

# Tackle mechanisms and match characteristics in women's elite football tournaments

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**Background:** Several tools have been used for assessing risk situations and for gathering tackle information from international football matches for men but not for women.

**Purpose:** To analyse activities in women's football and to identify the characteristics and risk potentials of tackles.

**Study design:** Retrospective video analysis.

**Method:** Video recordings of 24 representative matches from six women's top-level tournaments were analysed for tackle parameters and their risk potential.

**Results:** 3531 tackles were recorded. Tackles in which the tackling player came from the side and stayed on her feet accounted for nearly half of all challenges for the ball in which body contact occurred. 2.7% of all tackles were classified as risk situations, with sliding-in tackles from behind and the side having the highest risk potential. Match referees sanctioned sliding-in tackles more often than other tackles (20% v 17%, respectively). Tackle parameters did not change in the duration of a match; however, there was an increase in the number of injury risk situations and foul plays towards the end of each half.

**Conclusions:** Match properties provide valuable information for a better understanding of injury situations in football. Staying on feet and jumping vertically tackle actions leading to injury were sanctioned significantly more times by the referee than those not leading to injury ( $p < 0.001$ ), but no such difference was seen for sliding-in tackles (previously reported to have the highest injury potential in women's football). Therefore, either the laws of the game are not adequate or match referees in women's football are not able to distinguish between sliding-in tackles leading to and those not leading to injury.

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Football is the most<sup>1</sup> popular team sport, having 240 million licensed players<sup>2</sup> (40 million female players) and 207 Fédération Internationale de Football Association (FIFA)-affiliated member states worldwide.<sup>3</sup> Women's football has been increasing in popularity over the past 10 years with, for example, the numbers of licensed female players rising by 210% in the USA, 160% in Germany and over 30% in Sweden.<sup>4</sup> Also, public interest in top-level women's football has increased with average attendances during FIFA's Women's World Cup in 1999<sup>5</sup> and 2003<sup>6</sup> of almost 30 000 spectators per match, and during FIFA's U-19 Women's World Championship in Canada (2002) and Thailand (2004) of over 11 000 spectators per match.<sup>7, 8</sup>

Contact injuries in tackling and collision situations have been reported to be responsible for between 44% and 87% of all traumatic injuries in men's,<sup>1, 9–11</sup> women's<sup>11–14</sup> and adolescents' football.<sup>15, 16</sup> Hawkins and Fuller reported in 1999<sup>5, 9</sup> that 37% of all injuries or more than 90% of all contact injuries were due to tackling actions; body contact other than tackling is rarely reported as a cause of injury.<sup>17, 18</sup> However, earlier publications did not include unintentional collisions and use of elbow and heading under "tackle action", whereas more recent publications include all mechanisms that lead to contact between two or more players under tackles.<sup>19–21</sup>

All previously reported data on this issue are on men's football,<sup>19–23</sup> and three methods of analysing tackles and/or risk situations utilising video recordings have been used. Rahnema *et al*<sup>23</sup> analysed every action during the game that involved the ball and classified these events into three categories: "no injury potential", "injury potential" and "actual injury". They stated that being tackled or making a tackle put players at most risk; the only other information provided in that study was the time into the game and the area of the pitch where the tackle

occurred. Andersen *et al* defined injury risk situations and then analysed each incident using 19 variables.<sup>19</sup> They developed this method to describe incidents with a high risk of injury; however they did not provide any information about the general features of the match. Three main game situations were identified, leading to most of the injuries, namely, "breakdown attacks, defensive tackling duels and heading duels".<sup>20</sup> Fuller *et al*<sup>21</sup> analysed every event during match play—in which at least two players were competing for the ball and body contact occurred—for tackling direction, mode and action. This approach has provided valuable information about the tackle process and in combination with players' injury reports information on the risk potential of each type of tackle. In that study,<sup>21</sup> heading and two-footed tackles were found to be more likely to cause injuries than any other tackling action. On the basis of the above mentioned and other findings, in 2006, the International Football Association Board introduced changes to the laws of football to reduce the risk of injury to players.<sup>3</sup>

The present study aimed to:

- (1) analyse tackle actions in women's football in match situations and to assess their risk potential, using the definitions proposed by Andersen *et al*<sup>19</sup> as a function of player age, playing position and stage in a tournament;
- (2) compare the findings about tackle parameters in women's football with the findings reported previously for men's football.

