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Abstract [Required]**:**

Despite its increasing popularity, little is known about the techniques utilised in Brazilian Jiu-Jitsu competition and their relative success. This work aims to answer questions around the most used and successful takedowns, guardpasses, guard sweeps and submissions to allow development of coaching methods towards enhancing performance at lower belt levels. 140 tournament fights were analysed. The most common takedown was guardpull with 94% success. Significantly more single leg takedowns were attempted for blue belts, compared to white belts (p = .013). However, there was no significant difference in success (p = .150). White belts used 3 main types of guardpasses with 93% covering knee slice, knee pin and bullfighter pass. A greater variety of passes was observed at blue belt with 71% coming from these three passes. The four most commonly attempted guard sweeps were scissor sweep, back take, X-guard sweep and SitUp sweep all experiencing varying levels of success: 55% for the scissor sweep, 60% back take, 63% X-guard sweep and 38% for the sit up sweep. Of all the submissions attempted 34% were for arm bar, 21% triangle, 12% cross collar choke but there is almost an inverse relationship between use and success with the least used having higher success rates. Brazilian Jiu-Jitsu competition at this level was dominated by guard pull takedowns and submission attempts from guard illustrating the early focus on developing a competition strategy around this position. This information will aid coaches in development of techniques and tactics in order to better prepare players for competition.

Keywords: combat sport,performance analysis,scoring frequency,martial arts

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1   **Background**

2   Brazilian Jiu-Jitsu (BJJ) has its foundation as a self-defence art but has rapidly grown into a

3   widely practiced competitive sport. As such, competitive contests are primarily decided by

4   submission from joint locks or chokes or failing this by accumulated points decided based on

5   superior positions or positional transitions (1). The success of BJJ in the early days of the

6   Ultimate Fighting Championship firmly cemented its place in the martial arts offering since

7   1993. Since that early introduction it has grown to become one of the most popular martial

8   arts currently studied (1).

9   The presence of scientific articles on BJJ are limited, with the focus being injury profiling

10   (2,3,4), athlete profiling (5,6) or understanding the physiological demands (7,8,9). Whilst

11   these endeavours could contribute to the understanding of the demands of the sport and

12   therefore potentially aid in coaching development, competitive performance analysis is

13   lacking. Performance analysis has been used successfully in many sports including those with

14   similarities to BJJ (10,11) to objectively measure tactics. Such information is invaluable to

15   the technical and tactical development of such sports. To date similar approaches have not

16   been applied to BJJ.

17   Competitive BJJ allows participants to employ a large variety of techniques with the aim to

18   outscore or submit the opponent. Multiple takedowns, pins, joint locks and chokes can be

19   combined to provide a victorious outcome and to date no attempt to compare the

20   effectiveness of different techniques has been undertaken. At its core, competitive points are

21   accumulated from throwing an opponent or pinning them whilst on the ground, whilst a

22   successful submission will award victory to the practitioner regardless of the score. For this

23   reason, it is important that a deeper understanding of technique success is developed to aid in

24   the identification of the technical and tactical aspects most likely to be successful in

25   competition. Such an understanding will aid in the development of coaching education.

26   Therefore, the aim of this study was to analyse beginner BJJ matches to better understand the

27   nature of the techniques and their successes.

28

29   **Methods**

30   Using performance analysis to assess the fights required the establishment of objective

31   definitions for the techniques. A pilot review of BJJ contests by two authors was used to

32   establish the usability of a series of definitions for observable events. A tagging panel was

33   created using these definitions in Dartfish (v8).

34

35   *Sample*

36   With institutional ethical approval, the sample consisted of 140 fights and were obtained from

37   video footage of BJJ tournament fights from a publically accessible website. All personal

38   data were excluded from the final results. The inclusion criteria for contests were the whole

39   contest needed to be available, fighters were of white or blue belt rank, Gi or kimono fights

40   only, male (due to lack of available quantity of female fights) and all weight classes were

41   permitted. The use of Dartfish (v8) for the data collection allowed each athlete to be coded

42   with the time when the specific event occurred, the technique used (examples of which

43   include takedown attempt, guard pass, submission attempt etc). In addition, whether such an

44   attempt was successful or not. Briefly success was defined as scoring takedown, successful

45   position reversal (from bottom to top), full guard pass (not to half guard) or submission. The

46   option to code an event as 'other' was available for collective analysis of techniques not

47   recognised.

