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1 ATTACKING AGILITY ACTIONS: MATCH PLAY CONTEXTUAL 2 APPLICATIONS WITH COACHING AND **TECHNIQUE GUIDELINES**

3 **Abstract**

4 Attacking agility actions, such as side-steps, shuffle steps, crossover cutting, split-steps,
5 spins, decelerations, and sharp turns, are important maneuver in invasion team-sports, often
6 linked with decisive match winning moments. Generally, the aims of these actions are to 1)
7 evade and create separation from an opponent; 2) generate high exit velocities and
8 momentums; or 3) facilitate a sharp redirection. However, these actions are also inciting
9 movements associated with lower-limb injury. Given the importance of agility actions for
10 sports performance and potential injury risk, in this review we discuss the importance and
11 contextual applications of attacking agility actions, while providing coaching and **technique**
12 guidelines to best optimize the performance-injury risk conflict.

13 **Key words:** change of direction; cutting; deceleration; turning; evasion; injury mitigation

14 **Introduction**

15 Attacking or offensive agility actions, in the context of invasion team-sports (i.e., court and
16 field-based sports with the objective to score goals / points), can be defined as “distinct,
17 sharp, change of directions (COD) or decelerations performed for attacking purposes (i.e.,
18 team in possession) while being actively defended by an opponent(s) (44). The overriding
19 aim of attacking agility actions are often to gain territorial advantage to allow penetration of
20 defensive lines and are often characterized by: 1) evasion, deception and space separation
21 from an opponent(s), 2) timing and attainment of high sprinting velocity/momentum for
22 collisions or various offensive plays (e.g., channeling, overlapping, driving, outruns); and 3)
23 sharp changes of direction or speed that require skillful manipulation of the performers base
24 of support [BOS] relative to center of mass [COM]) to attain rapid accelerations and
25 decelerations (16) (**Figure 1**). For example, a rugby winger may perform a rapid deceitful
26 side-step to evade and avoid being tackled by a defender (**Table 1, Figure 1**); in American
27 football a rapid deceleration might be performed by a tight end to create separation and space
28 from a defender to receive a pass from the quarterback (**Table 2, Figure 1**); or a soccer player
29 performing a v cut (large redirection) to draw a defender out from position, to allow a team-
30 mate to exploit the space (**Table 2, Figure 1**). While these attacking agility actions may be
31 performed in isolated scenarios (1 vs. 1 / 1. vs. 2), these **maneuvers** may also be performed in
32 tandem with other attacking players in-order to **destabilize** defensive **organization** and create

33 scoring opportunities (45, 83). Therefore, attacking agility actions are key movements
34 associated with decisive and match-winning moments in invasion team-sports (41, 44, 85,
35 100, 105), and can be considered highly important attributes to develop.

36 Agility, globally, can be defined as “a rapid, accurate whole-body movement with a
37 change of direction, velocity, or movement pattern in response to a stimulus” (64, 102).
38 **Whereas**, gamespeed has been defined as “the ability to exploit the qualities of speed and
39 agility within the context of a sport” (60). In the context of team-sport match play, the result
40 of any agility action involves a perception-action coupling (91) in response to dynamic,
41 constantly-changing scenarios that occur within the game (**Table 3**). For example, an
42 Australian Rules Football (ARF), a ball carrier when visually scanning before and during the
43 execution of an attacking agility action will process multiple stimuli, such as the team-mate
44 options, location of goal, position and location of defender(s), the kinematics and body
45 postures of the defender(s), and possible attacking spaces to penetrate. These actions will
46 vary depending on an individual’s technical and tactical role within their given sport, such as
47 the clear differences between a basketball center and point-guard with respect to the general
48 locations they occupy and their tactical roles in the sport. Therefore, athletes need to be able
49 to **recognize** and exploit game scenarios within their specific context to use effective
50 movement skills within their physical capabilities (61).

