount position the fighter on top sits on the torso of the opponent with the fighters facing each other. In back control a fighter manages to advance on the opponent's back in a way that the fighter controls the

opponent. In Brazilian jiu-jitsu control while on back control is usually gained by placing both heels as hooks on the opponent's inner thighs. Dominant positions like side control, the mount and back control are strong positions while trying to execute submissions. (Cartmell. 1998)



Picture 3. Ongoing Brazilian jiu-jitsu match (IBJJF 2015)

2.2 Vale Tudo

In the early 20th century while Carlos and Helio Gracie developed Brazilian jiu-jitsu it was not competed as an own sport. Gracies wanted to prove the efficiency of the new martial art in no rules matches. No rules matches, known as Vale Tudo in Brazil, were popular in Brazil at the time. Vale Tudo is full-contact fighting with limited rules. In Vale Tudo a fighter can use both grappling and striking techniques. Some consider Vale Tudo as a predecessor of mixed martial arts which is a popular sport in the present day. (Sherdog. 2013)

Gracies challenged practitioners from another martial arts to fight in Vale Tudo matches. With Gracie's success in Vale Tudo by using Brazilian jiu-jitsu techniques the art gained popularity in Brazil. (MMA training tech. 2015)

2.3 Sport Brazilian jiu-jitsu

For many decades Gracie family and their students proved the efficiency of Brazilian Jiu-jitsu in Vale Tudo matches. In the 1960s Carlson, a son of Carlos Gracie, developed the first competition rules for Brazilian jiu-jitsu. Carlos himself was a successful representative of Brazilian Jiu-jitsu in Vale Tudo matches. In 1967, the Guanabara Jiu-Jitsu organization was founded. It was authorized by Brazilian National Sports Confederation. In the first Brazilian jiu-jitsu competition rules only takedowns, the mount and back control were rewarded with points. The matches were five minutes long and if a draw occurred a three minute overtime followed. It was the first time that time limits and point scoring positions were introduced to Brazilian jiu-jitsu. (Graciemag. 2014)

Carlos Gracie Jr., a son of Carlson Gracie, continued his father's work on developing the sport of Brazilian jiu-jitsu as he organized tournaments and competitions. In 1994, Carlos Gracie Jr. founded IBJJF, which is currently considered to be the most precious organization in Brazilian Jiu-jitsu. Since 1996 IBJJF has organized annually IBJJF World Championships which are considered to be the official world championship tournament in Brazilian jiu-jitsu. (IBJJF. 2016)

The uniform for Brazilian jiu-jitsu competitions and training is both a gi and without a gi. Brazilian jiu-jitsu without a gi is called no-gi Brazilian jiu-jitsu. Traditionally Brazilian jiu-jitsu was always practiced with gi. Since 2007 IBJJF has organized also no-gi Brazilian jiu-jitsu competitions. (IBJJF. 2016)

Brazilian jiu-jitsu uses a ranking system with different colored belts indicating the skill level of a practitioner. In addition to the weight classes also the belt ranking determines the division of competitors in competitions. The order of the belt ranking from lowest to highest ranking is: white, blue, purple, brown and black. In children's and juvenile's divisions grey, yellow, orange and green belts are also used. (IBJJF. 2012)

2.4 No-gi and submission wrestling

Traditional Brazilian jiu-jitsu is practiced with a gi. In the last decades no-gi Brazilian jiu-jitsu and a similar art, submission wrestling, have gained popularity. The first IBJJF no-gi world championships were held in 2007. No-gi Brazilian jiu-jitsu rules are the same as in gi Brazilian jiu-jitsu, only difference being the equipment. In no-gi the equipment is a compression t-shirt and shorts. It is not allowed to grab clothes in no-gi. (Worthington. 2014)



Picture 4. Ongoing no-gi Brazilian jiu-jitsu match (Graciemag 2012)

In 1999, the Abu Dhabi Combat Club, known as ADCC, began to organize submission wrestling world championships. At first the ADCC world championships were held every year and since 2001 the championships have been held every two years. Although the ADCC is a private organization the ADCC world championships are considered to be the official world championships of the sport. (ADcombat. 2015)

The rules of submission wrestling differ slightly from no-gi Brazilian jiu-jitsu. The main difference being twisting leg locks that are allowed in submission wrestling. (ADcombat. 2015) It can be speculated that one of the reasons for the increased popularity of no-gi and submission wrestling is the mixed martial arts which has rapidly increased its popularity in last decades. As no-gi and submission wrestling have gained popularity it has been speculated that if a competitor wants to succeed in no-gi and submission wrestling is it still reasonable to train also with the gi. Most ADCC world champions train Brazilian jiu-jitsu with gi as their main sport. (BJJ Heroes. 2015)

3 Rules of Brazilian jiu-jitsu

Currently there are many organizations operating in Brazilian jiu-jitsu and competitions are held under different rules and regulations. International Brazilian Jiu-Jitsu Federation (IBJJF) is the biggest organization in the world and its World Championships are considered to be the official world championships of the sport. (BJJ Eastern Europe. 2016) The rules covered in this chapter are the IBJJF rules.

3.1 Divisions and regulation match durations

Brazilian Jiu-jitsu is contested in age divisions and under a belt ranking system. Divisions and rankings affects match duration. Adult black belt matches are 10 minutes long. (IBJJF. 2012)

DIVISION	AGE RANGE	REGULATION MATCH DURATION
MIGHTY MITE I	(Current Year) - (Birth Year) = 4	02 minutes
MIGHTY MITE II	(Current Year) - (Birth Year) = 5	02 minutes
MIGHTY MITE III	(Current Year) - (Birth Year) = 6	02 minutes
PEE WEE I	(Current Year) - (Birth Year) = 7	03 minutes
PEE WEE II	(Current Year) - (Birth Year) = 8	03 minutes
PEE WEE III	(Current Year) - (Birth Year) = 9	03 minutes
JUNIOR I	(Current Year) - (Birth Year) = 10	04 minutes
JUNIOR II	(Current Year) - (Birth Year) = 11	04 minutes
JUNIOR III	(Current Year) - (Birth Year) = 12	04 minutes
TEEN I	(Current Year) - (Birth Year) = 13	04 minutes
TEEN II	(Current Year) - (Birth Year) = 14	04 minutes
TEEN III	(Current Year) - (Birth Year) = 15	04 minutes
JUVENILE I	(Current Year) - (Birth Year) = 16	05 minutes
JUVENILE II	(Current Year) - (Birth Year) = 17	05 minutes
ADULT	(Current Year) - (Birth Year) ≥ 18	05 minutes – White 06 minutes – Blue 07 minutes – Purple 08 minutes – Brown 10 minutes – Black
MASTER 1	(Current Year) - (Birth Year) ≥ 30	05 minutes – White / Blue 06 minutes – Purple / Brown / Black
MASTER 2	(Current Year) - (Birth Year) ≥ 36	05 minutes
MASTER 3	(Current Year) - (Birth Year) ≥ 41	05 minutes
MASTER 4	(Current Year) - (Birth Year) ≥ 46	05 minutes
MASTER 5	(Current Year) - (Birth Year) ≥ 51	05 minutes
MASTER 6	(Current Year) - (Birth Year) ≥ 56	05 minutes

Picture 5. IBJJF Divisions, age ranges and match durations (IBJJF 2012)

3.2 Weight classes

In addition to weight classes and belt rankings Brazilian jiu-jitsu is also contested in weight classes. Men and women have different weight classes. There are also different weight classes in Brazilian jiu-jitsu with gi and without gi. (IBJJF. 2012)

WEIGHT DIVISIONS		JUVENILE MALE	ADULT, MASTER AND SENIOR MALE	ADULT, MASTER AND SENIOR FEMALE	JUVENILE FEMALE
ROOSTER GALO	MAXIMUM WEIGHT	118.0 lbs	126.5 lbs		
		53,50 kg	57,50 kg		
LIGHT FEATHER PLUMA	MAXIMUM WEIGHT	129.0 lbs	141.0 lbs	118.0 lbs	106.5 lbs
		58,50 kg	64,00 kg	53,50 kg	48,30 kg
FEATHER PENA	MAXIMUM WEIGHT	141.0 lbs	154.0 lbs	129.0 lbs	116.0 lbs
		64,00 kg	70,00 kg	58,50 kg	52,50 kg
LIGHT LEVE	MAXIMUM WEIGHT	152.0 lbs	167.5 lbs	141.0 lbs	125.0 lbs
		69,00 kg	76,00 kg	64,00 kg	56,50 kg
MIDDLE MÉDIO	MAXIMUM WEIGHT	163.0 lbs	181.0 lbs	152.0 lbs	133.5 lbs
		74,00 kg	82,30 kg	69,00 kg	60,50 kg
MEDIUM HEAVY MEIO-PESADO	MAXIMUM WEIGHT	174.5 lbs	194.5 lbs	163.0 lbs	144.0 lbs
		79,30 kg	88,30 kg	74,00 kg	65,00 kg
HEAVY PESADO	MAXIMUM WEIGHT	185.5 lbs	207.5 lbs	No maximum weight	No maximum weight
		84,30 kg	94,30 kg		
SUPER HEAVY SUPER PESADO	MAXIMUM WEIGHT	196.5 lbs	221.0 lbs		
		89,30 kg	100,50 kg		
ULTRA HEAVY PESADÍSSIMO	MAXIMUM WEIGHT	No maximum weight	No maximum weight		
OPEN CLASS ABSOLUTO		Free (middle weight athletes and up are eligible)	Free	Free	Free (middle weight athletes and up are eligible)

