

Effect of a 6-Week Yoga Intervention on Swing Mechanics during the Golf Swing: A Feasibility Study

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1 **Effect of a 6-Week Yoga Intervention on Swing Mechanics during the Golf Swing: A**
2 **Feasibility Study**

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4 **Running head:** The influence of a yoga training programme on golf swing mechanics.

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6 **Location of study:** Abertay University Biomechanics Laboratory

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11

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25 **ABSTRACT**

26 Recent evidence suggests that participating in physical conditioning programmes can improve
27 golf performance, however, the effectiveness of a yoga intervention has yet to be investigated.
28 The aim of the current study was to investigate the effectiveness of a six-week yoga
29 intervention on golf swing mechanics. Ten male golfers participated in the laboratory-based-
30 study. Golf swing mechanics were collected from two testing sessions, before and after the six-
31 week yoga intervention, using the Vicon motion capture system. Following the six-week yoga
32 intervention, significant changes were observed between the yoga and control group in X-
33 Factor ($P \leq 0.05$) and a medium effect ($d \geq 0.50$) observed. No significant changes ($P > 0.05$)
34 and no effect ($d < 0.20$) were observed in the X-Factor stretch. Significant changes ($P \leq 0.05$)
35 and a medium effect ($d > 0.50$) were observed for the pelvis rotations following the yoga
36 intervention, however, no differences were observed in torso rotations or hand velocities ($P >$
37 0.05). The findings of this feasibility study suggest that yoga may be a promising intervention
38 in helping to improve golf swing mechanics, however, future research is required to confirm
39 the effect of the use of yoga during the golf swing due to the sample size.

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41 **Key words:** Biomechanics, Flexibility, Movement, ROM, Motion Analysis, Performance

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43 **Word Count:** 5466

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49 **INTRODUCTION**

50 Flexibility and mobility are vital for optimal performance when performing skills in various
51 sports (Cools et al., 2010; Sell, Tsai, Smoliga, Myers, & Lephart, 2007; Young, Clothier,
52 Otago, & Liddell, 2004). In order to perform the golf swing proficiently, a golfer must display
53 a good level of flexibility and mobility in order to maximise long game performance (Joyce,
54 2016), therefore, these attributes are more commonly found in lower handicap or professional
55 golfers (Joyce, 2016; Tilley & Macfarlane, 2012). It has been previously reported that an
56 increase in range of motion (ROM) around the shoulder, pelvis and torso regions can enable
57 greater rotation during the backswing, which can increase angular velocity (Chettle & Neal,
58 2001) and, in turn, increase club head velocity during the downswing (Keogh & Hume, 2012).
59 Furthermore, displaying a good level of flexibility during the golf swing can be an important
60 factor when aiming to improve posture during set-up and prevent injury caused by excessive
61 stress on joints (Farrally et al., 2003). The hips, torso and shoulders are common sites of
62 inflexibility in golfers, as the set-up position renders a repetitive bent over posture (Farrally et
63 al., 2003) which can have negative effects on performance (Joyce, 2016).

64

65 The separation of the hips (pelvic region) and torso (thorax region) at the top of the backswing
66 is a key component when aiming to maximise distance during the golf swing (Joyce, 2016),
67 and has been the focus of many golf performance and injury prevention studies in recent years
68 (Cole & Grimshaw, 2008a, 2008b; Henry, Berglund, Millar, & Locke, 2015; Joyce, 2016;
69 Myers et al., 2008; Sell et al., 2007; Sorbie, Gu, Baker, & Ugbole, 2018). The separation of
70 the hips and torso areas during the golf swing is known as the X-Factor (Joyce, 2016). In
71 addition to the X-Factor, the X-Factor stretch is becoming increasingly popular within golf
72 scientific research (An, Wulf, & Kim, 2013; Cheetham, Martin, Mottram, & St. Laurent, 2001;
73 Henry et al., 2015; Sorbie et al., 2018). The X-Factor stretch refers to the additional rotation