48   All data were collected by the same researcher, with over 9 years of experience in BJJ, to

49   provide consistency of interpretation for techniques. Completed data collection resulted in

50   each contest being represented by a coded matrix of events which was stored for later

51   analysis. Collective matrices were analysed using MatLab (R2017b) where bespoke

52   algorithms were developed to identify descriptive and analytical statistics relating to specific

53   techniques and their outcome.

54

55   *Analysis*

56   The resulting data were analysed and presented as attempts, success rates and percentages.

57   Each variable is considered independent for the analysis and breakdown into belt colour was

58   completed. Where possible chi-squared testing on the frequency data was completed to

59   investigate differences between blue belt (BB) and white belt (WB).

60   Success was defined according to Miller and colleagues (12) as:

61   % of successful techniques = (No. of successful techniques / total number of attempted

62   techniques) *100

63

64   **Results**

65   *Takedowns*

66   A total of 247 takedown attempts were recorded, from the 140 fights. The most common

67   takedown attempted was 'guardpull' which had an attempt frequency almost 3 times that of

68   the next most common. Guardpull was identified as 50% of all takedown attempts. 94% of

69   guardpull attempts were determined as successful and it was the most success of all

70   takedowns. Footsweeps and backwards takedowns also achieved high success rates (86%).

71   Other frequencies and successes are evident in figure (1).

72

73   "Insert Figure 1 here"

74   The belt split demonstrated a similar breakdown for white and blue belts, where 46% of all

75   takedowns were classified as guardpull for WB and 53% for BB with a common success rate

76   of 94%. There were a similar number of attempts of double leg takedowns across the belts,

77   whereas there was a significantly greater number of single leg takedowns attempts for BB

78   (18%, n=24) compared to WB (7%, n=8); χ^2 (1, $N = 247$) = 6.13, p = .013. However, there

79   was no significant difference in success χ^2 (1, $N = 247$) = 2.06, p = .150, (figure 2).

80

81   "Insert Figure 2 here"

82   The most frequently attempted takedowns (guardpull, single leg and double leg) resulted in a

83   mixed array of ground positions. Guardpull resulted in guard or half guard (bottom) 93% of

84   the time. Double leg takedown resulted in side control 31% of the time, however it also had a

85   high prevalence of resulting in guard (top) and turtle (bottom) 28% and 19% respectively.

86   Single leg takedown resulted in similar resulting positions, side control (top) 30%, guard

87   (top) 27% and turtle (bottom) 17% of the time.

88   The belt split illustrates that the double leg takedown by WB resulted in guard (top) 47% of

89   the time in contrast to just 11% for BB. Similarly, the double leg takedown resulted in side

90   control (top) 47% in contrast to WB where just 12% of double leg takedowns resulted in side

91   control (top). Furthermore, WB double leg takedowns resulted in guard (bottom) 18% in

92   contrast to 0% at BB.

93

94   *Guard passes*

95   A total of 107 guard passes were recorded. The most common guard pass attempt was knee

96   pin and knee slice, closely followed by the bullfighter pass. Success rates identified

97   bullfighter pass as most successful with similar success rates for the sao paolo and knee pin

98   pass.

99

100   "Insert Figure 3 here"

101   Passes at WB concentrated three passes, knee slice, knee pin and bullfighter pass accounting

102   for 93% of pass attempts. A greater variety of passes was witnessed at BB with 71% coming

103   from these three passes. Double under and leg drag passes accounted for a further 19% of

104   passes at BB compared to 0% at WB. The BB, WB split showed similar attempts of knee

105   slice and bullfighter passes. Knee pin was attempted more at blue belt but this was not

106   significantly different χ^2 (1, $N = 141$) $= 0$, $p = .995$.

107   Of the three common WB passes knee pin was 100% successful, with 81% and 82% success

108   rates for knee slice and bullfighter respectively. At BB bullfighter pass was most successful

109   of these three passes (89%) with 69% and 70% success for knee slice and knee pin

110   respectively. A particularly low success rate was noted for the double under pass at BB

111   (29%).

112

113   *Guard sweeps*

114   A total of 56 guard sweeps were observed. The four most commonly attempted guard sweeps

115   were scissor sweep, back take, X-guard sweep and SitUp sweep. Various levels of success

116   were noted for these sweeps; 55% for the scissor sweep, 60% back take, 63% X-guard sweep

117   and 38% for the sit up sweep. The belt split shows that WB attempted a scissor sweep on 10

118   occasions compared to just once for BB. DeLaRiva was attempted 5 times more often at blue

119   belt as was backtake (twice as often). In contrast Situp sweep was three times more common

120   at white belt as was spiderguard sweep.