51 Ultimately, **optimizing** agility development will require a specific understanding of
52 the key tactical sequences (i.e., attacking transitions and routines) and movement
53 requirements that support a team’s playing style to effectively carry out their game plan in
54 match play (23). However, **coaches** tasked with physical preparation should seek to
55 effectively **characterize** the components of agility in order to assess, train and monitor their
56 athlete’s agility development. This approach may allow practitioners to reverse-engineer the
57 requirements of their sport and identify the underpinning **technique (i.e., the relative position
58 and orientation of body segments when performing a task effectively), mechanical (i.e.,
59 impulsive capabilities), physical (i.e., strength and speed capabilities) and perceptual-
60 cognitive (i.e., rapid and accurate decision making) factors** that contribute to **agility**
61 performance (24, 81). This information can then subsequently be used to inform training
62 interventions that target enhancement of agility performance. Although it is not disputed that
63 perceptual-cognitive factors are highly important for attacking agility performance (due to
64 perception-action coupling), developing an athlete’s **technique**, and mechanical abilities to
65 perform the action (i.e., movement skill) in a rapid, controllable, and efficient manner can be

66 considered integral factors for improving agility performance and mitigating injury risk in
67 invasion team-sports (Tables 1-3) (27, 33, 46, 47, 75, 81).

68 Agility and gamespeed can both be considered open-skills (i.e., affected by external
69 stimuli in the environment) (13), and are independent qualities to COD speed, which is
70 limited to pre-planned tasks (104). As mentioned previously, agility performance is
71 underpinned by the interaction of perceptual-cognitive, physical, **technique** and mechanical
72 factors. Crucially, these can all be viewed as qualities that can be trained in isolation or in
73 combination in order to **optimize** agility and gamespeed development (29, 46, 47, 75, 91). For
74 the purpose of this review, we will predominantly focus on “**technique**”, which can be
75 defined as “the relative position and orientation of body segments as they change during the
76 performance of a sport task to perform that task effectively” (7, 69). A plethora of different
77 attacking agility actions are performed in invasion team-sports (44, 85, 100, 105), including
78 side-step cuts, crossover cuts (XOC), split step cuts, shuffle step cuts, spin **maneuvers**, turns,
79 and decelerations (Figure 1). Definitions and descriptions of these actions are presented in
80 Tables 1-2 and Figure 1. In extreme circumstances, athletes may even jump and flip over
81 opponents to create separation and avoid tackles, with famous instances observed in
82 American Football; for example, Jerome Simpson scored a touch-down flipping over a
83 defender on 12/24/2011. However, we will focus our attention on the technique of high-
84 intensity locomotor activities that are commonly observed during match play in invasion
85 team-sports. Importantly, the various attacking agility actions demonstrate kinetic and
86 kinematic differences, and thus, have distinct implications for both agility performance and
87 injury risk (33, 43, 53). These have been summarized in Tables 1-2 and Figure 1 based on
88 previous literature (25, 29, 33, 34, 36, 43, 75).

89 Of concern, high-intensity agility actions such as rapid directional changes and
90 decelerations are inciting movements associated with non-contact lower-limb injury (42, 62,
91 67, 68, 79, 90, 97), such as anterior cruciate ligament (ACL), medial and lateral ankle sprains,
92 groin, and hamstring strain injuries. These events typically involve the ball / implement
93 carrier with opposition players in close proximity and externally directed attention, evoking
94 high cognitive loading (42, 62, 67, 68, 79, 90, 97). For example, a handball player focusing
95 on defender(s) and goalkeeper’s movements while performing a feint and side-step cutting
96 maneuver to create separation to perform a shot. These agility actions have the potential to
97 generate high mechanical loads which, if exceed the tissue’s ultimate tensile strength
98 capacity, can cause tissue (mechanical) failure and subsequent injury (3, 25, 39, 66).

99 Mechanical loads can be further amplified when 1) movement quality (i.e., poor technique),
100 neuromuscular control and biomechanical deficits are displayed and 2) during unplanned,
101 externally directed / divided attention tasks where reduced preparatory times are evident
102 compared to pre-planned tasks (1, 12, 59). Importantly, however, from an injury-risk
103 mitigation perspective and maintenance of agility performance, it is well-established that
104 these injury risk factors are modifiable through carefully designed, targeted training
105 interventions (14, 25, 56, 82, 98). Consequently, understanding the techniques and mechanics
106 of attacking agility actions that can **optimize** performance while mitigating injury risk is of
107 great interest to practitioners working in invasion team-sports (**Tables 1-3**).