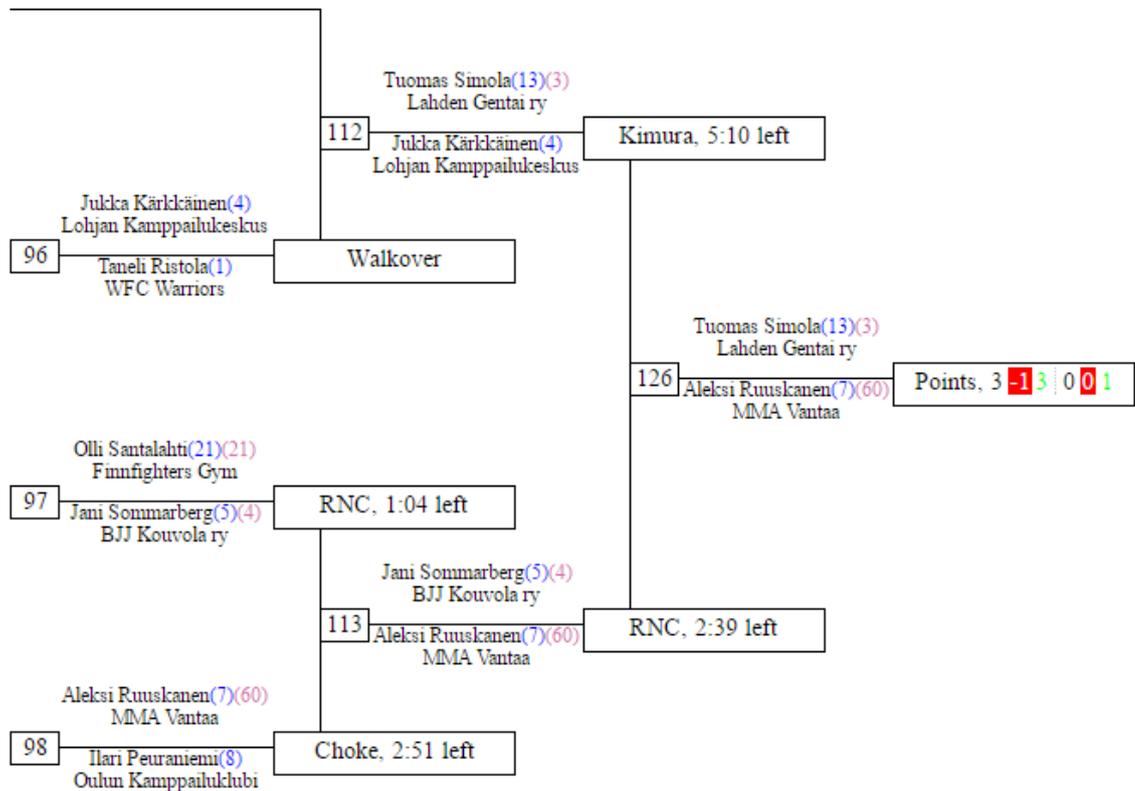
Picture 6. Weight classes in gi (IBJJF 2012)

WEIGHT DIVISIONS		JUVENILE MALE	ADULT, MASTER AND SENIOR MALE	ADULT, MASTER AND SENIOR FEMALE	JUVENILE 1 and 2 FEMALE
ROOSTER GALO	MAXIMUM WEIGHT	114 lbs	122.5 lbs		
		51,50 kg	55,50 kg		
LIGHT FEATHER PLUMA	MAXIMUM WEIGHT	125 lbs	136 lbs	114 lbs	103 lbs
		56,50 kg	61,50 kg	51,50 kg	46,50 kg
FEATHER PENA	MAXIMUM WEIGHT	136 lbs	149 lbs	125 lbs	114 lbs
		61,50 kg	67,50 kg	56,50 kg	51,50 kg
LIGHT LEVE	MAXIMUM WEIGHT	147 lbs	162.5 lbs	136 lbs	125 lbs
		66,50 kg	73,50 kg	61,50 kg	56,50 kg
MIDDLE MÉDIO	MAXIMUM WEIGHT	158 lbs	175.5 lbs	147 lbs	136 lbs
		71,50 kg	79,50 kg	66,50 kg	61,50 kg
MEDIUM HEAVY MEIO-PESADO	MAXIMUM WEIGHT	169 lbs	188.5 lbs	158 lbs	147 lbs
		76,50 kg	85,50 kg	71,50 kg	66,50 kg
HEAVY PESADO	MAXIMUM WEIGHT	180 lbs	202 lbs	No maximum weight	No maximum weight
		81,50 kg	91,50 kg		
SUPER HEAVY SUPER PESADO	MAXIMUM WEIGHT	191 lbs	215 lbs		
		86,50 kg	97,50 kg		
ULTRA HEAVY PESADÍSSIMO	MAXIMUM WEIGHT	No maximum weight	No maximum weight		
OPEN CLASS ABSOLUTO		Free (middle weight athletes and up are eligible)	Free	Free	Free (middle weight athletes and up are eligible)

Picture 7. Weight classes in no-gi (IBJJF 2012)

3.3 Brackets

Tournaments are competed with a bracket system. Each athlete is sorted into a bracket. Brackets are serving as an elimination system. A winning athlete goes through to the next stage of the bracket and losing a athlete is eliminated. (IBJJF. 2012)



Picture 8. Example of a bracket (FBJJF 2014)

3.4 Referee

The referee is the highest authority in a match situation. It is the referee's duty to make sure that all of the requirements are fulfilled, e.g. to check athletes' equipment and to make sure that all hygiene requirements are met. (IBJJF. 2012)

The referee starts and stops the match. The referee, using his/hers judging, awards points and advantages to athletes. If needed the referee also gives penalties and disqualify athletes. When announcing the final result of the match the referee raises the arm of the winning athlete. (IBJJF. 2012)

3.5 Rendering decisions

The winner of a match is determined by the following ways. (IBJJF. 2012)

- **Submission**
An athlete is forced to give up either verbally or physically with a hand or a leg.
- **Stoppage**
An athlete suffers an injury or acute illness e.g. vomits.
- **Disqualification**
When an athlete commits a severe foul. When an athlete commits four serious fouls or combativeness fouls.
- **Loss of consciousness**
An athlete loss consciousness due to a legal hold applied by the opponent or accidental head trauma.
- **Score**
The athlete with most points after regulation time is declared the winner. If points are tied the athlete with most advantages is declared the winner. If advantages are tied the athlete with less penalties is declared the winner.
- **Referee's decision**
If points, advantages and penalties are tied it is the duty of the referee to declare the winner based on which competitor has showed greater offence in the match.
- **Random pick**
If both athletes suffers simultaneous injuries during a semi-final or a final match and the score is tied the winner is determined by a random pick.

3.6 Points

The referee awards an athlete points after the athlete has gained point scoring position and held it for at least three seconds. If an athlete voluntarily relinquishes a point scoring position he/she has gained and secures it again, the athlete will not be rewarded new points from the position. (IBJJF. 2012)

An athlete gains cumulative points from point scoring positions while progressing into a new point scoring position as long as the three second rule is fulfilled. (IBJJF. 2012)

3.6.1 Takedowns

When standing on feet an athlete forces the opponent to the ground on the opponent's back, side or seated position, and maintains control for three seconds, the athlete is awarded two points. (IBJJF. 2012)



Picture 9. Single leg takedown (Graciemag 2013)