121   ***Submissions***

122   173 submission attempts were observed. Of all the submissions attempted 34% were for arm

123   bar, 21% Triangle, 12% cross collar choke, 8% kimura and 7% rear choke. All other

124   submissions had an attempt frequency of less than 5%. The success for these top five

125   submissions were best for the rear choke (75%) falling to triangle at just 22% (figure 4).

126

127   "Insert Figure 4 here"

128   The belt split illustrates a similar pattern of attempts at white belt (figure 5) for arm bar,

129   triangle, kimura and cross collar choke, however rear choke was lower with less than 5%

130   attempt frequency. BB Kimura attempts were below 5% attempt frequency with omoplata

131   registering as the 5th most common submission attempt at blue belt despite no attempts for

132   WB. Chi-squared testing reveal no significant difference in arm bar attempts χ^2 (1, N = 173)

133   = 0.58, p = .445, Cross collar choke χ^2 (1, N = 173) = 1.74, p = .186, or triangle χ^2 (1, N =

134   173) = 2.09, p = .148, attempts between the belts.

135

136   "Insert Figure 5 here"

137   A strong dominance of the guard was evident when investigating submission position. At

138   least 76% of arm bar, cross collar choke and triangle chokes where observed from the guard

139   (bottom) position. A greater variety of positions were observed for Kimura attempts but

140   guard was still the most frequent (30%) and side control top the next most frequent (20%).

141   The belt breakdown demonstrated a similar pattern with over 80% of arm bars, cross collar

142   chokes and triangles attempted from guard (bottom). At 63% of BB arm bars were attempted

143   from the guard, and over 75% of cross collar chokes and triangle chokes attempted from

144   guard. A statistically significant greater number of guard arm bar attempts were witnessed at

145   white belt compared to blue belt, χ^2 (1, $N = 103$) $= 4.13$, $p = .042$.

146

147   **Discussion and Conclusion**

148   The aims of this paper were to conduct an event based performance analysis of WB and BB

149   BJJ fights, and this represents the first such analysis therefore the findings are considered to

150   be novel. The findings are believed to offer players, coaches, referees and organisational

151   committees/governing body's insights into the events commonly encountered during this

152   level of BJJ match.

153   All matches commence in the standing position and the data generated by this study

154   illustrates that guardpull was by far the most common take down event and one which was

155   highly successful. Players at both belt levels achieved a high percentage of success resulting

156   in a guard control position. This strong focus on the sacrifice of the top position is highly

157   unique to BJJ, despite this previous studies have not quantified this (13,14) therefore this is

158   the first study to identify and quantify guardpull dominance in beginners BJJ. Throw analysis

159   in judo illustrated that sutemi-waza (sacrifice throws) were much less frequent and successful

160   in comparison to Te- or Ashi-waza (12). This suggests that the guard pull technique has either

161   been a strong focus of beginners BJJ or that the technique in itself is simple to master or

162   difficult to defend. It is not clear whether opponents are happy to follow this technique to the

163   ground i.e. allow the technique to be effective, in order to end up in the familiar guard top

164   position or whether effective defence to such a technique is lacking or difficult to grasp at this

165   level.

166   There were some interesting findings around the other takedowns regarding little used but

167   high success rates. A foot sweep and backwards takedown demonstrated an overall success

168   rate of 86% despite only being attempted 9% (n = 21) and 3% (n = 7) of the time

169   respectively. At WB, this success was 100% for backwards takedown, and foot sweeps 85%

170   and 88% respectively for WB and BB. This coupled with a 100% success rate for forwards

171   takedowns at blue belt suggest that certain techniques appear to be highly successful but only

172   for a few individuals. It is not known as to the back ground of these players, i.e. whether they

173   possess these skills prior to commencing training in BJJ or whether they have been able to

174   develop a high level of proficiency for these specific techniques. It seems however that the

175   players using these are highly successful with these takedowns and that these takedowns are

176   not attempted by those who are less confident of their competency.