74 that occurs between the hips and torso areas in the early stage of the downswing (Sorbie et al.,
75 2018). In order to increase the X-Factor at the top of the backswing and display an X-Factor
76 stretch during the initiation of the downswing, a golfer must display a good level of flexibility
77 around the pelvis and torso regions (Joyce, 2016). Greater X-Factor angles are often attributed
78 to lower handicap and elite golfers (Joyce, 2016). For example, Cole & Grimshaw, (2008b)
79 found a significant difference in the X-Factor between low handicap (<10) golfers (61.4 ± 10.8
80 $^{\circ}$) and high handicap (>18) golfers (54.1 ± 15.0 $^{\circ}$). Zheng et al., (2008) found similar significant
81 differences in the X-Factor angle when testing PGA Tour players (56.0 ± 4.0 $^{\circ}$) and high
82 handicap golfers (48.0 ± 2.0 $^{\circ}$).

83

84 In addition to reduced skill level, an individual's physical limitations, such as muscular strength
85 and flexibility levels, have a strong influence on the effectiveness of the X-Factor and X-Factor
86 stretch (Hellström, 2009), and this ultimately has a negative effect on driving performance
87 (Joyce, 2016). In order to improve these attributes, golf specific strength and conditioning
88 programmes are becoming prominent for golfers (Henry et al., 2015; Lehman, 2006; Lephart,
89 Smoliga, Myers, Sell, & Tsai, 2007; Lindsay & Horton, 2006). The main aim of many of these
90 programmes is to increase strength, power, and flexibility in order to improve performance and
91 reduce injury risk within the sport (Doan, Newton, Kwon, & Kraemer, 2006; Keogh et al.,
92 2009; Sell et al., 2007). Bull & Bridge, (2012) found that, following an 8-week plyometric
93 training intervention, X-Factor at the top of the backswing increased from 61.0 ± 8.0 $^{\circ}$ to 68.0
94 ± 11.0 $^{\circ}$. Furthermore, this increase in the X-Factor enabled golfers to increase club head
95 velocity by 4.7% and driving distance by 5.9% following the intervention. There is limited
96 research regarding flexibility interventions and their relationship with the X-Factor and X-
97 Factor stretch; however, by improving flexibility, it is suggested that golfers are able to create

98 faster club head speed, due to an increased range of motion in the backswing (Chu, Sell, &
99 Lephart, 2010; Draovitch & Simpson, 2007).

100

101 Yoga has become a popular method of flexibility training in many sports, including golf
102 (Briegel-Jones, Knowles, Eubank, Giannoulatos, & Elliot, 2013). Yoga is suggested to improve
103 muscular strength (Gothe, Kramer, & Mcauley, 2014) and range of motion (Amin & Goodman,
104 2014), which are all key components in performing the golf swing proficiently (Draovitch &
105 Simpson, 2007). Many yoga poses use body weight against gravity to exert force, which can
106 improve muscular strength (Gothe et al., 2014). Golfers need a high level of muscular strength
107 to achieve a powerful golf swing, especially within the trunk area, as this will affect a golfer's
108 maximum thorax and club head velocities (Draovitch & Simpson, 2007). Furthermore, it has
109 been reported that regular yoga practice will improve an individual's range of motion (Amin
110 & Goodman, 2014), however, this is yet to be found in relation to the golf swing.

111

112 Therefore, the aim of the current study was to determine the effectiveness of a six-week yoga
113 intervention with the aim of improving the X-Factor and X-Factor stretch during the golf swing.
114 Furthermore, the current study aimed to examine the pelvis and torso rotation and lead hand
115 velocity during the golf swing following the yoga intervention. It was hypothesized that
116 performing a yoga training programme would improve golf swing mechanics and, therefore,
117 increase the long game performance of the golfer.

118

119 **METHODS**

120 **Experimental Approach to the Problem**

121 In order to examine the given hypothesis of the current investigation, a randomized controlled
122 pre and post-test experimental design was used. Two groups of single handicap golf players

123 were randomized either into a six-week yoga intervention group or control group. This was to
124 examine the effect of yoga training on the X-Factor, X-Factor stretch, pelvis and torso rotation
125 and lead hand velocity during the golf swing.