3.6.2 Knee on belly

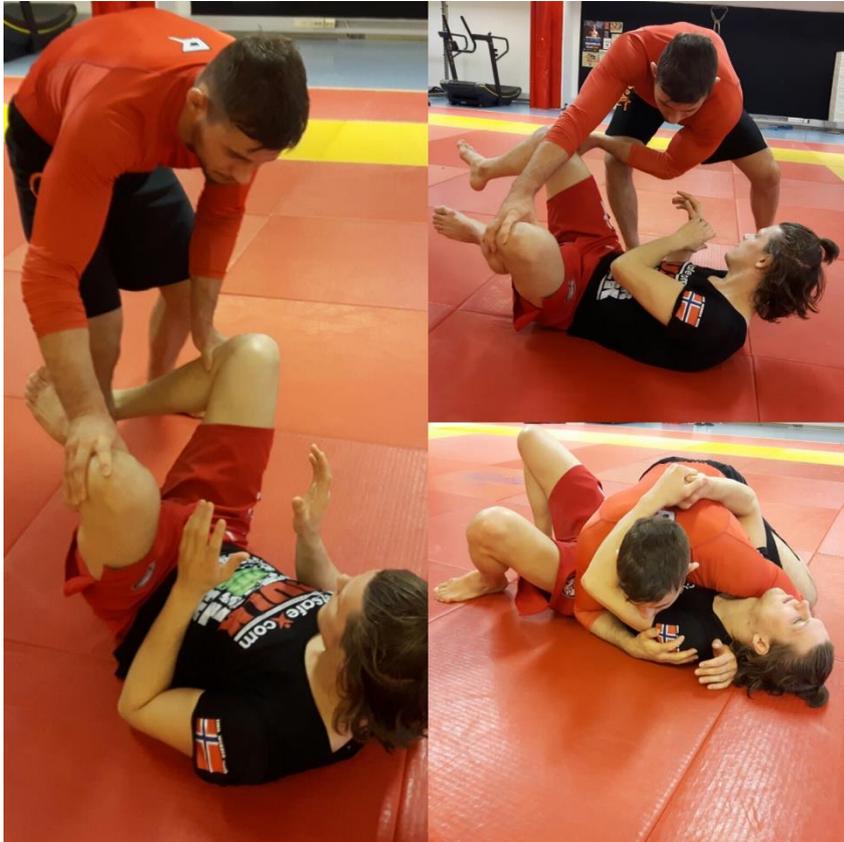
On the ground, after having passed the opponent's legs, an athlete places his/hers knee on the opponent's stomach or chest and is facing towards the opponent with the athlete's other leg straight on the mat, the athlete is awarded two points. (IBJJF. 2012)

3.6.3 Sweep

When an athlete who is on a bottom position on a ground sweeps himself/herself from bottom position into a top position and the sweep begins with at least one of the athlete's leg between the opponent's legs, the athlete is awarded two points. (IBJJF. 2012)

3.6.4 Guard pass

On the ground when the athlete on the top passes the bottom athlete's legs and maintains control for three seconds while the bottom athlete's back or side is on the mat, the athlete on top is awarded three points. (IBJJF. 2012)



Picture 10. Guard pass to side control (Tuomas Simola 2017)

3.6.5 Mount and back mount

On the ground when the athlete on top has passed the bottom athlete's legs and sits on top of the bottom athlete's torso and is facing towards the bottom athlete for three seconds, the athlete on top is awarded four points. (IBJJF. 2012)



Picture 11. Mount (Tutorialpoint 2016)

3.6.6 Back control

When an athlete is facing the opponent's back and puts his/hers both heels on the opponent's inner thighs and has control of the opponent's upper body for three seconds, the athlete is awarded four points. (IBJJF. 2012)

3.6.7 Advantages

An advantage is a performance or an attempt of a point scoring position with a purpose to advance in positions or trying to finish the match. If an athlete does not get a finish or a point scoring position but is close to it, the athlete is awarded an advantage. An athlete also receives advantage from the second penalty given to the opponent. (IBJJF. 2012)

3.6.8 Fouls and penalties

Fouls are divided into severe, serious and combativeness fouls. Severe fouls are subdivided into technical and disciplinary fouls. Technical fouls are received for example from a usage of illegal techniques. Depending on a severity of an illegal technique, fouls are classified either severe or serious. Technical fouls include also for example a usage of an inappropriate equipment. Disciplinary fouls are given if unsportsmanlike acts or behavior occurs. In case of a severe foul, an athlete that has performed the foul is disqualified. (IBJJF. 2012)

Serious fouls are given from minor illegal techniques. Serious fouls are also given from various actions during a match, for example from tactics in which an athlete tries to evade from combat or a usage of illegal grips from gi or no-gi equipment. (IBJJF. 2012)

Combativeness fouls are given to an athlete who stalls the action in a match. For example if an athlete is not seeking a positional progress or a submission and only prevents opponent's positional progression. (IBJJF. 2012)

Serious fouls are followed by penalties. With the first foul an athlete is given a penalty. With the second foul an athlete is given a second penalty and the opponent receives an advantage. With the third foul an athlete is given a third penalty and the opponent receives two points. With the fourth foul an athlete is disqualified. (IBJJF. 2012)

4 Match analysis

The structure of a match analysis can be divided into four factors that can be the following: (Navin 2011, 186)

1. The performer of the action
2. The action itself
3. The position of the action
4. The time of the action

4.1 Performance analysis

A performance analysis is to measure some specific move, performance or game with a purpose to obtain quantitative data. In the last decades many different notational systems have been developed to analyze sports. Data from a performance analysis is supposed to be concrete. Data also should be reliable and not be bias. The purpose of collected data is to give feedback to athletes on their performances and thereby improve their performance. (Navin 2011, 184)

4.2 Developing a notational analysis

The coaches and athletes of the sport should discuss which factors are important to analyze in the sport. (Navin 2011, 189)

A simple match analysis can be done in real time or by watching a match later on a video. In this case it should be decided in advance which ones are the monitored points and every time when a particular performance happens it will be marked down. (Navin 2011, 189) The problem in collecting the data is how to transform it to a form that is useful to athletes and coaches. When the amount of the data increases it is good to consider adding technical aid when gathering and analyzing the data. (Navin 2011, 192-193)

4.3 Analyzing combat sports

There are only quite a few studies and analysis done on combat sports. The studies done on combat sports are analysis of technique, modelling and examination of stress and energy cost and match analysis. (McGarry, O'Donoghue & Sampaio 2013, 415)

The attributes that enable success in combat sports are: coordination, the exactness of technique, speed, condition, tactical awareness and mental skills. (McGarry etc. 2013, 415)

There is no systematic study done yet on combat sports where all the aspects regarding the performance of athletes have been taken into consideration. However, there are studies done on specific aspects of various combat sports. Findings on a single combat sport can also be significant in other combat sports. (McGarry etc. 2013, 416)

Videos and video-based equipment are often used when conducting match analysis. (McGarry etc. 2013, 420) For example in karate there is a study done on the most used techniques in three different weight classes. In total 42 matches in three weight classes were analyzed. (McGarry etc. 2013, 420)

5 Statistical analysis

Collecting data and analyzing it is a part of every study. There are many different methods to collect and analyze data. (Blaxter etc. 2010, 183)

5.1 Collecting data

Data can be collected by reading, observing, measuring and inquiring or by mixing these methods. Collected data can be of a different kind. It may consist of numbers, words or a mixture of both. Data can be original which means that similar data has not been collected before. (Blaxter etc. 2010, 183)

A study can be quantitative or qualitative. Generally studies have both quantitative and qualitative characteristics to make studies more versatile. Before a study is conducted it is advisable to determine whether the data desired to be collected is quantitative or qualitative. (Blaxter etc. 2010, 185)

5.1.1 Documents

Virtually in every study a document preview is conducted to some extent. A researcher must be able to read, understand and analyze previously produced documents. Documents can be text, statistics, pictures or videos. (Blaxter etc. 2010, 186-187)

One of the purposes of a document preview is to examine the background of a topic. A background check helps to understand the topic better. The aim of a document preview is to answer questions “what” and “how many”. (CDC 2009, 1)

When using a document preview in a study it is advisable to research what has been documented before. A research ensures that a researcher gets the best answer to the problem at hand. It is advisable to check the accuracy of documents used. (CDC 2009, 1-2)

In a research where documents are analyzed it is common to use secondary data. Secondary data is previously recorded and possibly analyzed data. When using secondary data a researcher must be critical whether the presented information is valid or not in present day. It also must be taken into consideration whether the methods of the measurements in secondary are data up to date. (Blaxter etc. 2010, 189-191)

An advantage of a document review is easy accessibility and usability. It is cost-efficient to use documents. Disadvantages include possible bias, inaccuracy and incompleteness of

information. It is also possible that documents are inaccessible or out-of-date. (CDC 2009, 2)

5.1.2 Observation

In observation a researcher views, captures and analyzes a selected object or event. In observation a researcher takes notes in real-time when the event is in progress or later from the recordings of the event. (Blaxter etc., 2010, 197-199)

Since there are usually a lot of possibilities, it is advisable to limit in advance what to observe in selected phenomenon. If there are a lot of things to observe it is possible to take a sample. A sampling should be done by using the appropriate sampling methods for the research in question. (Taylor-Powell & Steele, 1996, 2)

Observation is a way to get descriptive data. By observing a researcher seeks to understand the ongoing event, behavior, process, or progression of a situation. Observation requires some form of a physical object that is examined. Observation is used in situations where other data collection methods are not suitable, for example in situations where it is not possible to interview the subject of the research. (Taylor-Powell & Steele 1996, 1)