177   However just looking at the success of the takedown does not consider the resultant position

178   achieved from the takedown. Unlike Judo, BJJ cannot be won outright by a throw/takedown

179   therefore resultant position is one of the primary aims of such techniques. This is critical to

180   understand if significant match advantage has been gained from the takedown. For example,

181   the backwards takedown resulted in equal chance of ending in side control, taking the back

182   (top) and mount (top) which could be described as attacking positions and a positive

183   outcome, however it also resulted in guard (bottom), a neutral/attacking position but in

184   addition guard (top), a negative position. Therefore, takedowns resulting in attacking

185   positions are critical to inform coaching practice. Few takedowns resulted in mount top or

186   back top, however 38% of single leg and forward takedowns and 33% of backwards

187   takedowns resulted in side control (top) for WB. This suggest that with 100% success rate for

188   backwards takedowns a 1 in 3 chance of ending up in side control (top). In addition, when

189   observing the other outcomes from this takedown, namely a 1 in 3 chance of ending in guard

190   (bottom) or back (top) this technique appears likely to result to significant attacking

191   advantage and unlikely to result in a negative position. This is in contrast with the forward

192   throw, which is usually attempted by turning your back on your opponent in standing, which

193   was only successful 53% of the time and resulted in a 1 in 4 chance of ending with your

194   opponent taking the back (top) position, one of the high scoring positions in BJJ. It did

195   however yield side control (top) 38% of the time, therefore this represents a high risk, high

196   reward tactic for WB. The single leg takedown, which resulted in side control top 38% of the

197   time also resulted in 1 in 4 landing in guard top demonstrating a medium risk for high reward.

198   Therefore for the white belt BJJ player who is keen to avoid ending up in the opponents

199   guard or a negative non attacking position, a forwards takedown or backwards takedown

200   offers low risk, however there is a high risk of a back take with a forwards takedown,

201   therefore the backwards takedown could be the preferred low risk, high reward option.

202   For BB, the 100% success observed with a forward throw resulted in ending up in guard or

203   half guard (top) 75% of the time which is not necessarily an attacking position. Similar

204   findings are evident for the foot sweep which despite a high success rate at blue belt (88%),

205   guard or half guard (top) was the outcome 63% of the time and only an attacking position

206   38% of the time. Therefore, the outcomes of such techniques for gaining advantage should be

207   questioned. The takedown most successful for securing an attacking position at BB leg

208   takedown which resulted in side control (top) almost 50% of the time. This takedown,

209   perhaps with its origins in judo (Morote Gari) where, before it became illegal, had an

210   observed successful frequency of 3% compared to all throws (15), or freestyle wrestling with

211   an observed frequency of 10% of all successful takedowns (16). Side control (top) would be

212   considered a strong attacking position and a very positive outcome from a takedown,

213   however there was a 1 in 4 chance that such an attempt would result in the opponent securing

214   the back. Moreover, despite a very low usage (only 3) the sacrifice takedowns resulted in

215   either mount (top), guard (bottom) or in back take for the opponent in equal measures.

216   Therefore, for the BB looking to secure a strong attacking position either sacrifice throw

217   (which maybe the domain of those who have grasped these techniques), or double leg

218   takedown with a high proportion ending in side control.

219   The outcomes of these takedowns have important implications for coaching, technique

220   development or tactics. It seems to suggest that either students at this level struggle to secure

221   the resultant position to take full advantage of the takedown or that defending these

222   takedowns is well developed as such to minimise the impact of the takedown. The exceptions

223   to this are the little used takedowns which seem to be adopted with those who have

224   concentrated on the development of these specific techniques. Perhaps specific drills or focus

225   should be placed on how to complete the takedown to ensure maximal advantage. This notion

226   has been identified in other combat arts and is sometimes referred to as transition. This is

227   unique in BJJ over Judo as with a perfectly executed takedown a Judo contest is over thus

228   preventing the need to secure the ground position. In contrast takedowns in BJJ serve only for

229   the transition to the ground.

230   Due to the dominance of the guard position, one of the key challenges in BJJ is passing the

231   guard. The findings of this study suggest that 93% (WB) and 71% (BB) of all guard passes

232   fall into the knee slice, bullfighter and knee pin pass categories. These were highly successful

233   at white belt suggesting either a strong focus on guard passing at this level or perhaps due to

234   less developed guard retention. The high success rates suggest this is a highly effective tactic

235   for this level of BJJ. However, this level of success reduces slightly for the knee pin and knee

236   slice for blue belt. The reasons for this are not immediately clear but suggests that as

237   experience is gained so does the ability to defend this attack. This suggests that an early focus

238   for BJJ coaching should be built around defending these very common attacks. In addition, it

239   may be tactically relevant to develop and train less common passes in order to surprise

240   opponents rather than rely on the common passes.