108 The purpose of this article, therefore, is two-fold: 1) to discuss the importance and
109 contextual applications of the attacking agility actions for the invasion team-sport athlete; and
110 2) to provide technique and coaching guidelines for attacking agility actions that optimize
111 performance and mitigate potential injury risk. A comprehensive overview of the
112 descriptions, advantages, applications, coaching and **technique** guidelines, and injury risk and
113 biomechanical considerations will be provided. This article will focus only on attacking
114 agility actions in the context of invasion multidirectional team-sports (i.e., football codes, ball
115 / implement carrying sports), whereby the sport's objective is to score points or goals in a
116 pre-defined location, often by gaining territorial advantage, penetrating defensive lines, and
117 evading opponents. This article should assist sports coaches, sports scientists, strength and
118 conditioning (S&C) coaches, and sports medicine staff from all levels who are involved in
119 field-based conditioning and who seek to develop their athlete's attacking agility **within a**
120 **multifaceted training program**.

121 ***Insert Figure 1 here***

122 ***Insert Table 1 here***

123 ***Insert Table 2 here**

124 **Attacking agility actions: importance and contextual applications**

125 A variety of agility actions are performed in invasion team-sports to accomplish the key aims
126 of attacking agility (44, 85, 100, 105) (**Tables 1-2, Figure 1**). Side-steps are the most
127 frequently occurring attacking agility action in netball (44), and in 1 vs. 1 scenarios (74%) in
128 **ARF** (85), while also linked to tackle break success (i.e., penetrating defensive lines) (65.8-
129 73.1%) in rugby union (100, 105). Shuffle and split steps, although not as frequently

130 performed as side-steps in netball (and most likely other sports) (44), are an effective
131 deceptive and evasive agility action, with greater decision errors made by defenders in
132 response to these actions compared to side-steps (9, 18, 33). However, practitioners and
133 athletes must be cognizant of the greater preparation times and subsequently smaller exit
134 velocities when performing split and shuffle steps (9) compared to side-steps, and consider
135 the trade-off between velocity and deception (33, 34). Thus, when travelling at moderate to
136 high approach velocities, a side-step may be more advantageous due to the importance of
137 velocity maintenance and shorter preparation times (33). Conversely, split and shuffles steps
138 may be more suitable for scenarios at low to moderate approach velocities and isolated 1 vs.
139 1 scenarios where longer preparation time is afforded and when greater deception and feint
140 **maneuvers** are needed. The velocity-angle trade-off would also infer that approaching at
141 lower velocities will make it easier to perform an evasive and sharper directional change to
142 create separation and increase tackle evasion success (i.e., tackled from an opponent(s)) (33).

143 Attacking agility XOCs are not as frequently performed as side-step agility actions in
144 sports such as rugby union (100, 105) or ARF (85), nor are they as effective as side-steps
145 with respect to tackle-break success (3.4-7.7% vs. 65.8-73.1%) (105). This is unsurprising, as
146 XOCs would not be considered a deceptive **maneuver** due to limited head and trunk feinting
147 movements. Additionally, medial foot plant across the midline seen during XOCs is not
148 considered a deceptive “false step”, nor conducive for creating perpendicular force to redirect
149 the COM sharply to create separation from an opponent(s) (33, 34). Conversely, the XOC is
150 critical when a subtle COD and redirection is needed, with the aim to maintain velocity. Such
151 actions are critical when channeling, overlapping and driving runs are deployed to 1) get into
152 space to receive a pass, 2) create high horizontal momentum to break through tackles or lines
153 in collision sports, 3) force opposition defenders to change position during diversion and
154 decoy runs, or 4) perform a slight deviation in path where a curvilinear / curved sprint
155 enables attainment or maintenance of high velocities (8, 15, 33, 34). However, because of the
156 multistep nature of directional changes (33), a XOC is commonly performed following the
157 main execution lateral step (i.e., side-step, shuffle, split steps – **Figure 1**) to help facilitate the
158 redirection (21, 33, 34), and as such, is a highly important action to develop in invasion team-
159 sport athletes.