When observing it has to be determined whether the subjects know that they are being observed. If the subject is aware of the observation it can affect the behavior of the subject. Covert observation ensures reliable results. When it is determined whether the subjects of observation are aware of being observed or not the decision should be considered from the perspective of ethics and morality. (Taylor-Powell & Steele 1996, 2)

With observing findings can be either quantitative or qualitative data. When performing more structured observation it often produces quantitative numerical data. Less structured observation produces qualitative data. In some cases it is good to combine both quantitative and qualitative methods. Prior to observation it should be considered what kind of data is wanted. (Taylor-Powell & Steele 1996, 3)

When used in data collection observation is time-consuming but with organizing and structuring it is possible to influence. It is possible that a researcher himself/herself is involved in research as an object in observation. If it is possible the event of observation should be recorded. It allows the event to be observed and analyzed afterwards. (Blaxter etc. 2010, 200-201)

5.2 Analyzing data

Once the data has been gathered follows data analysis. The process of data analyzing whether it is quantitative, qualitative or a mixture of both is quite similar. Using analytical methods such as coding, annotating, labeling, selection and summary a researcher composes the collected data and emphasizes the significant findings. (Blaxter etc. 2010, 208-209)

Data analysis is a process where collected data is interpreted. The analysis may be presented, for example, in form of a table, bar chart, line graph or in some other form of representation. In the process patterns such as similarities, differences, trends, and other relationships are searched from data. Analysis of the data is important when creating new theories and ideas. (TeacherVision 2014, 1-2)

The approach how to explore a topic varies. A researcher's approach can be positivist, negativist or something in between. Traditionally, a researcher presents a hypothesis that the study seeks to prove right or declare it to be false. It is not necessary to have a hypothesis. A study can be started by choosing an interesting topic and then collect data from it. Where as hypothesis is usually based on a theory that is trying to be proved or denied, a random collection of data can lead to a new theory. Regardless of the approach it is important to pay attention to significance, generalizability and validity of the study. (Blaxter etc. 2010, 209)

5.3 Data analysis methods

Observations that are marked in quantities often lead to ordinary forms that are possible to describe in tabular or diagrammatic tables. (Blaxter etc. 2010, 236)

When collecting discrete bits of information such as numbers and words, they can be encoded into numbers. Quantitative analysis can be divided into four categories: (Blaxter etc. 2010, 238)

- Descriptive statistics. Includes variable frequencies, averages and ranges.
- Inferential statistics. Determines the significance of data and results.
- Simple interrelationships. Cross-tabulation or correlation between two variables.
- Multivariate analysis. Study of linkages between more than two variables.

5.3.1 Descriptive statistics

Proportions, percentages and ratios can be measured from nominal or ordinal data. (Blaxter etc. 2010, 239)

Interval or ratio data central tendency can be measured by: (Blaxter etc. 2010, 239)

- Mean: total sum of values divided by the number of cases
- Median: the value of the middle case
- Mode: the most frequently occurring value

Measures of dispersions are: (Blaxter etc. 2010, 239)

- Range: the difference between the highest and lowest values.
- Standard deviation: the square root of the mean of the squared deviations from the mean

Inferential statistics can be used to compare the sample used in analysis to another sample or population. This shows the similarities or dissimilarities between the samples. (Blaxter etc. 2010, 239)

6 Methods

This research is a quantitative study and it follows the methods of statistical analysis. The data collection methods used in this study are document preview and observation. The collected data is analyzed by using descriptive statistics.

6.1 Purpose of the study

The purpose of the study is to examine no-gi Brazilian jiu-jitsu matches and gather information about them. The data gathered from the match analysis will aid in the progress of making a sport analysis on Brazilian jiu-jitsu, Brazilian no-gi jiu-jitsu and submission wrestling. The following information is gathered:

- Duration
- Rendering decision
- Submissions
- Point scoring positions

This research also studies differences in the features above between weight categories in no-gi Brazilian jiu-jitsu. Possible differences between weight categories provide more detailed information of the characteristics of the sport.

There is a study done on 2016 Brazilian Jiu-Jitsu World Championships (BJJ Heroes. 2016). The study researched among other things the type of endings of the matches and submissions in gi Brazilian jiu-jitsu. When comparing the studies between the gi world championships and the no-gi world championships, conclusions can be done on differences between these forms of Brazilian jiu-jitsu.

Matches can end in the following ways:

- Submission: An athlete taps at least twice the ground or the opponent, submits verbally or screams because of pain.
- Stoppage – An athlete suffers cramps, an injury or is bleeding in a manner that the bleeding can't be stopped.
- Disqualification – An athlete receives four penalties or commits a severe foul.
- Points – The athlete with most points is declared the winner.
- Advantages – If points are tied, the athlete with most advantages is declared winner.

- Penalties – If points and advantages are tied, the athlete with less penalties is declared winner.
- Referee's decisions – If the points, advantages and penalties are tied, the referee decides the winner based on which athlete has displayed greater offense in the match.

One of the goals of this study is to find out the most common type of match ending. The duration of a match in black belt Brazilian jiu-jitsu and no-gi Brazilian jiu-jitsu is 10 minutes. However, a match stops immediately when a submission, a stoppage or a disqualification happens. The goal is to find the average match duration. Finding out the average match duration might be useful when working on sport analysis.

Wide variety of submissions occurs in Brazilian jiu-jitsu. The goal is to find out the most common submission in no-gi Brazilian jiu-jitsu. The study done on the gi world championships reveals the common submissions on Brazilian jiu-jitsu with the gi. Finding out no-gi submissions gives a change to compare the two disciplines.

In gi and no-gi Brazilian jiu-jitsu there are point scoring positions of three different values:

- Two points: sweep, knee on belly and takedown
- Three points: guard pass
- Four points: mount, back mount and back control

The goal is to find out the amount of point scoring positions and find out how many of each point scoring positions there are on average per match. Advantages and penalties are also examined.

6.2 Subjects

The subjects of this study are all of the adult black belt category matches (N=128) from IBJJF No-Gi World Championships contested in Los Angeles, California on November 7th and 8th in 2015. Matches include both men and women categories from all weight classes including the open weight class categories.

In 128 matches, 116 competitors competed in an elimination tournament in weight classes and those willing in the open weight class. Out of 116 competitors 17 were women and 99 were men.

6.2.1 Combining weight classes

Due to a limited sample size weight classes were combined into larger weight categories. This enables a more practical comparison between the categories. Combining of the weight categories is done in the following way:

- Men light: -55,5kg, -61,5kg and -67,5kg
- Men medium: -73,5kg, -79,5kg and -85,5kg
- Men heavy: -91,5kg, -97,5kg and +97,5kg
- Men absolute: men open weight class
- Women all: -56,5kg, -61,5kg, -66,5kg, -66,5kg, -71,5kg and open weight class

6.3 Procedure

IBJJF No-Gi World Championships were contested in Los Angeles, California on November 7th and 8th in 2015. FloGrappling.com provided videos from all 128 adult black belt matches. The matches were analyzed in June-August of 2016.

There are only a few studies available on no-gi Brazilian jiu-jitsu. When searching from electrical databases such as SPORTDiscus and ESBCOhost as well as from written sources it turned out that there are no match analysis done on no-gi Brazilian jiu-jitsu. There is however a partial match analysis done on gi Brazilian jiu-jitsu (BJJ Heroes. 2016). Due to a lack of reliable sources the theory part of thesis especially chapter Brief history of Brazilian jiu-jitsu was mostly based on secondary sources such as online and magazine articles.

6.4 Measurement methods and tools

In this study the methods are document preview and observation. The collected data is analyzed by using descriptive statistics. This study is quantitative research.

The duration of each match was recorded by using stopwatch. The type of ending of each match was marked down as well as a submission if one occurred. Point scoring positions, advantages and penalties were marked down as a referee declared them.

A spreadsheet in Microsoft Excel was used to collect data and statistics from no-gi world championships. By using Excel and a statistical analysis program SPSS the collected data

was analyzed and presented as tables and charts. Excel was used to present the collected data with bar charts. Averages and standard deviations were also calculated with Excel. SPSS was used to create cross tabulations.

When comparing differences between gi and no-gi χ^2 test of independence was used. Unfortunately, due to a relatively small sample sizes, the expected counts are too small and therefore the test could not be used with most of the cross tabulations.

7 Results

7.1 Duration

A no-gi Brazilian jiu-jitsu adult match time is scheduled to be 10 minutes in adult black belt division. The average match time of all 128 matches in No-Gi World Championships 2015 were 7 minutes and 18 seconds, with 66 out of 128 matches lasting full 10 minutes. When matches were divided in five different categories the average match times and standard deviations were the following:

Table 1. Durations / weight category.

Weight category	Men light	Men medium	Men heavy	Men absolute	Women all	All matches
Average match time	7min 11s	7min 53s	7min 24s	7min 37s	5min 9s	7min 18s
Standard deviation	3min 25s	3min 7s	3min 9s	3min 0s	3min 33s	3min 20s
Shortest match	42s	37s	43s	1min 37s	23s	23s
Number of matches	17	43	25	24	19	128

In men categories the average match times of each category are within a range of 42 seconds from each other. The table also shows that the match duration in women is shorter compared to men.