241   Submissions are a critical aspect of BJJ as they result in an instant victory. Therefore, BJJ

242   training is largely based around the idea of securing a submission. Over the years a great

243   number of submission techniques have been developed. Despite such a large quantity of

244   available submissions, only 8 types of submission were witnessed for white belt, and 9 for

245   blue belt. There was a strong focus on submission attempts from guard with 75% of all

246   submission attempts common from the guard (bottom) position. Of all the submission

247   attempts at white belt from the guard 37% were for the arm bar. At BB around 2/3rds of all

248   submission were from the bottom guard position and of these 1 in 5 was for the arm bar. Such

249   a propensity for one technique seems to suggest that competition results in a reductionist

250   approach to submission attempts where the submission repertoire of beginners is narrowed

251   significantly. Mixed martial arts demonstrated that the elbow locks (very similar to the arm

252   bar) were responsible for 9% of all stoppages (17) and was by far the most common joint

253   lock witnessed. This suggests such a technique is high popular and effective across a range of

254   arts perhaps due to its ease in application or effectiveness as a submission or difficultly to

255   defend. Coaches should concentrate of developing methods of appropriate defence for this

256   highly popular submission. Despite this high popularity, the triangle choke was more frequent

257   at blue belt with 1 in 4 submission attempts from the guard being for this technique. This was

258   observed to cause 2.3% of stoppages in MMA matches being the third most common (17). As

259   some of the fighter in the study by Buse (17) were from a BJJ background it is possible that

260   these skills are reflective of those learnt at beginner BJJ players. Despite these subtle

261   differences it identifies the strong emphasis of early BJJ training involving the guard. It is

262   evident that avoiding defeat at this level of competition requires an ability to defend arm bar

263   and triangle attacks from inside the guard.

264   The synthesis of these matches seems to suggest a common thread or theme to the generic

265   approach to BJJ at this level. There appears to a strong focus on the guard. Takedowns

266   dominated by guard pulls, low guard pass counts, submission attempts from guard with a

267   strong focus on arm bar and triangle and therefore this information should prove valuable to

268   players and coaches alike in developing training to defend or enhance tactical approach to

269   winning at this level.

270

271   This study demonstrates for the first time an analysis of the techniques used during beginner

272   BJJ matches. The results were dominated by the guard, from guardpull as the most common

273   takedown to submissions from guard being most prevalent. This confirms the uniqueness of

274   BJJ for developing a strong propensity for developing a competition strategy dominated from

275   being on ones back. This information will aid coaches in development of techniques and

276   tactics in order to better prepare players for competition.