**Abbreviations:** B, from behind; F, from the front; FIA, football incident analysis; S, from the side; st, staying on feet; si, sliding-in; vj, vertical jump

**METHOD**

**Tackle assessment**

We analysed 24 representative matches from six top-level women’s football tournaments (1999 and 2003 FIFA Women’s World Cup, 2000 and 2004 Women’s Olympic Football Tournament, 2002 and 2004 U-19 Women’s World Championship). The number of matches analysed, and the teams and matches selected from each tournament was based on:

- the number of matches played in the group and knockout stages of each tournament;
- the number of games played by teams from the various confederations in each tournament.

No team was assessed more than once in any tournament.

Every match was reviewed by one of the authors on two separate occasions to provide a consistent assessment of all parameters. The mean intrarater reliability was 94% (direction 93.2%, mode 96.7% and action 92.0%). Fifteen minutes of one of the selected matches were not available for analysis, so a 15-min part from an equivalent stage of an equivalent match played in the same tournament was included. One of the six matches from the knockout stage went into extra time, which was included in the analysis.

A tackle was defined as any incident during normal play in which there was obvious contact between at least two players.<sup>21</sup> At least one of the players had to be challenging for the ball. We excluded off-the-ball events from our analysis. The tackled player was defined as the player being either in possession of the ball at the time of the contact or the player from the team in control of the ball immediately before the incident, such as in the case of passes, throw-ins, free kicks and corner kicks.<sup>21</sup>

Every tackle incident was analysed for the following parameters<sup>21</sup>:

- tackle direction (tackling player coming from behind, side or front with respect to the tackled player);
- tackle mode (position of the tackling player in terms of staying on feet, sliding-in or jumping vertically);
- tackle action (the tackling player’s action involving a one-footed, two-footed, use of arm/hand, upper body or head challenge);
- referee’s decision (non-foul, foul, yellow card, red card as determined by the match referee);
- on-pitch treatment (any medical attendance seen on video regardless of whether the match was interrupted by the referee);
- time into the match.

In addition, we analysed football incident analysis (FIA) injury risk incidents, defined by Andersen *et al*<sup>19</sup> as “any tackling situation in which the match was interrupted by the referee; or a player was on the ground for more than 15 seconds or the player appeared to be in pain or receiving medical treatment during the match”.<sup>19 20</sup> Information relating to a player’s position was obtained from the official FIFA records of each tournament.<sup>5-8 24 25</sup>

**Data presentation**

To simplify the presentation of the results, the tackling parameters for direction and mode were combined to create a tackle code consisting of nine direction–mode combinations. (Abbreviations used for tackle direction: B, from behind; S, from the side; F, from the front; and for tackle mode: st, staying on feet; si, sliding-in; vj, vertical jump.)

The incidence of tackles was expressed as the number of tackles per match and per 1000 player hours. The total hours of match play were computed as follows:

$$22 \text{ players} \times 90 \text{ min} = 33 \text{ match hours}$$

We did not take into account injury time and reduced numbers of players on the field,<sup>1 10 26</sup> but the extra time played in one match during the knockout stage of a tournament was included in the analysis. Comparisons of tackle frequencies as a function of playing position were based on a typical 1–4–4–2 playing formation.<sup>20 27–29</sup>

**Data analysis**

We analysed the data using frequencies, cross-tabulations and Pearson’s correlation test. We used  $\chi^2$  tests for comparison of tackle frequencies and their parameters. The 95% confidence intervals were calculated as follows:

$$95\% \text{ CI} = \text{incidence} \pm 1.96 \times (\text{incidence/square root (number of incidents)})$$

Statistical significance was accepted at  $p < 0.05$ .