126

127 **Participants**

128 Ten right-handed male amateur golfers volunteered to participate in this study. Five
129 participants were randomized into an experiment group (mean \pm SD age: 19.60 ± 2.30 years;
130 stature: 179.66 ± 5.80 cm; body mass: 87.04 ± 17.86 kg and handicap: 5.00 ± 3.00) and five
131 participants into a control group (mean \pm SD age: 25.20 ± 5.02 years; stature: 184.02 ± 4.80
132 cm; body mass: 83.89 ± 14.99 kg and handicap: 5.20 ± 4.71). Additional anthropometric
133 measurements (shoulder offset, elbow width, wrist width, hand thickness, leg length, knee
134 width, ankle width) were recorded during the initial stages of the testing process in order to run
135 a customized Golf Model (Sorbie et al., 2018). Low handicap golfers were selected to
136 participate in the study as it provided a representative sample of the population, whilst
137 excluding the probability of technique having a major influence on results (Joyce, Burnett,
138 Cochrane, & Reyes, 2016). Participants had to be free of any musculoskeletal injuries for a
139 period of three months prior to the study, as these factors may limit flexibility and golf swing
140 attributes (Lindsay & Horton, 2006). Participants were also required to undertake no
141 conditioning or resistance training 48 hours prior to the testing sessions. All participants
142 completed a consent form and physical readiness questionnaire before participating in the
143 current study. Full ethical approval was granted from Abertay University, School of Health
144 Sciences prior to data collection.

145

146

147

148 **Experimental Procedure**

149 All participants performed a standardized warm up, which consisted of a moderate paced run
150 for 2.5 minutes. Participants then performed 10 body weight squats, 10 keyhole arm swings
151 and 10 air swings prior to data collection. Following the warm-up, participants performed 5
152 golf swings using a standardized driver. All golf shots were struck from a rubber tee which was
153 placed on an artificial golf mat fixed to the floor in the centre of the laboratory. During each
154 golf shot, participants were instructed to perform their standard golf swing with the aim of
155 maximizing distance and accuracy. Participants were instructed to aim towards a target area on
156 the wall.

157

158 Following the initial test, participants that were assigned to the experiment group took part in
159 a six-week yoga intervention, targeting key areas of inflexibility within golfers including the
160 shoulders, torso and pelvis. Participants performed six 30-minute sessions over the six-week
161 intervention period (Amin & Goodman, 2014). Participants in the control group were instructed
162 to continue their normal daily routine including fitness and golf training, without any yoga
163 practice. All participants were then tested again following the six-week intervention period,
164 completing the identical protocol completed on the first visit to the laboratory.

165

166 **Data Collection**

167 During the 5 golf shots that were performed before and after the six-week intervention, three-
168 dimensional (3-D) data were collected using the an 8-camera Vicon Bonita (Oxford Metrics
169 Ltd, United Kingdom) Motion Analysis System operating at 200 Hz. To ensure the system had
170 been correctly calibrated, the camera residual was < 0.2 mm. Spherical retro-reflective markers
171 (1.4 cm) were adhered to the skin on anatomical regions according to the adapted version of
172 the Vicon Plug-in-Gait Model (Vicon Motion Systems Ltd, Oxford, UK) (Sorbie et al., 2018)

173 using double-sided tape. To ensure accurate 3-D data collection, participants were asked to
174 wear tight fitting shorts and their own golf shoes when performing all golf shots.

175

176 **Data Reduction and Analysis**

177 Following the labelling of all trials, the data was smoothed using a Butterworth filter (15 Hz)
178 and exported to Microsoft Excel (version 2013). A multi-segment model used to analyse the
179 X-Factor in the current study was developed using BodyBuilder (Oxford, UK) and used in
180 Vicon version 2.7. This multi-segment model, which calculates the torso and pelvic separation,
181 is suggested as a valid method of obtaining X-Factor values. A schematic representation of the
182 model used in the current study has been previously published (Brown et al., 2013). The X-
183 Factor stretch was calculated by subtracting the X-Factor at the top backswing from the
184 maximum X-Factor value during the downswing. Other swing phases of interest included: lead
185 arm parallel to the ground during the downswing, pre-impact (the point at the last 40 ms before
186 impact), and impact (Figure 1) (Myers et al., 2008). These positions were determined from the
187 position of the retro-reflective markers on the upper extremity (Myers et al., 2008). In order to
188 measure the lead hand velocity (left marker (LFIN)), the frame at the lead arm parallel during
189 the downswing, pre-impact and impact of the ball was identified. Following this, the XYZ data
190 was calculated using the following equation:

$$191 \quad \textit{Absolute position} = \sqrt{x^2 + y^2 + z^2}$$

192

193 *****INSERT FIGURE 1 NEAR HERE*****

194

195 **Statistical Analysis**

196 All calculations were performed on Microsoft Excel (version 2013) and SPSS (version 23).
197 Normal distribution for all variables was assessed using the Shapiro-Wilk test. A null

198 hypothesis for the tests was accepted due to all P values being greater than 0.05. Upon this
199 being determined, an unpaired T-Test was used to identify differences in swing mechanics data
200 sets when measuring the effects of the yoga intervention. The unpaired T-Test measured the
201 absolute differences between the pre and post measures and was selected due to the small
202 sample size used within this feasibility study. $P \leq 0.05$ was considered significant. In addition
203 to the P value, effect sizes were calculated using Cohen's d method (Cohen, 1988). The
204 following scale of thresholds was used to analyse the magnitudes of effect size: 0.80 large; 0.50
205 medium; and 0.20 small. Clinically meaningful data was calculated based on a previously used
206 method (Liow & Hopkins, 2003), which was interpreted qualitatively as follows: <1%, almost
207 certainly not; <5%, very unlikely; <25%, unlikely; 25–75%, possible; >75%, likely; >95%,
208 very likely; and >99% almost certain.

209

210 **RESULTS**

211 **X-Factor**

212 Significant differences were observed for the X-Factor at the top of the backswing following
213 the completion of the yoga intention ($P \leq 0.05$) and a medium effect between groups was
214 observed ($d = 0.50$). From a qualitative perspective, these results are very likely (96%) to be
215 clinically meaningful (Figure 2).

216

217 *****INSERT FIGURE 2 NEAR HERE*****

218

219 **X-Factor Stretch**

220 No significant differences were observed for the X-Factor stretch during the golf swing
221 following the completion of the yoga intention ($P = 0.21$). A medium effect was observed

222 between groups ($d = 0.57$), however, these results are unlikely (30%) to be clinically
223 meaningful (Figure 3).

224

225 *****INSERT FIGURE 3 NEAR HERE*****

226 **Swing Mechanics**

227 The means, standard deviations, group statistical differences, group effect sizes and qualitative
228 chances for each of the variables assessed are displayed in Table 1. Specifically, angle of
229 rotations of the pelvis and torso for the four phases of the golf swing are displayed in Table 1.

230 In addition to the angles of rotation, hand velocities at the three latter stages of the golf swing
231 are also displayed in Table 1.

232

233 *****INSERT TABLE 1 NEAR HERE*****

234

235 **DISCUSSION**

236 The aim of the current study was to evaluate the effectiveness of a six-week yoga training
237 programme on golf swing mechanics. Specifically, the study aimed to describe the changes, if
238 any, in the X-Factor and X-Factor stretch during the golf swings performed pre and post the
239 six-week yoga intervention. Furthermore, the current study aimed to investigate the changes,
240 if any, in pelvis and torso rotation and lead hand velocities during specific phases of the golf
241 swing following the yoga intervention. It was hypothesized that swing mechanics when
242 performing golf swings with the driver would improve following the yoga intervention due to
243 the increased ROM. Additionally, due to this hypothesized increased ROM, it was
244 hypothesized that lead hand velocity would increase throughout the latter phases of the golf
245 swing. As a result of the findings of this feasibility study, the hypotheses in relation to ROM
246 were partially accepted. Moreover, the hypotheses for lead hand velocity during the golf swing

247 were rejected. However, as discussed later in this section, these results have been rejected with
248 caution.