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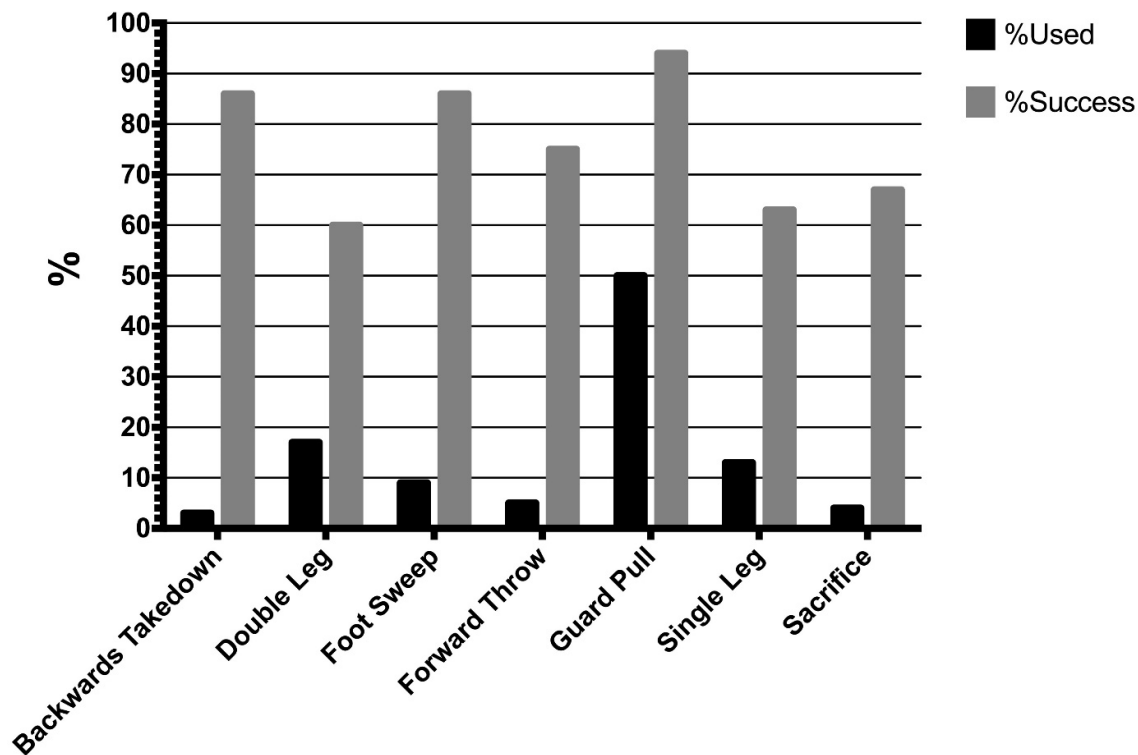
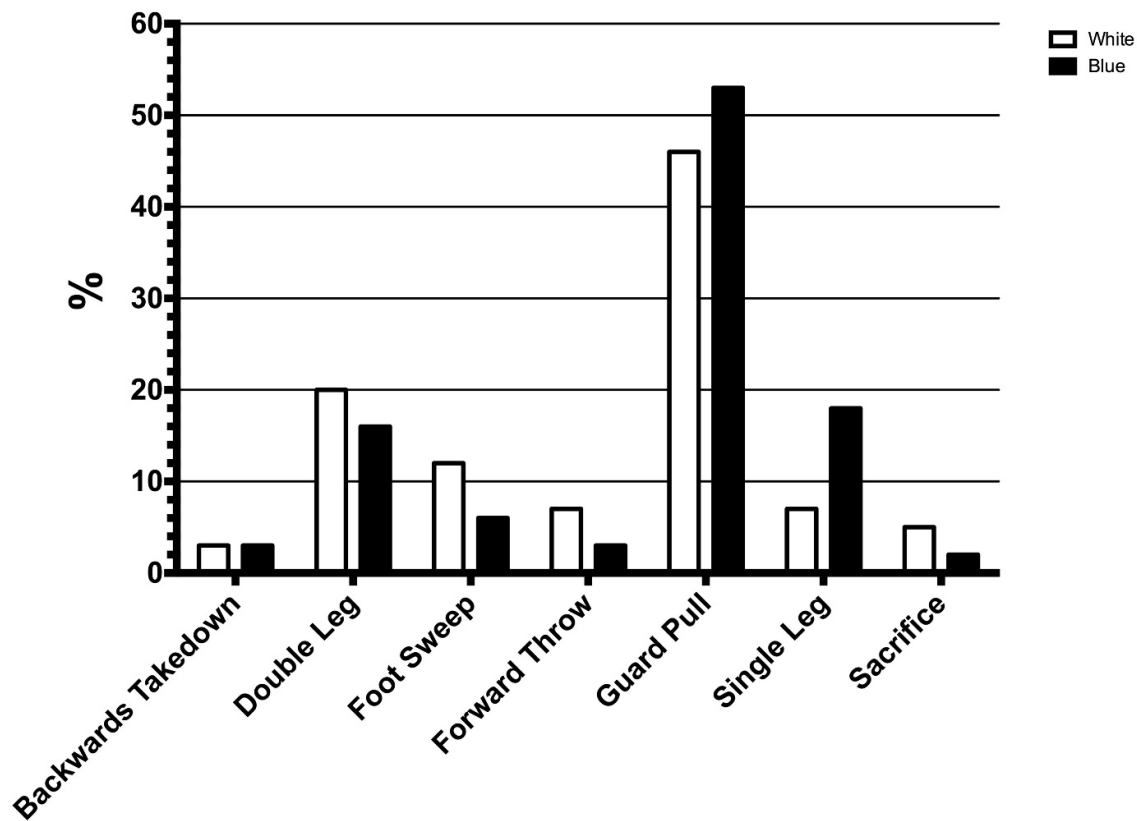Figure 1. Percentage of takedown attempts and percentage of success