**RESULTS**

We identified and analysed 3531 tackles, of which 96 (2.7%) equated to FIA incidents. There were, on average, 147 (95% CI 142 to 152) tackles/match, 4397 tackles/1000 player hours, 4.0 (95% CI 3.2 to 4.8) FIA incidents/match and 119.6 (95% CI 96.1 to 143.9) FIA incidents/1000 player hours. The mean number of tackles/match for each tournament did not differ significantly (range 139–158 tackles/match) although the numbers for individual games varied considerably (World Cup 1999, China v Sweden: 125; World Cup 2003, Sweden v Korea Republic: 219).

**Tackle mechanism**

More than 60% of the tackles recorded were from the side and in more than 65% of the tackles the tackling player stayed on her feet. The combined tackle code of tackling from the side and staying on feet (S-st) was the most common tackle (43.9%; table 1): all other tackle combinations were less than 15% of the total. Sliding-in tackles occurred in 11.6% (410/3531, see table 3) of the tackling situations, with most of these tackles coming from the side (62.7% (257/410, see table 3)).

The most frequent tackling code (S-st) was found to have the lowest incidence of FIA injury risk situations (16.1 FIA situations/1000 tackles) followed by B-st and S-si (table 3). The highest incidences of FIA injury risk situations were found for sliding-in tackles from the front (F-si) and behind (B-si)

**Table 1** Number of matches analysed in the present study

Tournament	No. of games played		No. of games analysed		Matches analysed (%)
	Group stage	Knockout stage	Group stage	Knockout stage	
Women’s World Cup					
1999	24	8	4	1	
2003	24	8	4	1	16
Olympic Games					
2000	12	4	2	1	
2004	12	8	2	1	17
Women’s U-19 World Cup					
2002	18	8	3	1	
2004	18	8	3	1	15

**Table 2** Comparison of the six tournaments included in the analysis for the present study

	World Cup		Olympic Games		U-19 World Cup	
	1999	2003	2000	2004	2002	2004
Participating teams*	16	16	8	10	12	12
Mean actual time* (min, s)	55', 35"	59', 16"	60', 23"	56', 95"	55', 45"	58', 38"
Qualification	58', 22"	57', 36"	60', 58"	56', 35"	55', 29"	57', 42"
Knockout	52', 48"	64', 15"	59', 46"	57', 50"	56', 01"	59', 33"
Yellow cards*	77	65	46	40	56	79
Qualification	62	49	31	21	41	51
Knockout	15	16	15	19	15	28
Red cards*	5	1	0	0	2	3
Goals/match*	3.84	3.34	2.62	2.75	3.88	3.54
Injuries/match†	1.3	1.7	2.1	2.3	2.8	2.2
Contact v non-contact ratio†	3.2	3.9	5.4	3.7	4.2	4.6
Tackle match	144.8	149.2	153.7	157.7	142.5	139.3

and for aerial challenges from the front (F-jv). Tackling from the front in general showed a significantly higher risk potential than the other directions (76.9 v 21.0 FIA situations/1000 tackles, respectively;  $p < 0.001$ ). Tackles from behind were sanctioned significantly more times by referees than tackles from the front and side (behind: 25.2%; front and side: 14.5%;  $p < 0.001$ ), and aerial challenges were sanctioned significantly fewer times than other tackle modes (11.7% v 19.1%, respectively;  $p < 0.01$ ). Yellow cards were awarded significantly more often for tackles from the front than for tackles from other directions (2.5% (9/390) v 1.1% (35/3141), respectively;  $p < 0.05$ ) and sliding-in tackles received significantly more yellow cards than for other tackle modes (3.4% (14/410) v 1% (30/3121), respectively;  $p < 0.001$ ).