When taking a closer look on when a stoppage occurred in the matches the following table is obtained:

Table 2. Timeslots / Weight category cross tabulation.

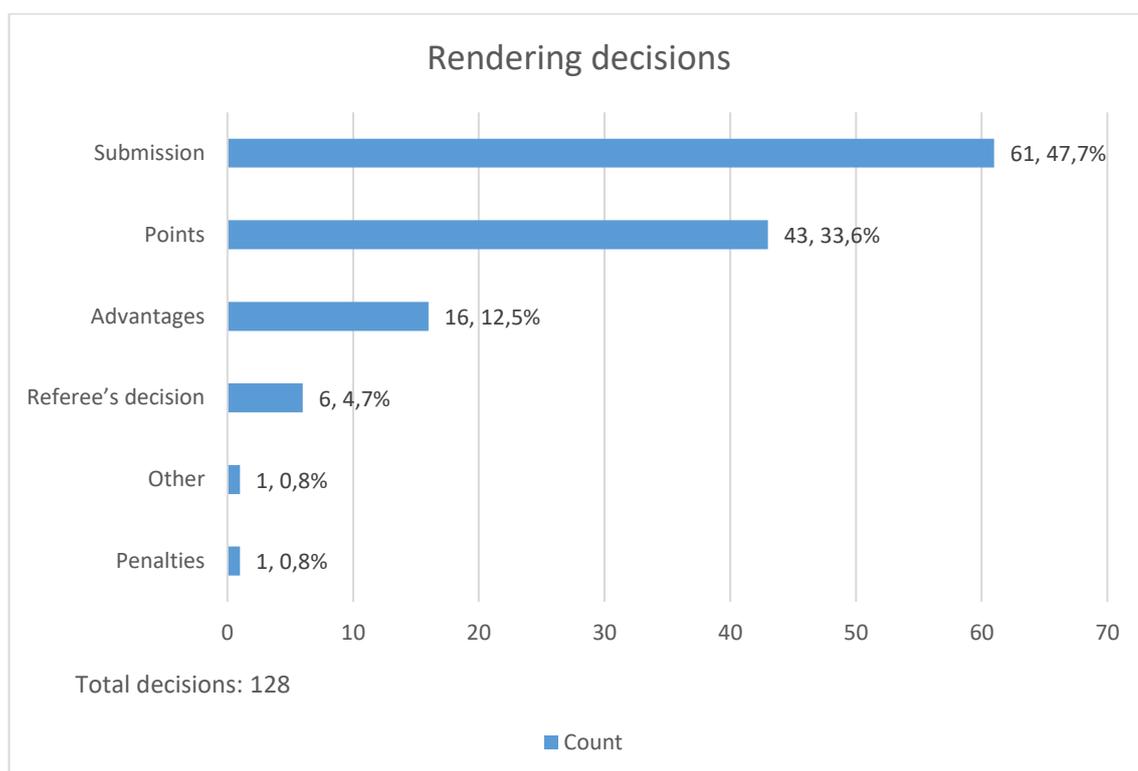
		Weight category										Total	%
		Men light	%	Men medium	%	Men heavy	%	Men absolute	%	Women all	%		
Timeslots	00.00 - 00.59	1	5,9	3	7,0	1	4,0	0	0	1	5,3	6	4,7
	01.00 - 01.59	1	5,9	1	2,3	1	4,0	1	4,2	4	21,1	8	6,3
	02.00 - 02.59	1	5,9	0	0	1	4,0	1	4,2	3	15,8	6	4,7
	03.00 - 03.59	1	5,9	4	9,3	2	8,0	2	8,3	1	5,3	10	7,8
	04.00 - 04.59	2	11,8	1	2,3	1	4,0	3	12,5	2	10,5	9	7,0
	05.00 - 05.59	0	0	3	7,0	1	4,0	2	8,3	0	0	6	4,7
	06.00 - 06.59	1	5,9	1	2,3	2	8,0	0	0	1	5,3	5	3,9
	07.00 - 07.59	0	0	0	0	2	8,0	1	4,2	1	5,3	4	3,1
	08.00 - 08.59	1	5,9	3	7,0	0	0	0	0	1	5,3	5	3,9
	09.00 - 09.59	0	0	1	2,3	0	0	1	4,2	1	5,3	3	2,3
	10.00 -	9	52,9	26	60,5	14	56,0	13	54,2	4	21,1	66	52,0
Total		17	100	43	100	25	100	24	100	19	100	128	100

Most of the matches in men categories went the full time. However, women's matches were shorter and only 21.1% of matches went the full duration. In overall stoppages occurred rather evenly during the matches with slight emphasize in the first half of regulation.

7.2 Rendering decision

Out of 128 matches 61 ended with a submission. In 43 matches winner was determined via points. In 16 matches points were tied and winner was determined with advantages. In six matches a rendering decision was given by a referee's decision, when points, advantages and penalties were even. One match ended via disqualification and one with penalties, when points and advantages were even.

Table 3. Rendering decisions.



When looking differences in rendering decisions between weight categories results are the following:

Table 4. Rendering decision / Weight category cross tabulation.

		Decision												Total
		A	%	B	%	C	%	D	%	E	%	F	%	
Weight category	Men light	8	47,1	7	41,2	1	5,9	0	0	1	5,9	0	0	17
	Men medium	17	39,5	16	37,2	7	16,3	0	0	3	7,0	0	0	43
	Men heavy	11	44,0	9	36,0	5	20,0	0	0	0	0	0	0	25
	Men absolute	10	41,7	8	33,3	2	8,3	1	4,2	2	8,3	1,0	4,2	24
	Women all	15	78,9	3	15,8	1	5,3	0	0	0	0	0	0	19
All matches		61	47,7	43	33,6	16	12,5	1	,8	6	4,70	1	,8	128

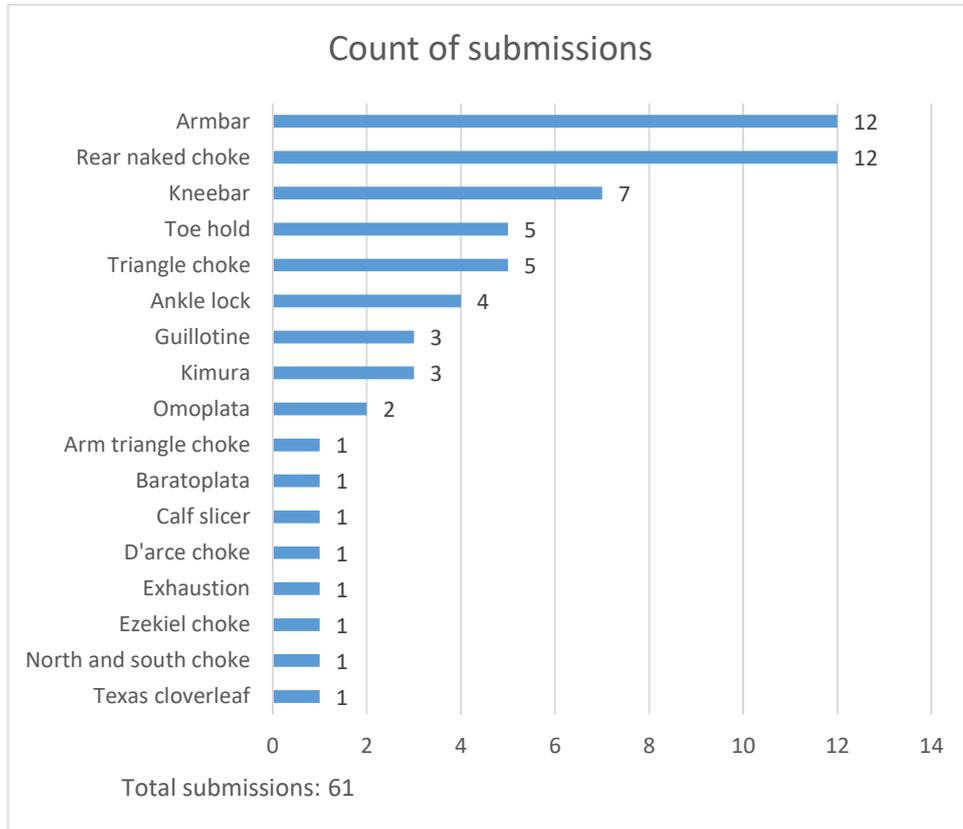
A = Submission, B = Points, C = Advantages, D = Penalties, E = Referee decision, F = Other

All men categories follows the average of all matches. The table also that that the percentage of submissions in women is higher than in men. Only four out of 19 matches in women went full 10 minutes.

7.3 Submissions

A total of 61 out of 128 matches ended due to a submission. Submission types were the following:

Table 5. Submission types.