249

250 As previously discussed, scientific literature often describes the separation between the pelvis
251 and torso at the top of the backswing as the X-Factor (Mclean & Andrisani, 1996). Whereas
252 the X-Factor stretch refers to the separation of the pelvis and torso during the initial stages of
253 the downswing (Mclean & Andrisani, 1996). From a biomechanics perspective, the correct
254 pelvic and torso rotation throughout the golf swing is essential for maximising club head speed
255 which, in turn, improves driving performance (Joyce, 2016). It has been previously reported
256 that as the skill level of the golfer increases (lower handicap), pelvis rotation reduces at the top
257 of the backswing and then increases during the downswing and impact phases (Myers et al.,
258 2008). These researchers also reported that upper torso rotation during the four phases of the
259 golf swing were similar when comparing skill level. Although the upper torso levels were
260 similar between the different levels, the reduction in pelvic rotation resulted in greater upper
261 torso-pelvic separation (Myers et al., 2008). It has been previously reported that the separation
262 of the torso and pelvis requires a good level of flexibility and ROM, and is often attributed to
263 lower handicap golfers (Lephart et al., 2007).

264

265 The current study reported that several of the ROM measurements throughout the swing
266 significantly increased following the six-week yoga intervention. Specifically, the X-Factor at
267 the top of the backswing significantly increased ($P \leq 0.05$) and a medium effect ($d \geq 0.50$) was
268 observed when comparing the yoga intervention group and control group. As a result of a
269 qualitative analysis, these results are very likely to be clinically meaningful, which suggests
270 that the yoga intervention had a positive effect on the X-Factor. A similar medium effect ($d \geq$
271 0.50) was observed within the X-Factor stretch, however no statistical significance ($P \geq 0.05$)

272 was observed between groups. As a result of a qualitative analysis, these results are very
273 unlikely to be clinically meaningful which suggests that the yoga intervention had no effect on
274 the X-Factor stretch. In relation to pelvis rotation, statistical significance ($P \leq 0.05$) was
275 displayed at all phases of the golf swing with the exception of the impact of the ball ($P \geq 0.05$).
276 During the phases that were significant between groups, medium ($d \geq 0.50$) and large ($d \geq 0.80$)
277 interactions were also displayed. These results in relation to the findings are either very likely
278 or likely to be clinically meaningful (Table 1). For the torso rotation, no significant differences
279 were observed at any phases of the golf swing when comparing groups ($P \geq 0.05$). As a result
280 of the effect size measurements and qualitative analysis (Table 1), it was deemed that the six-
281 week yoga intervention is unlikely to influence torso rotation during the golf swing. These
282 findings enabled the experimental hypothesis in relation to ROM to be partially accepted.
283 Finally, no significant difference ($P \geq 0.05$) was observed in lead hand velocity at any phases
284 of the golf swing, however, a medium effect ($d \geq 0.50$) was found at impact. As a result of
285 these findings, in relation to lead hand velocity the second experimental hypothesis was
286 rejected. However, this rejection is reported with caution due to the varying qualitative results
287 (Table 1). These inconsistencies may be due to the small sample size used within this feasibility
288 study.

289

290 The current findings in relation to the X-Factor at the top of the backswing and torso-pelvis
291 separation are in agreement with previous research that has investigated flexibility and ROM
292 interventions (Amin & Goodman, 2014; Lephart et al., 2007). Specific to golf, Lephart et al.,
293 (2007) reported a 6.8% increase ($49.8^\circ \pm 7.6$ vs. $53.5^\circ \pm 5.6$) in the X-Factor following an
294 eight-week stretching programme which is similar to the 9.72% increase ($51.9^\circ \pm 8.7$ vs. 57.2
295 $^\circ \pm 5.9$) observed in the current study. This increase in X-Factor displayed within the current
296 study and the study by Lephart and colleagues is positive in relation to golf performance. It has