### Time of match

We found that slightly more tackles occurred in the last 15 min of a match but this was not statistically significant (table 4). There was no change in the distribution of the nine tackle codes as a function of the time into the match. The distribution of

yellow cards showed a significant difference with regard to the same, with 46.1% of all yellow cards given in the last 15 min of each half ( $p < 0.05$ ); however, the number of cards given in the first and second half did not differ significantly. As there were only two red cards, these were not included in the analysis. The number of FIA situations/tackle in the last 15 min of each half was more than twice that in the earlier 30 min of each half ( $p < 0.001$ ) as was the numbers of on-pitch treatments ( $p < 0.025$ ). There was a significant correlation between FIA situations and yellow cards ( $r = 0.88$ ;  $p < 0.05$ ), and yellow cards and on-pitch treatments ( $r = 0.81$ ;  $p < 0.05$ ), but not for foul and FIA situations ( $r = 0.33$ ).

### Playing position

Most of the tackles were sustained by midfielders (51.4%); however, taking into account the number of players in each position, forwards were the most tackled players, followed by midfielders and defenders. Goalkeepers were only tackled on average every second game, whereas forwards were challenged on average 13 times/match (396 tackles/1000 player hours). Tackling mechanisms did not differ significantly among playing positions, although defensive players experienced less jumping tackles than other field players (10.2% v 24.7%, respectively;  $p < 0.001$ ).

### Type of tournament

We did not find any significant differences among the three types of tournament in the incidence of tackles, foul play, FIA risk incidents or yellow cards, or tackle mechanisms.

### Stage in tournament

Group matches and knockout matches did not differ significantly in the mean number of tackles per match, on-pitch treatments and FIA risk situations (qualification: 3.6/match; knockout: 5.2/match). Significantly more aerial challenges occurred in knockout matches than during the qualification round (26.1% v 22%, respectively;  $p < 0.05$ ). There were no other significant differences with regard to the tackle mechanism.

**Table 3** Tackle parameters and frequencies as function of tackle code

Tackle code	Tackles n (%)	One-footed	Action upper body			Tackles/match	Foul/tackle (%)	FIA/1000 tackles
			Two-footed	Heads	Others			
Women								
B-st	499 (14.1)	274	0	84	0	141	20.8	20.0
B-si	82 (2.3)	77	4	0	0	1	3.4	85.4
B-vj	384 (10.9)	6	0	331	2	45	16.0	11.7
S-st	1550 (43.9)	560	0	488	1	501	64.6	14.1
S-si	257 (7.3)	244	11	0	0	2	10.7	15.6
S-vj	369 (10.5)	9	0	340	1	19	15.4	10.3
F-st	259 (7.3)	151	2	83	1	22	10.8	19.7
F-si	71 (2.0)	52	14	0	0	5	3.0	18.3
F-vj	60 (1.7)	8	0	42	1	9	2.5	20.0
All	3531 (100)	1381	31	1368	6	745	147.1	17.4
Men <sup>21</sup>								
B-st	1499 (17.5)	998	1	30	0	470	12.2	66.2
B-si	405 (4.7)	382	17	2	0	4	3.3	42.5
B-vj	1132 (13.2)	12	1	934	15	170	9.2	20.8
S-st	1960 (22.9)	1336	2	212	0	410	15.9	54.0
S-si	1140 (13.3)	1085	47	2	0	6	9.3	30.5
S-vj	289 (3.4)	16	2	154	4	113	2.3	41.9
F-st	1372 (16.0)	1222	2	45	1	102	11.2	26.6
F-si	628 (7.3)	542	74	1	1	10	5.1	20.2
F-vj	147 (1.7)	11	1	99	4	32	1.2	29.9
All	8572 (100)	5604	147	1479	25	1317	69.7	40.4

B, from behind; F, from the front; S, from the side; st, staying on feet; si, sliding-in; vj, vertical jump. FIA, football incident analysis.