The most common submissions in 2015 No-Gi Brazilian Jiu-Jitsu World Championships were an armbar and a rear naked choke.

Specific submissions can be divided in four main submission categories: arm locks, leg locks, chokes and others.

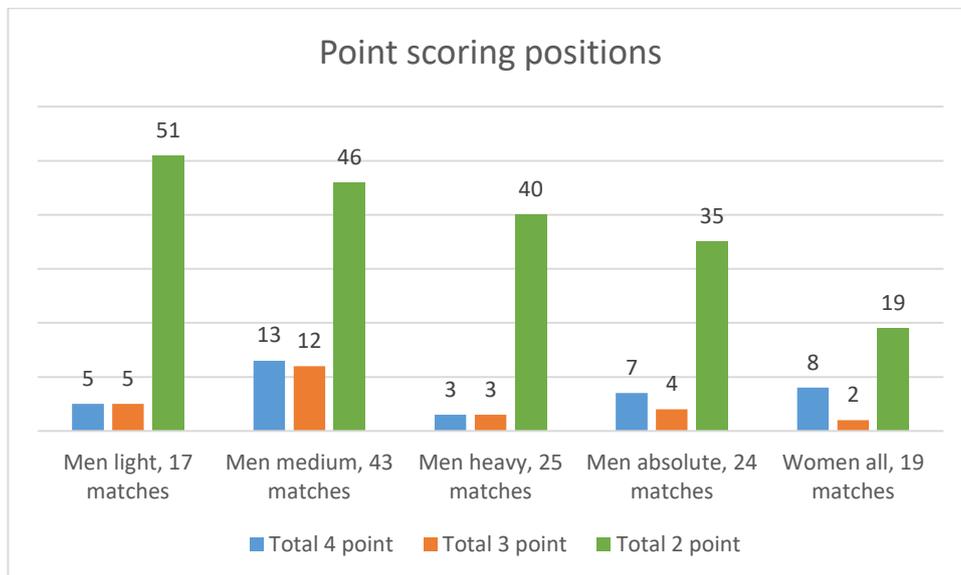
Table 6. Weight category / submission type cross tabulation.

		Submission type								Total
		Arm	%	Leg	%	Choke	%	Other	%	
Weight category	Men light	4	50,0	1	12,5	3	37,5	0	0	8
	Men medium	5	29,4	5	29,4	6	35,3	1	5,9	17
	Men heavy	4	36,4	5	45,5	2	18,2	0	0	11
	Men absolute	2	20,0	2	20,0	6	60,0	0	0	10
	Women all	3	20,0	5	33,3	7	46,7	0	0	15
Total		18	29,5	18	29,5	24	39,3	1	1,6	61

The table shows how submission types are divided between weight categories. Chokeholds are the most common submissions overall. Arm locks and leg locks seem to be equally common with 29.5% of total submissions being arm locks and 29.5% being leg locks. In men light category there is an exceptionally large proportion of arm lock submissions where as in men heavy category leg lock submissions are dominating. Chokeholds seem to be the most common submissions in men absolute category and in women.

7.4 Point scoring positions

Table 7. Point scoring positions.

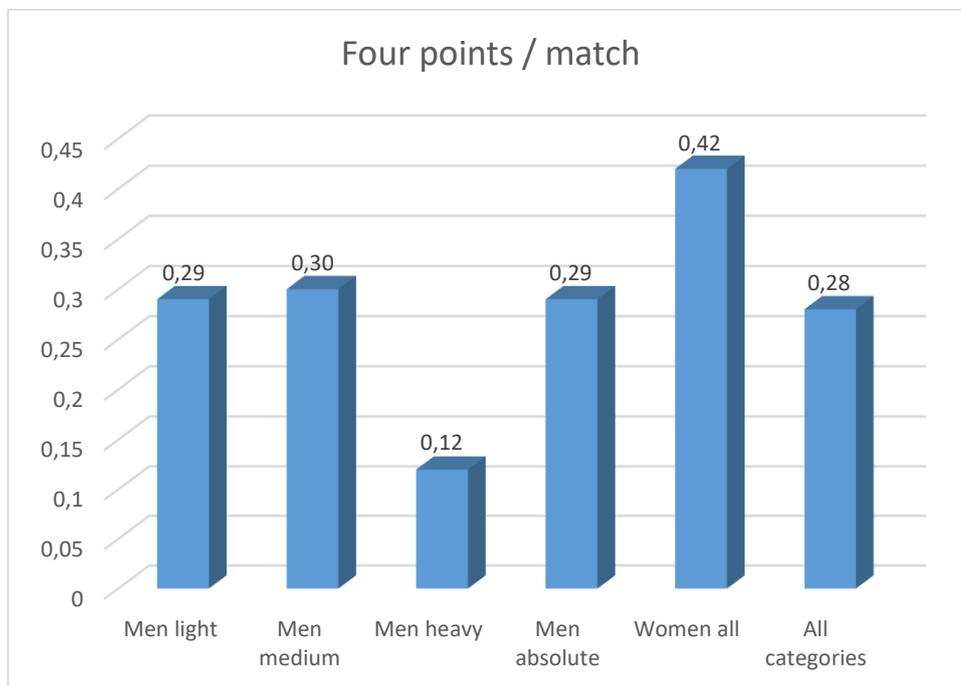


In all of the 128 matches in No-Gi World Championships 2015 a total of 604 points were scored by competitors. That makes on average 4.72 points scored in a match and 2.36 points per a competitor in a match.

7.4.1 Four point scoring position

In 128 matches a four point scoring position were achieved 36 times which equals 144 points.

Table 8. Weight category / Four point scoring position bar chart.

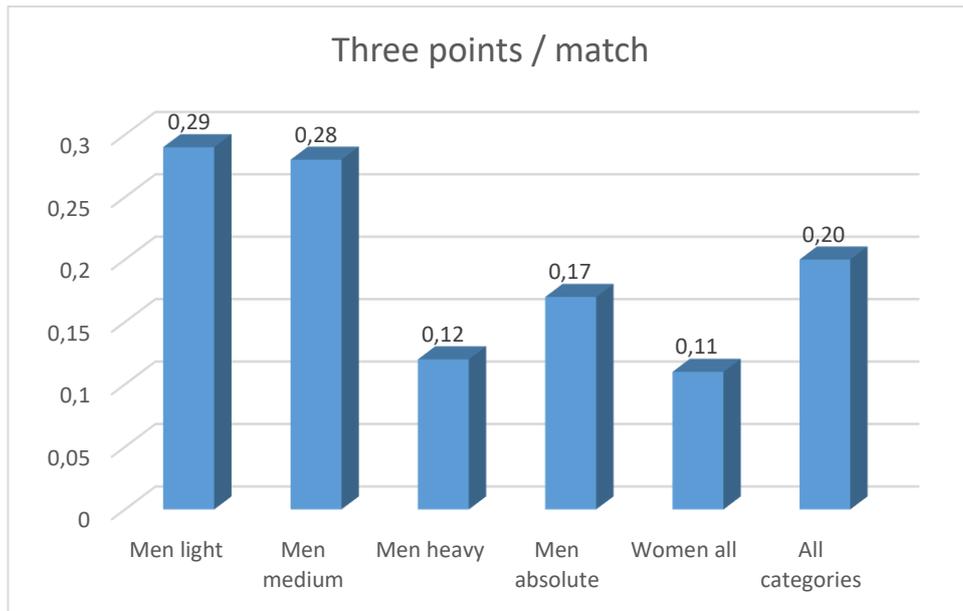


The highest ratio of a four point scoring position per match is in women category and lowest in men heavy category. Men light, medium and absolute categories follow the average of all categories.

7.4.2 Three points scoring position

In 128 matches a three point scoring position were achieved 26 times which equals 78 points.

Table 9. Weight category / Three point scoring position bar chart.

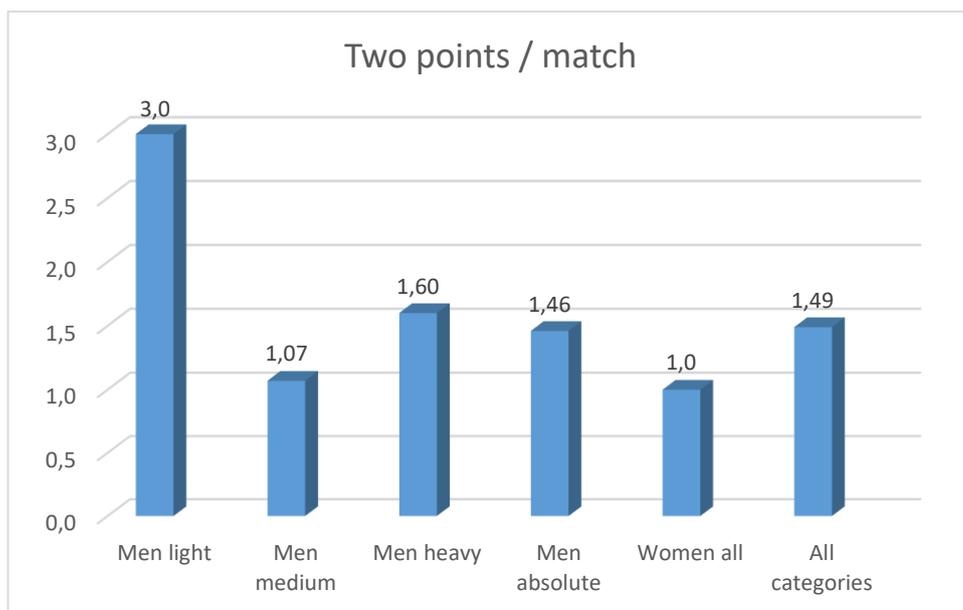


The lowest ratio of three point scoring positions is in women category. In men it seems that in lighter weight classes there are more three point scoring positions.