160 An insufficiently researched but important agility action is the spin **maneuver**. To our
161 best knowledge, Fox et al. (44) and Rayner (85) are the only researchers to quantify this
162 action in netball and ARF, respectively, **observing the occurrence of the spin maneuver to be**

163 the least compared to other attacking agility actions. Nevertheless, further research is needed
164 to quantify spinning agility actions in other sports as they are often observed to be effective in
165 maneuvering successfully through crowded spaces. For example, ball carriers in rugby codes,
166 American football and basketball, typically aim to protect the ball on the 'blind side' by
167 turning away from the defender, and successfully evade tackles and blocks by making
168 themselves a smaller target. Practitioners must not directly assume and associate frequency
169 with importance, and thus developing an athlete's agility literacy (e.g., movement solutions)
170 will provide them with a greater arsenal of deceptive actions to perform within the contextual
171 demands of the sport, making themselves more difficult to anticipate and less predictable to
172 the opponent (33, 75).

173 An undervalued and underreported attacking agility action are decelerations, which
174 can have critical roles in creating space separation from a defender (52, 53). This is
175 exemplified by the much higher rates of change in velocity that are possible during
176 decelerations compared to accelerations, making it possible for invasion team-sport players to
177 change speed and direction in very short time frames and distances (52, 54). Figure 2
178 illustrates an offensive American Footballer who performs a high-intensity deceleration to
179 avoid an opponent's tackle from the side, before changing direction and reaccelerating to
180 maintain forward translation and territorial advantage. In this example, the space to attack the
181 opponent on the inside whilst also avoiding the tackle would not be possible or as effective in
182 players with a lower deceleration capacity. As such, a higher deceleration ability is central to
183 reducing horizontal momentum and facilitating sharp angled directional changes $\geq 60^\circ$ (28,
184 34, 36).

185 To our best knowledge, Rayner (85) is the only researcher to quantify and
186 contextualize decelerations as an attacking agility action, observing an ~8% frequency in
187 ARF. Bloomfield et al. (6) reported that soccer players performed on average 9.3
188 decelerations per 15 minutes, with ~72% and ~96% lasting less than 1 and 2 seconds,
189 respectively. Interestingly, Bloomfield (6) characterized the locomotor activities prior to and
190 preceding the decelerations, reporting that soccer players perform decelerations from a
191 variety of sprint velocities, and perform skips, shuffles, runs, and sprints following the
192 decelerations across a spectrum of velocities. Moreover, a recent meta-analysis has
193 highlighted that more intense decelerations occur more frequently than accelerations across a
194 plethora of multidirectional sports (soccer, rugby codes, ARF, field-hockey) (52). CODs of
195 90-180° are frequently observed in ARF (85), netball (95), soccer (5, 86), and ultimate

196 frisbee (92), whereby deceleration plays a fundamental role in facilitating the sharper
197 directional change (28, 34, 36).

198 In addition to invasion team sports that involve an offside rule where the defender(s)
199 is generally positioned in front of the attacker (i.e., rugby codes), attacking agility maneuvers
200 that involve directional changes $\geq 90^\circ$ are an important quality to develop in ball carrying
201 sports where the ball can be passed in any direction 360° (generally with no offside
202 restrictions excluding soccer) such as ARF (85), netball (95), soccer (5, 86), basketball, and
203 ultimate frisbee (92). It is therefore imperative that athletes have the capacity to decelerate
204 and turn effectively $\geq 90^\circ$ due to the 360° directional change requirements in most invasion
205 team-sports (34, 75). For example, in ARF, ~50% of the attacking agility events occurred
206 with the defender at the side or behind the attacker (85). This can have important implications
207 for attacking agility drill design. For example, it would be advantageous to increase the
208 variation and contextual interference by altering the starting position(s) of the defender(s) to
209 better reflect the multidirectional movement demands of invasion team-sports (85). In order
210 to improve our understanding of the agility and contextual demands of invasion team-sports,
211 and to better inform our training and testing of agility, further research is necessary which
212 comprehensively quantifies and classifies the attacking agility actions in line with movement
213 classifications presented in this review.