**Table 4** Tackle parameters as a function of the time in match

Time (min)	Tackle	Foul	Tackle/foul (%)	FIA/1000 tackles	On-pitch treatments	Yellow cards*	Goals scored*
0–15	608	115	18.9	9.9	2	25	66
16–30	550	90	16.4	23.6	8	46	80
31–45	536	98	18.3	42.9	11	71	76
46–60	595	96	16.1	25.2	5	52	84
61–75	586	77	13.1	20.5	5	65	91
76–90	636	135	21.2	42.5	11	90	102
Extra time	20	4	20.0	0	0	10	11

\*Official FIFA record books.<sup>5–8 24 25</sup>  
FIA, football incident analysis.

## DISCUSSION

Many studies have used video recordings to analyse the causes of injury in international men<sup>19–21 30–32</sup> and women's<sup>32 33</sup> football; however, information about tackles is scarce, particularly in women's football. Rahnama *et al*<sup>23</sup> provided the first data on tackles using video analysis, but they did not identify specific tackle mechanisms. The studies on FIA included specific risk situations<sup>19 20 31</sup> and therefore did not provide a general view of the game. Fuller *et al* studied the propensity for different tackle parameters to cause injury<sup>21</sup> and showed that high-risk tackle situations could be identified using video analysis.

The present study recorded a mean of 147 tackles/match. Neither the type of nor the stage in the tournament had a significant effect on the number of tackles. Comparable frequencies of tackles in men's football were reported by Andersen *et al*<sup>19</sup> (120–150 tackles/match), and Rahnama *et al*.<sup>23</sup> (150 player-to-player contacts/match). Fuller and others—who used the same definition for tackle as in the present study—reported only 70 tackles/match.<sup>21</sup>

Most of the tackles identified in this study were from the side (61.6%) followed by challenges from behind (27.3%). The data on men's football<sup>21</sup> shows similar findings for almost all tackle codes except staying on feet tackles from the side (64.6 tackles/match for women and 15.9 tackles/match for men). These tackles usually involved low physical contact. Hence, tackle parameters in women's and men's football may be considered to be similar; the difference in incidence of S-st tackles may arise from a difference in the interpretation of a tackle. Contact between two players is usually clearly visible on the video recordings; but whether there was a realistic possibility of gaining possession of the ball in the challenge is subjective in such situations. It is crucial to record all tackle mechanisms that theoretically could lead to injury. As every body contact situation can potentially lead to injury, it is suggested that:

“a tackle refers to any challenge for the ball, in which visible body contact occurs between at least one player of each team.”

This study found an average of four FIA situations per match for women; data on men's football indicate considerably lower numbers (1.6–2.2 FIA incidents/match).<sup>20 30</sup> This is an interesting observation because most recent publications have reported lower or equal rates of injury in women's football.<sup>1 14 26</sup> Our evaluation of FIA risk situations highlighted that tackles from the front were nearly four times more likely to result in a risk situation. From Tscholl and colleagues<sup>33</sup> data, the likelihood of an injury following a tackle from the front is five times higher than from other directions ( $p < 0.001$ ). Tackles from behind were three times less likely to result in injury ( $p < 0.025$ ),<sup>33</sup> but this was not reflected in the results of the present study for FIA risk situations. This may be due to players simulating a harder

## What is already known on this topic

- Several investigations in men's football have shown that video analysis is a useful aid to determine high-risk tackle situations.

impact in the tackle in an attempt to obtain a more severe sanction by the match referee against the tackling player. Tackles from behind were sanctioned significantly more times by the referees ( $p < 0.001$ ).

