Biological maturity and injury in elite youth football

F. Le Gall1, C. Carling2, T. Reilly3

1Institut National du Football, Centre Technique National Fernand-Sastre, Clairefontaine-en-Yvelines, France, 2Institut National du Sport et de l’Education Physique, Paris, France, 3Research Institute for Sport and Exercise Sciences, Liverpool John Moores University, Liverpool, UK

Corresponding author: Christopher Carling, Institut National du Sport et de l’Education Physique, 11 Avenue du Tremblay, Paris, France. Tel: +33 1 4891 07 93, Fax: +33 1 4891 07 93, E-mail: ccarling@sport-consultants.com

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The purpose of the present study was to investigate injury according to biological maturity in elite under-14 youth football players based at the National Football Institute, France. Over 10 seasons, injury incidence, severity and distribution were compared in 233 players classed according to individual biological maturity determined by skeletal age into three cohorts as early, normal and late maturers.

A non-significant higher injury incidence was found in early and normal maturers compared with late maturers. In contrast, the latter group sustained a significantly higher incidence of major injuries compared with early maturers (0.3 vs 0.6 vs 0.9, \( P < 0.039 \)). A significantly higher incidence of osteochondroses was reported in normal and late maturers (0.3 vs 0.7 vs 0.9, \( P = 0.014 \)), whereas tendinopathy incidence was greater in early and normal maturers (0.06 vs 0.08 vs 0.02, \( P = 0.033 \)). Early maturers incurred the highest incidence of groin strains and re-injuries (\( P < 0.05 \)). There was no significant difference between groups in the seasonal disposition of injury.

Biological maturity status did not significantly affect overall injury incidence in elite French youth football players, although there were differences between maturity groups when patterns of injury location, type, severity and re-injury were analyzed.

There are limited data on the epidemiology of injuries in adolescent football across all levels of play (Emery et al., 2005) and particularly in elite youths training full time to become professional players. Although these studies on the future generations of professional players have highlighted the extent of the injury problem (Volpi et al., 2003; Price et al., 2004; Le Gall et al., 2006), further investigation is needed to identify any high risk groups as the potential to succeed may in part be determined by the susceptibility of players to injury (Singer & Janelle, 1999).

The incidence of injuries in football players varies according to intrinsic (person-related) factors such as player age (Dvorak & Junge, 2000). The majority of the literature on youth football suggests that injury rates increase with age (Backous et al., 1988; Inklaar, 1994; Schmikili & Bol., 1995; Volpi et al., 2003; Price et al., 2004; Emery et al., 2005; Le Gall et al., 2006). Consideration of injuries in youth players should also take into account that players are still growing and that individuals of the same chronological age (CA) often differ in maturity status. Mismatches in biological maturity may create a potential competitive inequality and therefore have implications for injury (Malina et al., 2000). There is limited and contrasting evidence on the relationship between maturity and injury in team sports and to our knowledge, no studies on elite football. Backous et al. (1988) carried out a study on injuries and their relation to physical maturity in a summer football camp for youths. A relationship was established between injuries and physical maturity with certain musculo-skeletal characteristics linked to specific injuries. A higher rate of injury was found in the more mature boys who were muscually weak. A direct correlation has also been observed between advanced sexual maturity and increased injury rates in American Football (Linder et al., 1995). These findings contrast with another study on American Football reporting that physically immature adolescents are more prone to injury when playing football with age-matched peers who are more physically mature (Violette, 1976). Furthermore, Vidalin (1988) showed that a majority of 11 youth football players aged 12–15 years injured during the course of one season had skeletal ages (SAs) categorizing them as late maturers. It has been recommended that epidemiological research be carried out in elite youth football to examine the potential link between level of maturation and susceptibility to injury (Price et al., 2004; Le Gall et al., 2006).
The purpose of this study was to investigate in elite French male youth football whether players classed as biologically early, normal and late maturers differed according to the incidence and severity of injuries sustained. The nature and location of these injuries over the course of the season were also compared according to the biological maturity of players.

Materials and methods

Study period and subjects
In this prospective observational study, injuries related to biological maturity were investigated in elite male youth players at the National Football Institute (INF), part of the Clairefontaine National Football Centre, France. Epidemiological data were captured over a period of 10 seasons from August 1995 to June 2005. Over the 10-season study period, 233 players belonging to the under-14 age group were examined. Data were collected from each participant over the one season he spent in the under-14 group. Consent forms for all medical investigations were completed for each subject by the parent or guardian as the players were below the legal age of consent. Approval for the study was obtained from the Ethics Council of the Federation Française de Football.