7.4.3 Two points scoring position

In 128 matches a two point scoring position were achieved 191 times which equals 382 points.

Table 10. Weight category / Two point scoring position bar chart.

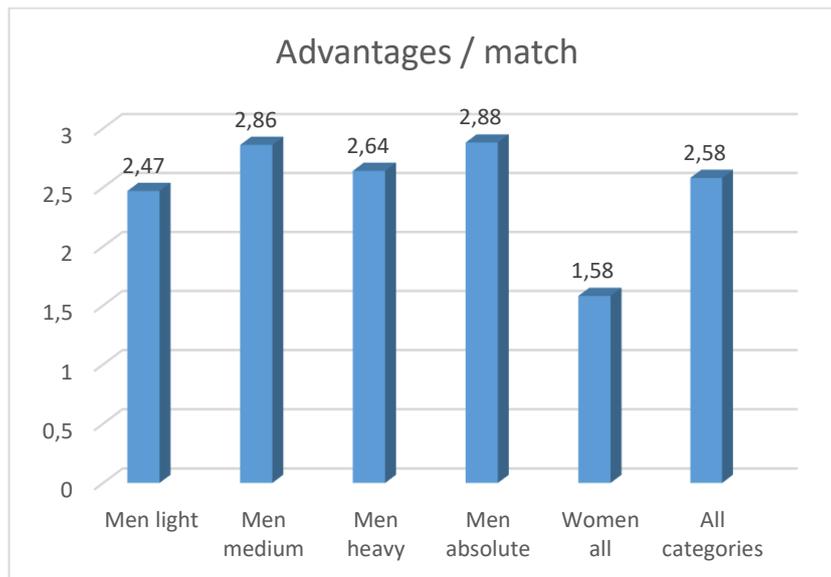


Clearly the highest two point scoring positions ratio per match is in men light category with three two point scoring positions per match. In women category and men medium category the ratio is the lowest.

7.4.4 Advantages

In 128 matches 330 advantages were rewarded to competitors.

Table 11. Weight category / advantages bar chart.



Women category has the lowest ratio of advantages per match. The ratios in men categories are nearly the same.

7.4.5 Penalties

In 128 matches 62 penalties were given to competitors.

Table 12. Weight category / penalties cross chart.



In men categories in lighter weight classes there is a higher ratio of penalties per match. Exceptionally in women category there was no penalties given to competitors.

8 Discussion

The sample size of this study was limited. Overall 128 samples (matches) was an adequate amount to conduct a reliable study. However when divided into weight categories due to a limited sample size the results acquired by the study were directional.

The material observed in the study is fairly recent (2015) and therefore reliable. It should be noted that the sport is constantly evolving and further studies need to be conducted to ensure valid information. Due to the nature of the study, observation of archives, the study is unbiased.

Brazilian jiu-jitsu and no-gi Brazilian jiu-jitsu are fairly new sports. There is a limited amount of studies and publications made about the sport. Therefore the quality of sources available in a theory part, especially in chapter 2, Brief history of Brazilian jiu-jitsu, is poor.

The subscriber of the thesis the Finnish Brazilian Jiu-Jitsu Federation, has stated interest to utilize results and conclusions of the study in order to develop the coaching of the sport. Match analysis provides a base on which to conclude a sport analysis. Match analysis and the thesis, especially since done in English, can be distributed internationally in order to develop the sport.

8.1 Duration

The average match time 7 minutes 18 seconds in the 2015 No-Gi World Championships might give a direction how to exercise for no-gi Brazilian jiu-jitsu. However, when considering the characteristics of the sport as some athletes try to win matches as fast as they can and some athletes play with the points, an athlete should be diverse in a preparation.

One hypothesis in Brazilian jiu-jitsu is that in higher weight classes matches are shorter due to an allegedly higher submission rate. Often is said that the skill difference is greater in higher weight classes and also in lighter weight classes the skill level is better. It is also assumed that in higher weight classes the durability of athletes is weaker and due to that matches are shorter.

The study shows that in men weight categories match durations are approximately the same. Matches in men weight categories varies between seven and eight minutes.

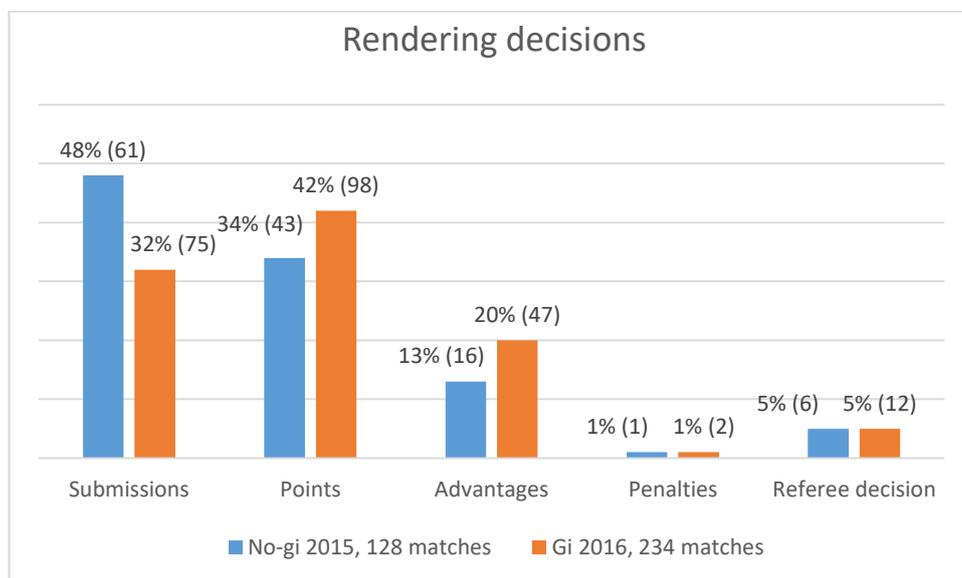
It is assumed that there is a lower skill level in women Brazilian jiu-jitsu compared to men. It is also assumed that in women divisions skill differences are greater. In Brazilian jiu-jitsu the skill level often shows in submissions. In order to be able to submit an opponent there needs to be difference in either a skill or physique level. In women category a match duration was lower than in men averaging 5 minutes 9 seconds which would support the claim of greater skill differences between women.

One hypothesis is that if a submission occurs it happens close to the end of the regulation time. The argument is that the longer a match continues the more a potential lack of durability begins to appear. However, the study shows that the last minutes of a match are less likely to have a submission finish. Between three and five minutes of a match seems to be most likely time for a finish. This might be due to a time needed for a superior competitor to gain a dominant position that allows submission finish.

8.2 Rendering decisions

The study shows that in no-gi Brazilian jiu-jitsu there are more submission finishes than in Brazilian jiu-jitsu with gi (BJJ Heroes. 2016). When comparing the world championships between the two disciplines results are the following:

Table 13. Comparing rendering decision percentages.



After running χ^2 test of independence we get a p-value of 0.047 (appendix 1) which means that gi and no-gi have differences in rendering decisions. One hypothesis to a higher submission rate in no-gi is that IBJJF no-gi world championships are open to any registered black belts compared to the gi world championships where 50 ranking points

are required to be allowed to compete. Because of the ranking points the level of athletes of gi world championships could be higher and that would explain a higher amount of even matches.