Although sliding-in tackles have been shown previously<sup>33</sup> to have the highest risk of injury, in the present study of FIA situations (see table 3, 5% (FIA risk situations) *v* 2% (other two tackle modes);  $p < 0.01$ ), they were the least sanctioned injury situation.<sup>33</sup> Although referees sanctioned the actions of staying on feet and jumping vertically significantly more often if they resulted in an injury than in non-injury situations (staying on feet: 40% *v* 19%, respectively,  $p < 0.001$ ; jumping vertically: 40% *v* 12%, respectively,  $p < 0.001$ ), the difference between sliding-in tackles resulting in injury or not in injury (27% *v* 20%, respectively) was not statistically significant. Therefore, either the laws of the game are not adequate or match referees are not able to distinguish sliding-in tackles leading to injury from sliding-in tackles without consequent injury. Tscholl *et al*<sup>33</sup> reported that nearly 1 in 3 injuries caused by a sliding-in tackle were sustained when the ball had been played before the tackling player made contact with the injured player. According to law 12 of the Laws of the Game: “no free kick will be awarded if a player tackles an opponent to gain possession of the ball making contact with the ball before touching the player ...” unless “He plays in a dangerous manner”. Furthermore, tackles in which the ball was played first resulted in significantly more injuries to the tackled player ( $p < 0.05$ ) and were less likely to be sanctioned by the referees than tackles in which the opponent player was touched first ( $p < 0.01$ ).<sup>33</sup> The laws of football include a wide latitude of interpretation by referees<sup>34</sup>; therefore, changes in the application of law 12 may have to be considered to reduce the range of interpretation, but further research is needed to clarify the situation.

In the football matches analysed in the present study, there was no significant change in the incidence of tackles or in tackle parameters as a function of the period of play. However, in the 24 matches analysed, we found a significant increase in the incidence of foul play and yellow cards awarded in the final 15-min period of each half (16% *v* 20% in the last 15 min respectively;  $p < 0.025$ ). The official FIFA record books of the six

## What this study adds

- It is important to determine the general match characteristics as well as tackling information to gain a better understanding of injury causation.
- An increase in the number of tackles, risk situations and yellow cards towards the end of each half of a match and the increasing fatigue may partly explain the increased frequency of injuries found previously in this period of the match.
- The present analysis found that sliding-in tackles—which previously have been reported as having the highest propensity for injury—were not particularly regarded by the match referees in injury situations. This issue is specifically discussed in this article.

tournaments<sup>5-8 24 25</sup> and other recent published data focusing on injury situations<sup>9 14 35 36</sup> confirm this finding. The increase of FIA risk situations in this period (which has been shown to correlate highly with yellow cards,  $r = 0.88$ ) and the increase in reported injuries in previously published literature<sup>10 12 14 16</sup> indicate an increased intensity of playing towards the end of each half. However, the recorded FIA risk situations may include some feigned actions, as discussed by Andersen *et al.*<sup>19</sup>

Forwards were the most tackled players, the players sustaining most injuries in FIA risk incidents and the players sustaining the most injuries in women's football.<sup>13 33 37</sup> Although midfielders experienced approximately the same number of tackles per match as defenders, they were two times more exposed to FIA risk situations than defenders (160 v 80 FIA risk situations/1000 h, respectively), but they sustained the least injuries.<sup>33 38</sup>

The tournaments analysed (World Cup, Olympic Games and U-19 World Championship) did not differ significantly in any of the tackle parameters analysed. The trend reported by Junge *et al.*<sup>14</sup> for an increasing incidence of injury from the World Cup to the Olympic Games to the U-19 tournaments may indicate a more aggressive style of play at this level; however, this was not supported by an increased incidence of FIA risk situations or a change in tackle parameters. Tackle characteristics of knockout matches seemed to be different from those of matches played during qualification rounds. This difference may reflect the augmented aggressiveness to challenge the ball as well as the playing styles of the more talented teams that qualify to participate in the knockout stages of tournaments.

## CONCLUSIONS

It is vital to know how many injuries occur and also to understand the circumstances in which they occur, hence the importance of match characteristics. Risk situations are difficult to define and to determine in football. The FIA risk situation definition has previously been shown to be a valuable research tool; however, the present study highlights that there are differences in the tackle mechanisms associated with injury and FIA risk situations. This questions equating FIA risk situations with the risk of injury.

We found that tackles leading to injury were sanctioned more frequently by the match referees than non-injury tackles, except for sliding-in tackles. Therefore, the context of sliding-in tackles and referees' decision has to be elaborated further to ensure players' safety because these tackles have been shown to have the highest injury potential.

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