Figure 2. Percentage of use of different takedown types, split by belt.
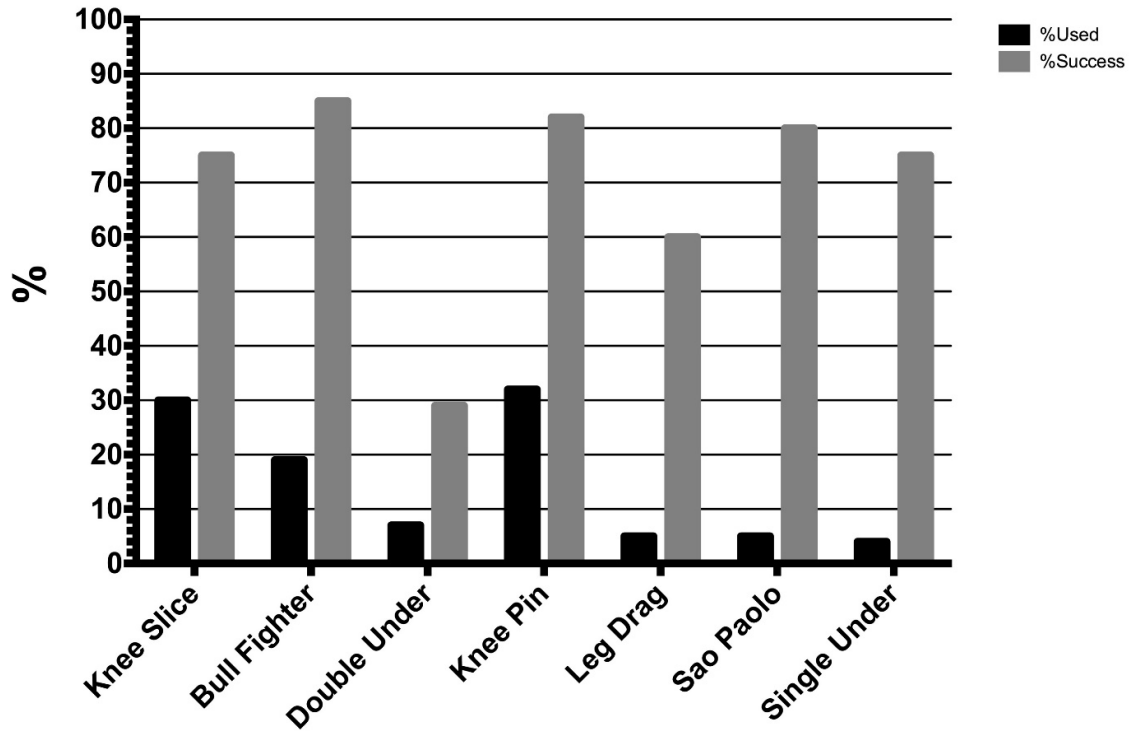
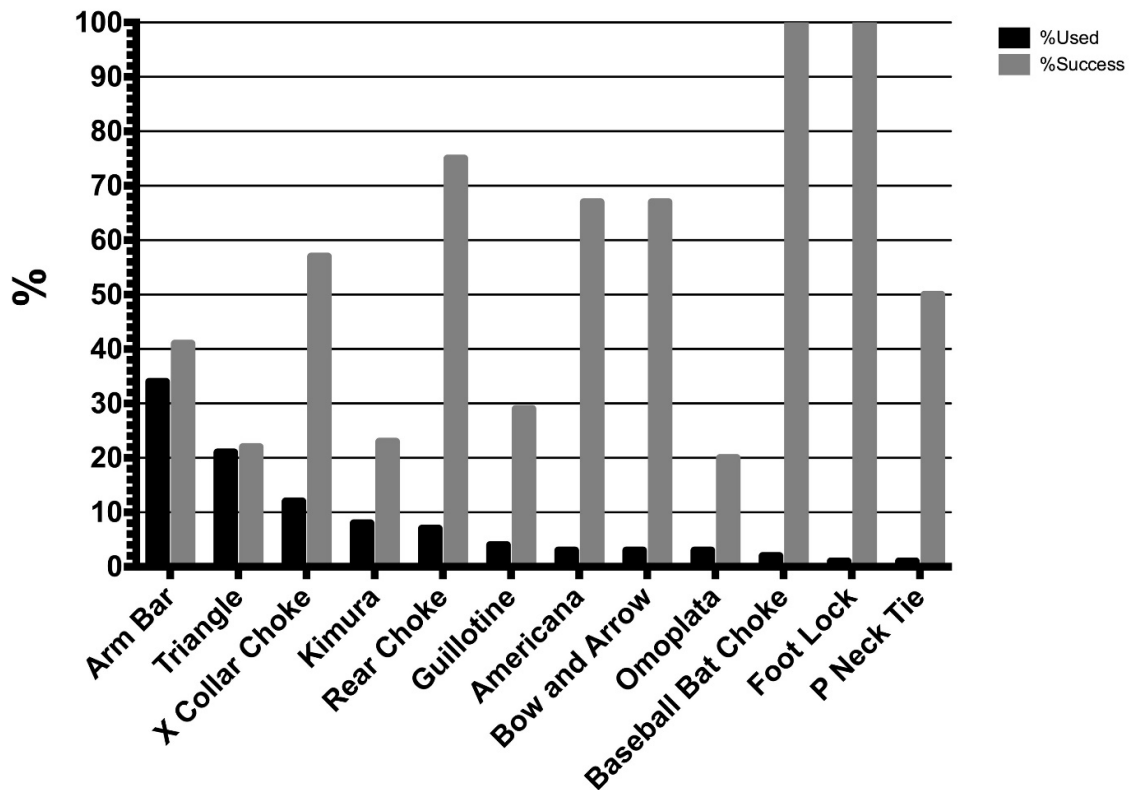Figure 3. Overall use of guardpass attempts and percentage success