Study procedure
Before enrolling at the Centre and before acceptance into the elite program, each player underwent medical screening (Hagglund et al., 2005). This screening program was used to identify the existence of any pathophysiological condition that may have contraindicated playing competitive football (Le Gall et al., 2006). On acceptance at the Centre, a standard radiological examination of the left hand and wrist of each player was carried out at the beginning of the season to determine SA using the matching atlas of Greulich and Pyle (1959). The Greulich–Pyle method is used internationally as a standard method for determining skeletal maturity (Rikhasor et al., 1999) as it involves very low exposure (1 mrad) to radiation (Carpenter & Lester, 1993) and the results are simple, easy and quick to obtain (Le Gall, 2005). In the present study, we preferred the use of a radiological examination to determine maturity status rather than the Tanner staging method as there is reluctance to utilize clinical evaluations of secondary sex characteristics (genital and pubic hair development, testicular volume) due to individual privacy concerns of young players and often their parents (Malina & Cumming, 2004). Other studies have also shown self-reporting of sexual maturation by adolescents based on the Tanner staging method to be unreliable (Schlossberger et al., 1992; Desmangles et al., 2006). To assess intra-observer reproducibility, the radiographs of 15 players were randomly selected from the sample as a whole and subsequently re-assessed 6 months after the initial assessments were made (Malina et al., 2000). The mean difference between assessments of SA was 0.1 years [standard deviation (SD) = 0.14], indicating a high level of intra-observer reproducibility. The correlation between assessments was 0.94.

As SA is an indicator of biological maturity status (Malina & Bouchard, 1991), 233 players were classed according to individual SA compared with CA determined by the radiological examination into three cohorts as early, normal and late maturers. Normal maturers refers to an SA that is within 1.0 year of CA, early maturers refer to an SA that is older than CA by more than 1.0 year and late maturers refer to an SA that is younger than CA by more than 1.0 year. This procedure is similar to previous studies that used differences between skeletal and CAs to classify youth athletes into maturity categories (Krogman, 1959; Rochelle et al., 1961; Malina et al., 2000, 2005). Using a band of 1 year allows for the error associated with the assessment of SA and provides a broad range of youths who are classified as average or “on time” (Malina et al., 2000). All these study procedures were carried out by the same physician specialized in sports medicine and based at the Centre for 13 years and were in place throughout the 10-season period of the present study.

Calculation of exposure and injury incidence

When fit, players trained at the INF for 2 h each day over the 39-week season. Fit players also participated in up to 40 matches each season that took place at the weekends for their home clubs. Injury incidence was calculated as the number of injuries/1000-h exposure in training and matches. Depending on the vacation calendar, the season for elite French youth football runs from August to June and the players are generally absent from training and competition for 1 week in October, December, January and 2 weeks in February and April and from mid-June until August.

Injury definitions and severity

Injuries were diagnosed and recorded for each player over the whole study period by the same physician who also carried out the screening process. This procedure reduced the chance of bias and differences in injury interpretation, recall and changes in observation methods between practitioners, thereby optimizing the reliability of the study. A recordable injury was defined according to the definition previously used in studies on elite football as one received during training or competition and that prevented the injured player from participating in normal training or competition for more than 48 h, not including the day of the injury (Hawkins et al., 2001; Price et al., 2004; Le Gall et al., 2006). Re-injuries were defined as the same type of injury to the same side and location within 2 months after the final rehabilitation day of the previous injury (Hagglund et al., 2005; Walden et al., 2005a). Injury severity depended upon the time the player was absent from training or competition and was classed into four sub-divisions, as major (more than 4 weeks), moderate (1–4 weeks), mild (4–7 days) and minor (2–3 days), respectively (Price et al., 2004; Hagglund et al., 2005; Walden et al., 2005a; Le Gall et al., 2006). The type and location of each injury sustained were also recorded. Finally, the date of each injury was recorded in order to examine monthly variations in the data over the entire playing season including both the pre-season and competitive season.

Analyses

Data were analyzed using the SPSS statistical package (SPSS Science Inc., Chicago, Illinois, USA). Descriptive and comparative data are presented. The SD and 95% confidence interval (95% CI) are included for results expressed as means. Statistical comparisons within the dataset were investigated using the non-parametric Mann–Whitney U-test and Kruskal–Wallis one-way analysis of variance on ranks. Where possible, a post hoc Student–Newman–Keuls (SNK) multi-comparison test was conducted on the ranks to isolate any differences between age groups. The level of probability for statistical significance was set at P<0.05.
Results
Exposure and biological maturity
Across all groups, the overall exposure to football was 104,850 h (90,870 training hours and 13,980 match hours). Players had 6.5 h of training/match hour and a ratio of 4.9 training sessions/match. Table 1 presents the number, CA and SA of players according to maturity status. Of the total sample, 12.0% were classed as late maturers, 63.5% as normal matures and 24.5% as early matures.