297 been previously reported that an increase in X-Factor is correlated with skill level (Myers et
298 al., 2008) and ball velocity (Chu et al., 2010). In relation to the pelvis rotation at the top of the
299 backswing, Lephart et al., (2007) reported a 13.4% reduction ($-56.1^{\circ} \pm 10.8$ vs. $-49.4^{\circ} \pm 6.8$)
300 in pelvic rotation following the intervention. The current study reported a 7.7% reduction ($-$
301 $56.4^{\circ} \pm 10.6$ vs. $-52.4^{\circ} \pm 9.9$) following the yoga intervention. In relation to golf performance,
302 it has been reported that golfers that displayed reduced pelvis rotation at the top of the
303 backswing also displayed greater carry distance (Lephart et al., 2007), ball velocity (Lephart et
304 al., 2007; Myers et al., 2008) and club head velocity (Lephart et al., 2007). Subsequently, as
305 the golf swing progresses to the downswing and impact phases, pelvis rotation increases when
306 examining golfers with a greater ball velocity (Myers et al., 2008). These results are similar to
307 the current study, where pelvic rotation increased during the downswing, pre-impact and
308 impact phases of the golf swing following the six-week yoga intervention. Although the current
309 study did not measure performance variables in relation to the golf club or golf ball, lead hand
310 velocity was measured. Following the yoga intervention, lead hand velocity increased during
311 the acceleration phase (6.9%), pre-impact phase (10.2%) and impact phase (5.9%). Although
312 these increases appear to be positive in relation to golf performance, no significant changes
313 were observed following the yoga intervention. However, as a result of the qualitative analysis,
314 the lead arm results at the acceleration phase and pre-impact phase are likely to be clinically
315 meaningful. These inconsistencies within the results of the current study and with the literature
316 could also be due to the low sample size within the current study.

317

318 In relation to the torso rotation at the top of the backswing, Lephart et al., (2007) reported a
319 3.8% reduction ($-106.4^{\circ} \pm 9.5$ vs. $-102.6^{\circ} \pm 8.1$), however, these changes were not significant.
320 Similar to these results, the current study reported no significant changes and only small
321 interactions were observed following the six-week yoga intervention ($-108.34^{\circ} \pm 15.4$ vs. -

322 108.57 ° ± 10.5). Although the torso rotation at the top of the backswing was not affected
323 following the six-week yoga intervention, the decrease in pelvis rotation was greater than the
324 change in torso rotation, which significantly increased the X-factor. Therefore, these findings
325 suggest that a more stable torso will enable a greater torso-pelvic separation, resulting in
326 improved swing mechanics (Lephart et al., 2007; Myers et al., 2008). These findings during
327 the backswing were also consistent for the downswing, pre-impact and impact phases of the
328 golf swing (Table 1).

329

330 Although there are no previous scientific studies that have investigated the effect of yoga on
331 golf swing mechanics, previous research has investigated the effect of yoga to increase ROM
332 and flexibility. Amin & Goodman, (2014) reported that flexibility significantly improved
333 following a six-week yoga intervention. Specifically, these researchers reported significant
334 increases in the sit and reach test (29.50 cm ± 7.08 vs. 30.87 cm ± 7.01) following a 6-week
335 yoga programme. Although this study did not measure specific movements that are relevant to
336 the golf swing, the two studies show that performing yoga over a six-week period can be an
337 effective method to increase ROM and, therefore, can be a useful method when aiming to
338 increase ROM during the golf swing.

339

340 Due to the positive findings in relation to yoga and golf movement mechanics within this
341 feasibility study, a full-scale trial is warranted. Therefore, as a result of the small sample size
342 within this feasibility study, the current findings must be interpreted with caution as they may
343 not be generalizable to a larger population. Furthermore, only low handicap golfers were tested
344 in this feasibility study, therefore, the result may only be valid for this population. Although
345 this skill level may be viewed as a limitation, technique variations within higher skilled golfers
346 is reduced, which can be more beneficial when testing with a smaller sample size. As the

347 current study was feasibility of the effect of yoga on golf swing mechanics, future studies
348 should incorporate a larger sample size, include females within the sample and also include a
349 greater variation of golfers. Furthermore, no performance variables in relation to the golf driver
350 or the golf ball were measured during the testing of this study, only hand velocities were
351 measured. Future studies examining the effect of a yoga intervention on golf performance
352 should investigate performance variables such as club head speed, ball speed and carry distance
353 in order to truly reflect performance.