214 ***Insert Figure 2 here***

215 **Agility *technique* considerations: practical applications**

216 Attacking agility actions are key movements associated with decisive and match winning
217 moments in invasion team-sports (Figure 2, Table 3) (41, 44, 85, 100, 105). Agility
218 movements are skills, and have *technique*, biomechanical, and physical determinants (75).
219 **Therefore**, it is central that they are trained and developed as part of multifaceted agility
220 training framework **by developing** athletes' perceptual-cognitive abilities, technique and
221 mechanics, and physical capacities (33, 75, 81). While S&C coaches are primarily
222 responsible for the physical preparation and development of athletes (24), an integrated
223 approach across the multidisciplinary department to agility development is needed. For
224 example, where possible, S&C practitioners are encouraged to work with the skills coaches,
225 biomechanists, sports medicine staff, and motor control / skill acquisition experts in a
226 collaborative approach to most optimally design and **program** agility training methods.
227 Accordingly, practitioners should design representative learning environments that facilitate

228 effective transfer of physical capacity gains to on-field agility performances. For example, for
229 practitioners who are limited with time for S&C and isolated agility training, one possible
230 solution is to integrate agility drills into **technique** / tactical training sessions, or working
231 collaboratively with the skills coach to help design sports-specific attacking agility drills and
232 scenarios to promote agility, sports technique, and tactical development (77, 103). One such
233 example is advising and designing small-sided games and attacking versus defending
234 scenarios to provide the representative environments and constraints for agility development
235 (77, 103). Additionally, integrating agility drills into warm-ups prior to **technique** or tactical
236 skills training is also another opportunity to provide an agility stimulus, develop movement
237 solutions, and modify athletes' technique (33) **in line with the guidelines presented in Tables**
238 **1-3**. However, it is beyond the scope of this article to discuss agility **programing** and drill
239 design, and thus, practitioners are encouraged to read the following literature for further
240 information (24, 33, 77, 80, 81, 103).

241 The majority of attacking agility actions covered in this review involve a COD which
242 is defined as a "reorientation and change in the path of travel of the whole-body COM
243 towards a new intended direction" (20, 101) and often involves a break in cyclical running
244 (75) (**Figure 1**). However, it is not disputed that accelerations, curvilinear sprints, and
245 decelerations can in their own right be agility actions (**Figure 2**). Nonetheless, as agility COD
246 technique is imperative for facilitating effective braking and propulsive impulse to move and
247 redirect the COM laterally or horizontally for velocity maintenance, separation, or sharp
248 redirections (33, 75), it is central to understand the mechanics and techniques which **optimize**
249 COD agility performance (**Tables 1-2**). Agility actions that include a COD (**Figure 1**),
250 generally, can be divided into four phases (33, 75) (**Table 3**):

- 251 1. Initiation: Linear / Curvilinear / Lateral motion
- 252 2. Preparation: Preliminary deceleration / preparatory postural adjustments
- 253 3. Execution: Main COD plant phase
- 254 4. Follow-through: Reacceleration

255 These four phases of COD will be influenced by the approach speed / velocity,
256 athlete's physical capacity, COD angle, and the contextual and agility demands of the sport-
257 specific scenario, with the biomechanical demands of directional changes angle- and
258 velocity-dependent (33, 34, 75). For example, as intended COD angle increases, GCT during
259 the main execution foot contact progressively increases to facilitate greater impulse (braking

260 and propulsion) and COM deflection, while horizontal momentum must reduce in order to
261 facilitate the directional change (34). Therefore, the deceleration requirements must increase
262 (i.e., braking impulse), and thus deceleration mechanics play a critical role in facilitating
263 sharp agility actions (34, 36, 75) (Table 2). Despite this, there is currently no research to our
264 knowledge that has investigated how improving deceleration ability (i.e., the physical and
265 technique components) could facilitate superior agility performance, and thus, is a
266 recommended avenue for further research.

267 While approach velocity is a critical determinant of subsequent exit velocity during
268 COD tasks (33, 34, 37, 49), practitioners and athletes should be conscious of the speed-
269 accuracy trade-off, whereby greater approach speeds will make it more challenging to slow
270 down and re-direct the COM sharply (34). This is pertinent whereby attackers must evade
271 and create separation from an opponent(s) and re-directing the COM at a greater angle will be
272 critical to avoid being tackled / blocked. Finally, these agility actions are typically performed
273 over multiple steps, with the foot contacts preceding the main execution foot contact, such as
274 the penultimate foot contact (PFC) (and potentially steps prior) playing a critical role in
275 braking or preparing the main execution foot contact for effective weight acceptance and
276 push-off (28, 33, 36, 87) (Tables 1-3). Additionally, because of the angle-velocity trade-off,
277 full redirection and deflection of the COM cannot be achieved during the main execution step
278 (19, 34), thus the following foot contact(s) are subsequently involved in redirection (21, 34,
279 87) as illustrated in Figure 1 and Table 3. As such, multiple steps are necessary to facilitate
280 rapid decelerations, redirections, deceptive / feinting maneuvers, and reacceleration, and thus
281 agility actions should be coached as a multistep strategy (Figure 1, Tables 1-3).