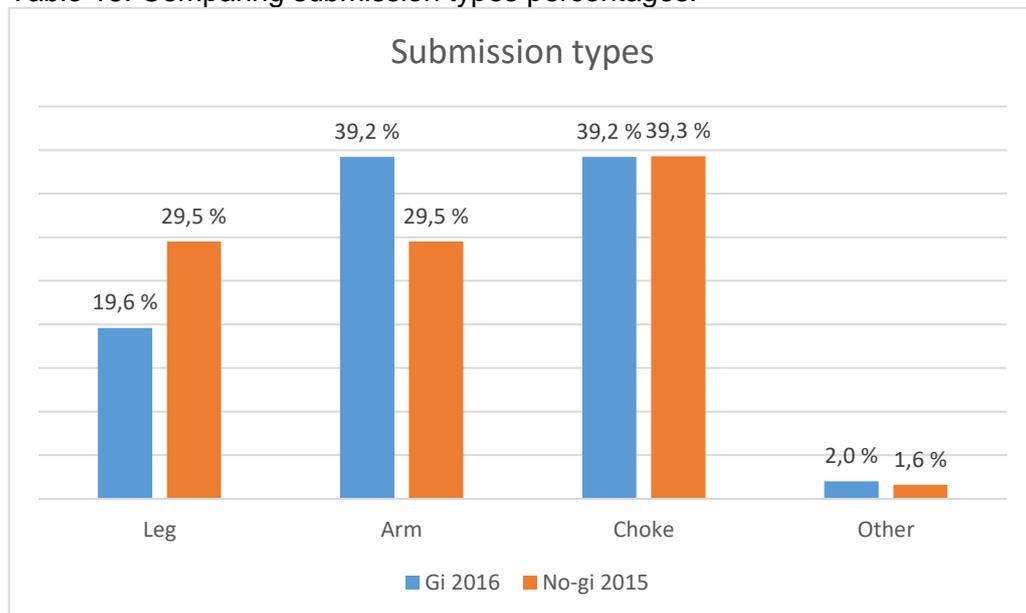
8.3 Submissions

As stated in the previous chapter the submission rate was higher in no-gi world championships than gi world championships. When looking how submissions divided between different submission types between the two disciplines the results are the following:

Table 14. Comparing submission types.

Submission type	Gi World Championships 2016		No-Gi World Championships 2015	
	Count	Percentage	Count	Percentage
Leg	10	19,6%	18	29,5%
Arm	20	39,2%	18	29,5%
Choke	20	39,2%	24	39,3%
Other	1	2%	1	1,6%

Table 15. Comparing submission types percentages.



After running χ^2 test of independence we get a p-value of 0.394 (appendix 2) which means that gi and no-gi have no significant differences in submission types. It is interesting to notice that the percentage of choke submissions is virtually the same in gi and no-gi. With gi there are much more choke submissions available than no-gi because of different collar and lapel chokes that can only be executed with gi. One explanation could be that due to the lack of friction in no-gi back control may be the best dominant position to

control and from back control rear naked choke is the most common submission. With gi there may be more submissions from other dominant positions like side control or mount due to a better control that gi enables.

When looking the submissions targeted to an arm the percentage is higher with gi. Again it can be argued that with superior control that gi enables submissions from point scoring positions are easier to achieve.

There is a difference in submissions targeted to legs between the two disciplines. In no-gi submissions from legs are more common. An explanation to this can be the alleged difficulty to pass the guard in no-gi compared to gi. The lack of grips and faster pace could make guard passing harder in no-gi. Compared to other types of submissions, a leg submission requires a less dominant position in order to attack for a submission. The similar nature of no-gi Brazilian jiu-jitsu and submission wrestling should be also noted. In submission wrestling a wider range of leg attacks is permitted. Some competitors train and compete only in no-gi and submission wrestling and therefore have more advanced leg submission skills. Further study is needed to show the differences between gi and no-gi submissions.

8.4 Point scoring positions

This was the first study done on point scoring positions in Brazilian jiu-jitsu or no-gi Brazilian jiu-jitsu. Therefore no comparison could not be done.

In 128 matches two point scoring positions were achieved 191 times. It makes approximately 1.5 two point scoring positions per match. Two point scores are the most common scores in no-gi Brazilian jiu-jitsu. In Brazilian jiu-jitsu the amount of points awarded from point scoring positions are determined by the difficulty of achieving the position. Consequently it is alleged that two point scoring positions should be the most common. In addition a total of three two point scoring positions occur in Brazilian jiu-jitsu: a sweep, a takedown and a knee on belly.

The only three point scoring position in Brazilian jiu-jitsu, a guard pass, were achieved 26 times. It makes approximately 0.2 guard passes per match. As shown a guard pass is a considerable difficult point scoring position. It can be assumed that especially in no-gi guard passing is difficult because of the lack of grips that are provided in gi. In addition it should be noted that to achieve points with a guard pass an athlete must have specific

control of the opponent for three seconds compared to for example a sweep or a takedown where lesser control is needed.

Four point scoring positions, a mount, a back mount and back control, were achieved 36 times which equals 144 points. It makes approximately 0.28 four point scoring positions per match. Four point scoring positions are dominant positions that are hard to achieve. It often happens that when an athlete tries to prevent the opponent from gaining a two or three point scoring position by using standard defensive moves the athlete actually gives the opponent a good chance of gaining a four point scoring position like back control. It should also be noted that in Brazilian jiu-jitsu transitions between a mount and back control are fairly common and are always awarded with points because four point scoring positions are considered equal.

In 128 matches 330 advantages were awarded to competitors. Further study is needed to verify the amount of rendering decisions due to advantages in past competitions. It could be argued that competitive Brazilian jiu-jitsu is getting more even and the amount of matches resolved with advantages will be higher. Brazilian jiu-jitsu is a growing sport worldwide and as the level of the sport increases so does the level of competitions. The amount of advantages provides an indication of how difficult it is to finish a point scoring position or a submission.

9 Conclusions

On average a black belt no-gi Brazilian jiu-jitsu match lasts approximately slightly over seven minutes. Matches in men categories are longer while in women category the average match duration is approximately five minutes. However, most of the matches in men categories 62 out of 109 went the full 10 minutes, while in women category only 4 out of 19 matches went full time. When considering the characteristics of the sport the study indicates that shorter match times and higher submission rate are caused by greater skill differences in women comparing to men.

The most usual type of match ending in no-gi Brazilian jiu-jitsu is a submission (47,7%). Victory via points (33,6%) and advantages (12,5%) are also common. A submission rate in women category is remarkably higher than in men categories. Based on the results it can be advised that athletes and coaches should focus equally on both submissions and point scoring positions when planning the training.

An armbar and a rear naked choke are the most common submissions in no-gi Brazilian jiu-jitsu. Chokeholds altogether are the most popular submissions followed by leg locks and arm locks. It seems that when training submissions it is advisable to focus on rear naked choke and armbar submissions.

Two point scoring positions are the most usual ones. Three and four points scoring positions occur more rarely. In men categories there are more advantages given to competitors than in women category. In addition, there were no penalties given in women categories. Due to commonness of two point scoring positions it is advisable to focus on those positions.

In no-gi Brazilian jiu-jitsu more matches end via submission than in gi Brazilian jiu-jitsu. Victories via points and advantages are more common in gi. There are a similar proportion submissions via chokeholds in no-gi and gi. In no-gi there are more finishes via leg locks and in gi there are more finishes via arm locks.

When comparing the goals of the study to the finished product it can be stated that the study was successful. It gives a comprehensive insight about duration, type of ending, submissions and point scoring positions in no-gi Brazilian jiu-jitsu. Based on this study further studies about Brazilian jiu-jitsu can be made. Hopefully this study provides the base on which sport analysis can be concluded. In this study no-gi Brazilian jiu-jitsu and Brazilian jiu-jitsu are compared for the first time in this manner because this is the first match

analysis study done on no-gi Brazilian jiu-jitsu. In Brazilian jiu-jitsu scene differences and similarities between gi and no-gi are often debated. Therefore this study can add depth to that discussion.

It should be noted that this study focused on the statistical side of match analysis. Before comprehensive sport analysis on Brazilian jiu-jitsu can be made further studies about the sport are needed. In Brazilian jiu-jitsu there are a lot of traditions and myths about training and sport in general with little evidence behind those claims. In order to develop the sport it is important to have scientific evidence on which training is based on.

This project deepened the knowledge about the sport and especially on what occurs in competition matches. The study provides additional information based on which athletes and coaches of the sport can plan the training of the athletes.

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Appendices

Appendix 1. χ^2 test of independence on rendering decisions.

$r \times c$ Contingency Table: Results

The results of a contingency table χ^2 statistical test performed at 06:28 on 21-MAR-2017

data: contingency table

	A	B	
1	61	75	136
2	43	98	141
3	16	47	63
4	1	2	3
5	6	12	18
	127	234	361

expected: contingency table

	A	B
1	47.8	88.2
2	49.6	91.4
3	22.2	40.8
4	1.06	1.94
5	6.33	11.7

chi-square = 9.61
degrees of freedom = 4
probability = 0.047

Appendix 2. χ^2 test of independence on submission types.

$r \times c$ Contingency Table: Results

The results of a contingency table X^2 statistical test performed at 06:55 on 21-MAR-2017

data: contingency table

	A	B	
1	18	10	28
2	18	20	38
3	24	20	44
	60	50	110

expected: contingency table

	A	B
1	15.3	12.7
2	20.7	17.3
3	24.0	20.0

chi-square = 1.86
degrees of freedom = 2
probability = 0.394