354

355 **CONCLUSION**

356 The results of this feasibility study indicate that yoga may be a promising intervention in order
357 to improve golf swing mechanics, with the aim of improving long game performance.
358 Specifically, yoga training improves torso-pelvic separation which, in turn, can improve long
359 game performance in golf. This feasibility study can inform future research designs and full-
360 scale studies where researchers want to measure the effect of yoga on golf swing mechanics
361 and golf performance variables. From the current findings, applied practitioners may wish to
362 explore yoga as a training method in order to improve golf movement patterns, however, future
363 research is required to confirm the effect of the use of yoga within the game of golf, with the
364 aim of improving golf swing mechanics and golf performance variables.

365

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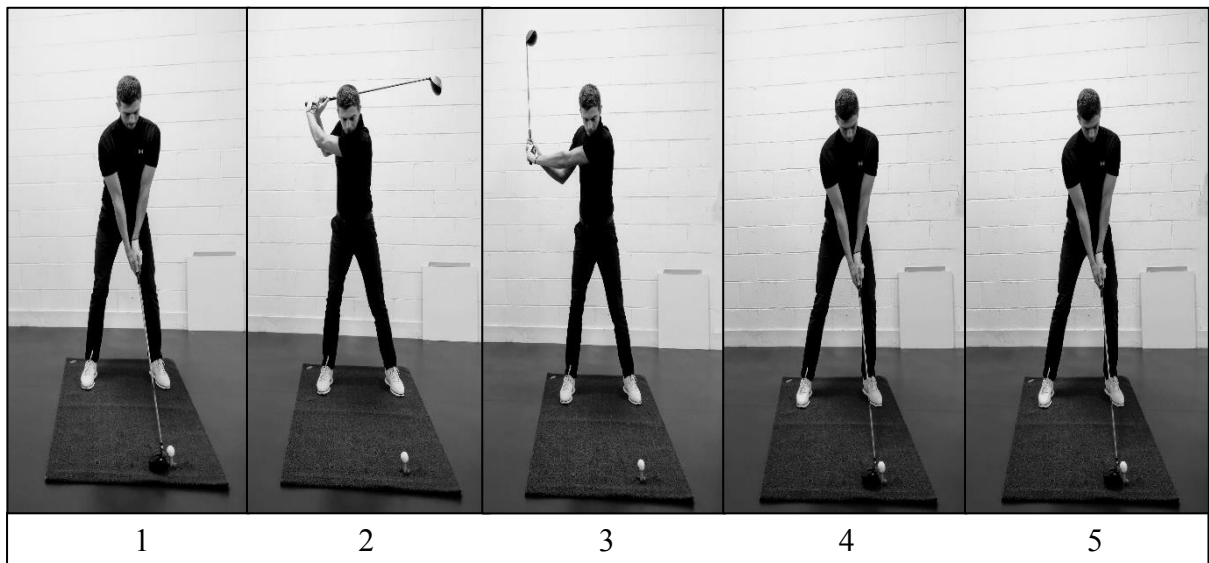


Figure 1: Silhouette description of the phases of the golf swing. 1 – Set-up position, 2 – Top of the backswing, 3 – Lead arm parallel to the ground during the downswing, 4 – Pre-impact (the point at the last 40 ms before impact), 5 – Impact of the golf ball.

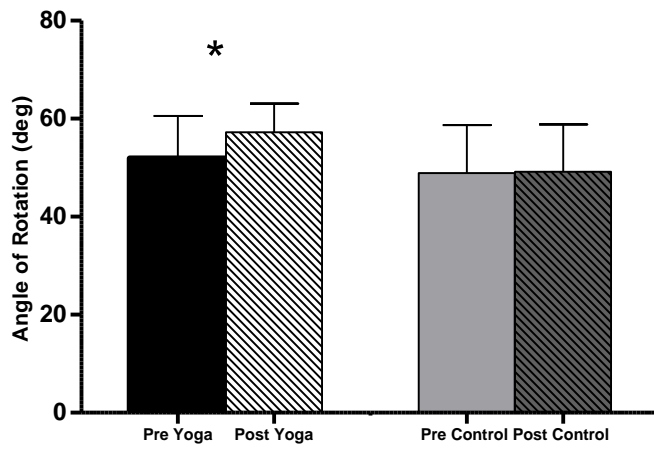


Figure 2: X-Factor at the top of the backswing for the yoga intervention group and the control group. Note: Statistical significance is shown with * ($P \leq 0.05$).