282 It is worth noting that while it will indeed be advantageous for athletes to be able to
283 perform a plethora of different attacking agility actions (Figure 1), their ability to perform
284 particular agility actions may be limited and constrained by their physical capacity (22, 63,
285 65, 94, 96), and the athlete's awareness of their own physical limitations (i.e., so called
286 'affordances' for action) could influence the attacking agility actions they decide to perform
287 in sport. Thus, while developing technique and movement literacy is integral for attacking
288 agility development, practitioners are encouraged not to neglect their athlete's physical
289 capacity when modifying attacking agility technique. It is important that a multifactorial and
290 holistic approach to the evaluation (i.e., needs analysis, qualitative and quantitative analysis
291 of COD and agility, strength and power diagnostics) (33, 64, 81) and development
292 (multicomponent model which targets physical capacities and impulsive qualities through a

293 variety of training modalities, technique development, speed and deceleration, perceptual-
294 cognitive factors) (33, 75, 77, 81) of attacking agility is adopted which is **periodized and**
295 sequenced accordingly (33, 34, 77). Readers are encouraged to read the following articles for
296 further guidance on this (33, 64, 75, 77, 81).

297 **Agility “performance-injury risk” conflict: practical applications**

298 While linked to decisive moments in multidirectional invasion sports, agility actions,
299 particularly those which involve lateral foot plants, are injury inciting events associated with
300 non-contact lower limb injuries such as ACL (17, 62, 68, 79), hamstring strain, medial and
301 lateral ankle sprains (42, 97), and groin injuries (90), particularly in cutting dominant sports.
302 Injuries to tissues occur **because of** a mechanical load which exceeds the tissues’ tolerance
303 capacity (39, 66, 78). When performing agility actions, potentially very high mechanical
304 loads (25, 38, 43, 66), particularly knee joint loads, can be generated which are amplified
305 when certain **techniques** are displayed (25, 43), in conjunction with suboptimal movement
306 quality and neuromuscular control (i.e., high-risk deficits), high approach velocities and
307 sharper directional changes, and externally directed attention with high cognitive loading (12,
308 25, 27, 29, 31, 38, 43). As maximizing athletic performance which transfers to the pitch or
309 court is imperative, mitigating injury risk and maximizing player availability (i.e., being able
310 to field strongest line-up over the season) is also important for sports success, reducing
311 negative financial implications, and promoting athlete welfare (40, 57, 82). Although injuries
312 are a complex interaction of internal and external factors (4), movement quality and
313 neuromuscular control and biomechanical deficits are modifiable risk factors (14, 56, 82,
314 98), and thus, understanding the optimal agility techniques to **maximize** performance while
315 mitigating injury risk is of great interest to practitioners.

316 With respect to cutting agility actions, a “performance-injury risk” conflict is present
317 (25, 29, 37, 43, 55, 76, 88), whereby specific mechanical and **techniques** associated with
318 superior exit velocities, deflections / redirections of COM, and deceptive movements are at
319 odds with safer performance (i.e., reduced mechanical loads), such as wide lateral foot plants,
320 reducing knee flexion and hip flexion, high impact ground reaction forces, and lateral trunk
321 flexion and rotation (from a deception perspective). As athletes are driven by performance,
322 athletes are less likely to adopt safer strategies at the expense of faster performance (37, 43,
323 55), which is problematic, as the aim of S&C **is** to improve athletic performance and mitigate
324 injury risk (24, 37, 81). Subsequently, four viable strategies are available to mediate the