Figure 4. Use of submission attempts and percentage success
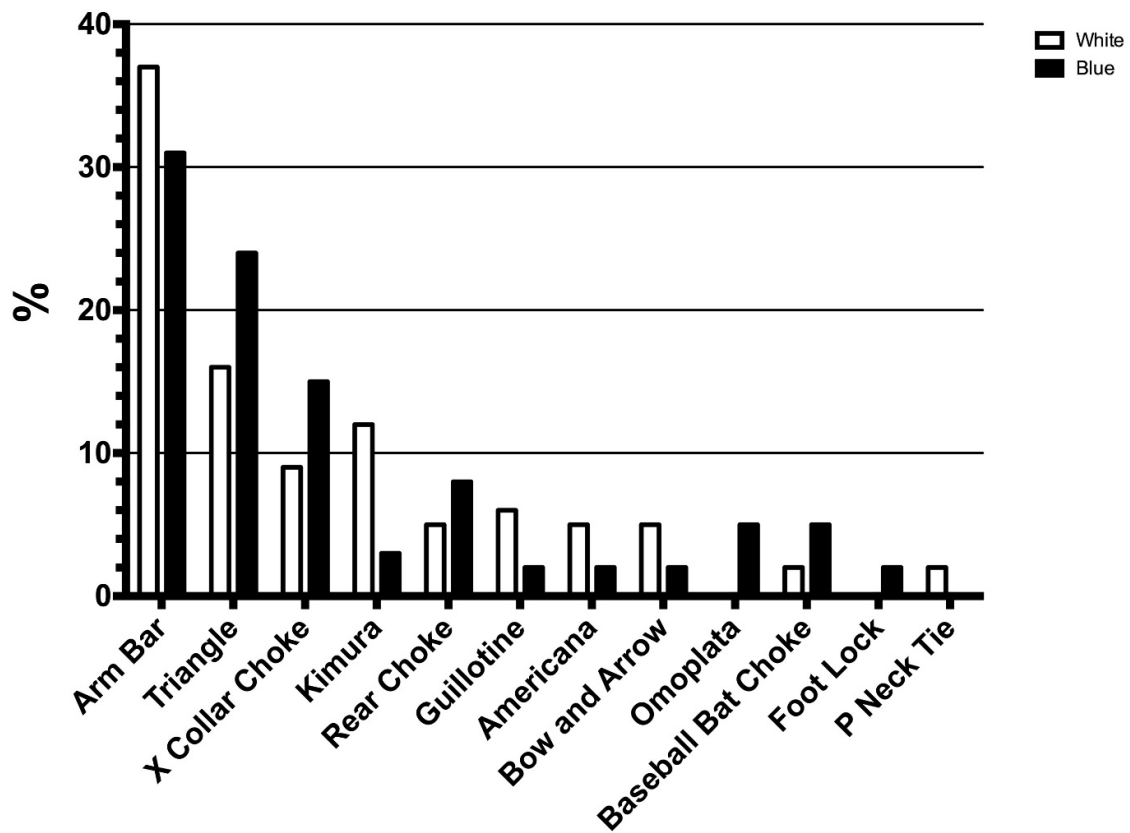

Figure 5. Submission attempts across blue and white belt.

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17th Sept, 2018

Dear Editor,

Re: **Technique utilisation and success in competitive Brazilian Jiu-Jitsu matches at white and blue-belt**

We would like to take this opportunity to thank you for considering our manuscript.

As corresponding author I can confirm all authors contributed significantly to the manuscript and are to be considered authors. I have the authority to act on behalf of the authors.

The material submitted is unpublished and original it had not and will not be submitted for publication elsewhere until a decision is made regarding its acceptability for publication in the Asian Journal of Sports Medicine. If accepted for publication, it will not be published elsewhere without the written permission of the Editor-in-Chief. The experimental work conforms to the highest standards of safety and ethics, and to the laws of the country in which the work took place. As the study used publically available data no consent was necessary.

We look forward to you considering our work for publication.

Yours sincerely

Dr Jonathan Williams