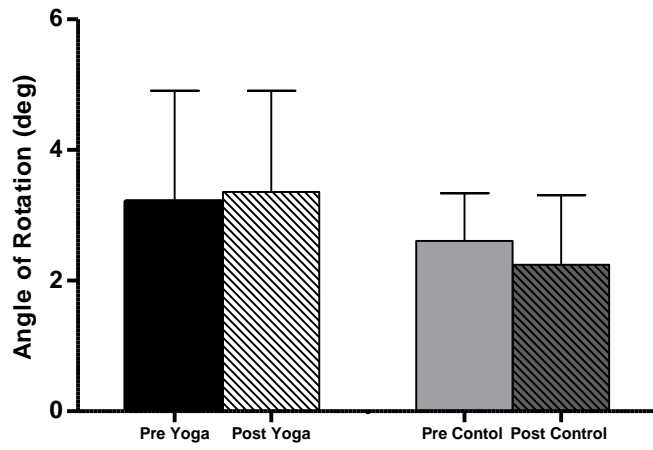


Figure 3: X-Factor stretch for the yoga intervention group and the control group.

Table 1: The means, standard deviations, group statistical differences, and group effect sizes for swing mechanics

Swing Mechanics	Pre Yoga	Post Yoga	Pre Control	Post Control	<i>P</i>	<i>d</i>	Qualitative
Pelvis Rotation at Top of Swing (°)	-56.42 ± 10.64	-52.39 ± 9.92	-49.69 ± 11.36	-48.73 ± 10.89	0.01*	<u>0.29</u>	89%
Pelvis Rotation at Parallel (°)	5.79 ± 2.15	8.07 ± 3.27	1.66 ± 5.32	2.06 ± 4.92	0.04*	<u>0.42</u>	89%
Pelvis Rotation at Pre-Impact (°)	23.90 ± 5.07	26.91 ± 5.05	22.90 ± 3.73	23.16 ± 3.82	0.04*	<i>0.69</i>	95%
Pelvis Rotation at Impact (°)	33.56 ± 3.20	36.57 ± 4.46	32.57 ± 5.49	32.28 ± 6.54	0.09	0.86	92%
Torso Rotation at Top of Swing (°)	-108.34 ± 15.40	-108.57 ± 10.45	-98.55 ± 11.68	-97.87 ± 10.78	0.76	0.06	12%
Torso Rotation at Parallel (°)	-32.00 ± 8.47	-29.03 ± 10.87	-33.55 ± 12.21	-32.83 ± 12.05	0.15	<u>0.25</u>	<u>63%</u>
Torso Rotation at Pre-Impact (°)	-10.28 ± 4.83	-8.04 ± 4.70	-6.19 ± 10.89	-5.28 ± 11.46	0.26	0.19	47%
Torso Rotation at Impact (°)	4.82 ± 3.39	6.46 ± 2.40	4.65 ± 7.80	4.67 ± 8.87	0.11	<u>0.36</u>	79%
Hand Velocity at Parallel (m.s ⁻¹)	30.62 ± 3.58	32.90 ± 3.58	28.29 ± 6.04	28.61 ± 6.31	0.18	<u>0.44</u>	79%
Hand Velocity at Pre-Impact (m.s ⁻¹)	27.17 ± 2.77	30.27 ± 1.76	24.61 ± 5.67	25.05 ± 5.78	0.17	<u>0.62</u>	84%
Hand Velocity at Impact (m.s ⁻¹)	22.96 ± 2.50	24.39 ± 2.51	20.27 ± 4.78	20.59 ± 4.42	0.33	<u>0.26</u>	59%

Note: Statistical significance is shown with * ($P \leq 0.05$). Large effect ($d > 0.80$) between groups are shown in **bold** font. Medium effect ($d > 0.50$) between groups are shown in *italic* font. Small effect ($d > 0.20$) between groups are shown in underlined font. Qualitative chance: Very likely displayed in **bold** font. Likely displayed in *italic* font. Possibly displayed in underlined font. Parallel - lead arm parallel to the ground.