325 potential “performance-injury risk” conflict during agility maneuvers: 1) reducing “high-risk”
326 postures that offer no associated performance benefits (e.g., reducing knee valgus through
327 resistance, neuromuscular control, jump-landing training) and improving preparatory postural
328 adjustments (e.g. PFC braking and placement via technique modification training and
329 eccentric strength training) (29, 37) (Table 1-3); 2) building physical capacity (rapid force
330 production, muscle activation, neuromuscular control) and tissue robustness to tolerate and
331 support the potentially large mechanical loads (e.g., multicomponent training program which
332 integrates resistance, plyometric, balance and dynamic trunk stabilization training) (14, 26,
333 35, 37, 71-73, 82); 3) development of athletes perceptual-cognitive abilities and capacity to
334 tolerate high cognitive loads (i.e., developing players situational awareness, visual scanning,
335 anticipatory skills, and decision making ability and speed via agility training and feedback
336 and video training) (48, 59); and 4) monitoring and periodization of high impact and high
337 mechanically loading tasks that helps to mediate the physiological responses associated with
338 these sporting environmental challenges (e.g., use of player tracking and / or wearable
339 devices to monitor frequency and intensity of metrics such as of decelerations, accelerations
340 and directional changes) (39, 66, 70).

341 **Agility technique models and movement principles: practical applications**

342 A “one size fits all” approach is unlikely to exist for optimal agility actions, and the optimal
343 techniques are likely to be dependent on the intended movement, angle of directional change
344 (if applicable), entry velocity, athlete physical capacity, sporting scenario and contextual
345 demands (33, 34, 75, 81, 85). Movement variability (increased unpredictability and multi-
346 dimensionality) and a dynamic coordinative approach may provide an athlete with greater
347 flexibility and adaptability to environmental constraints and perturbations, potentially
348 resulting in a greater capacity for task execution (50, 84). Furthermore, although an optimal
349 zone of movement variability will likely exist (inverted u – “goldilocks effect”) (50, 56), in
350 the context of injury risk mitigation, movement and coordinative variability may enable a
351 more variable distribution of loading and stresses across the different joints and tissues,
352 potentially reducing the cumulative loading on internal structures (2, 50, 51). Creating
353 athletes who possess adaptable movement strategies and multiple movement solutions to
354 solve the problems they encounter during the unpredictable and chaotic nature of
355 multidirectional invasion sports will therefore be imperative from both performance and
356 injury risk mitigation perspectives (33, 75). As such, the underlying agility philosophy is to
357 create fast, robust, effective 360° athletes who are equally proficient at changing direction

358 rapidly and controllably from both left and right limbs, across a range of velocities (low,
359 moderate, and high velocities), with an arsenal of movement solutions (well-developed
360 agility movement literacy) to perform a variety of agility actions within the contextual
361 demands of the sport (Figure 1) (75).

362 A perfect agility **technique** model is unlikely to exist, as agility techniques will differ
363 across individuals of different anthropometrics, physical capacity, perceptual-cognitive
364 ability, skill level, and training history (33, 81). However, it cannot be disputed that there are
365 key fundamental **technique** characteristics and biomechanical movement principles (Table 1-
366 3), which are optimal and necessary to facilitate rapid, controllable, and effective attacking
367 agility actions which should be adhered to when coaching agility movements (Table 3).
368 Readers are encouraged to read the following articles for further information on the
369 **programming** and training methods for agility enhancement (33, 75, 77, 81).

370 ***Insert Table 3 here***

371 **Conclusion**

372 In this article we have provided a comprehensive overview of the various attacking agility
373 actions and practitioners should acknowledge the advantages, disadvantages, contextual
374 applications, and biomechanical considerations when coaching these techniques (Figure 1,
375 Tables 1-3). Invasion team-sports are unpredictable and chaotic in nature, typically
376 demanding athletes to continuously scan and process multiple stimuli (team-mates,
377 ball/implement, defenders etc.). Because of this unpredictability, invasion team-sport athletes
378 require the ability to perform attacking agility actions within a 360° turning circle from both
379 limbs. Therefore, it is integral to that practitioners develop athletes who possess adaptable
380 movement strategies and multiple movement solutions to solve the problems they encounter
381 (33, 75). Practitioners are therefore encouraged to follow the provided coaching and
382 **technique** guidelines to develop their athletes attacking agility technique to best mediate the
383 performance-injury risk conflict (Tables 1-3). This can be simply integrated into warm-ups,
384 or most likely beneficially incorporated into technical-tactical drills, working in combination
385 with skills coach to increase sport-specificity, increase athlete / coach “buy-in” and
386 adherence, and mitigate injury risk (30, 33, 36, 77).

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