Injury incidence and severity
Injuries documented across all age groups totalled 588, with an overall rate of injury acquisition per player of 5.6/1000 playing hours between groups (Table 2). No significant difference was found in overall injury incidence /1000 playing hours between groups ($P = 0.497$). The incidence of training injury did not differ between the three groups ($P = 0.741$). The highest incidence of match injury was sustained in the early-maturing group (early = 13.2 vs normal = 12.3 vs late = 6.5, $P = 0.452$).

The majority of injuries in all groups were classed as minor or mild, resulting in an absence of 1 week or less. Both early and normal matures sustained a higher incidence of moderate injuries compared with late matures, a difference that approached significance (early = 1.7 vs normal = 2.0 vs late = 0.6, $P = 0.061$). A significantly higher incidence of major injuries ($P = 0.039$) was observed in late compared with early matures (early = 0.3 vs normal = 0.6 vs late = 0.9, post hoc late vs early matures, $P < 0.05$). The incidence of major injuries sustained during training and matches is listed in Table 3 according to group. No difference was revealed between groups for the incidence of major injury in matches and in training.

The average layoff time per injury across the three age groups was 17.4 days, and players were absent from training and competition for an average of 43.9 days/year. According to maturity status, the average layoff time per injury for early, normal and late groups was 13.4, 18.4 and 20.7 days, respectively. Early-maturing players were absent from training and competition for an average of 34.4 days/year compared with 47.7 for normal and 42.9 late matures.

Type and location of injuries
The knee was the most common location for injury /1000 h exposure in normal and late matures compared with the thigh in early matures. A significantly greater incidence of groin injuries was reported in early and normal matures compared with late matures (early = 0.9 vs normal = 0.44 vs late = 0.08, $P = 0.002$, post hoc vs late matures $P < 0.05$). Otherwise, no other statistical significant differences in injury location were reported between groups. Normal and early matures sustained the same incidence of lower extremity injuries, which was higher than that of late matures (early = 4.2 vs normal = 4.2 vs late = 3.7, $P = 0.736$).

Sprains and strains were more common in early-maturing players, meniscal injuries and cases of back pain were more common in normal-maturing players as were contusions and fractures in late-maturing players. There was a significantly greater incidence of tendinopathies in early- and normal-maturing players ($P = 0.033$) compared with late matures (early = 0.06 vs normal = 0.08 vs late = 0.02, post hoc vs late matures, $P < 0.05$). A significant difference ($P = 0.014$) in the incidence of osteochondral disorders was obtained in late and normal matures compared with early matures (late = 0.9 vs normal = 0.7 vs early = 0.3 (post hoc both groups vs early matures, $P < 0.05$).

A significantly higher incidence of groin strains was reported in early-maturing players compared with other groups (early = 0.62 vs normal = 0.2 vs late = 0.08, $P = 0.006$, post hoc early vs all groups, $P < 0.05$). In both early-and normal-maturing players, most tendinopathies were reported in the knee and groin compared with the ankle in the late-maturing group. Osteochondral disorders significantly affected the knee more in late matures ($P = 0.006$) compared with the other maturity groups (early = 0.63 vs normal = 0.35 vs late = 0.04, post hoc late vs all groups, $P < 0.05$).

The majority of major injuries across all groups were osteochrondoses (37.8%), fractures (33.9%),

Table 1. Number, chronological age and skeletal age of players

<table>
<thead>
<tr>
<th></th>
<th>Early matures ($N=57$)</th>
<th>Normal matures ($N=148$)</th>
<th>Late matures ($N=28$)</th>
<th>All maturity groups ($N=233$)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Chronic age</strong></td>
<td>Mean (SD)</td>
<td>Range</td>
<td>Mean (SD)</td>
<td>Range</td>
</tr>
<tr>
<td>range</td>
<td>13.4 (0.3)</td>
<td>12.75–14</td>
<td>13.3 (0.3)</td>
<td>12.3–14.4</td>
</tr>
<tr>
<td>range</td>
<td>15.0 (0.9)</td>
<td>12.0–18.0</td>
<td>13.4 (0.5)</td>
<td>12.5–14.5</td>
</tr>
<tr>
<td><strong>Skeletal age</strong></td>
<td>Mean (SD)</td>
<td>Range</td>
<td>Mean (SD)</td>
<td>Range</td>
</tr>
<tr>
<td>mean</td>
<td>13.3 (0.3)</td>
<td>12.75–14</td>
<td>13.3 (0.3)</td>
<td>12.75–13.9</td>
</tr>
<tr>
<td>mean</td>
<td>11.8 (0.5)</td>
<td>11.0–12.5</td>
<td>11.0–12.5</td>
<td></td>
</tr>
<tr>
<td>mean</td>
<td>13.6 (1.2)</td>
<td>11.0–18.0</td>
<td>13.6 (1.2)</td>
<td></td>
</tr>
</tbody>
</table>
Table 2. Injury incidences according to player maturity

<table>
<thead>
<tr>
<th></th>
<th>Early maturers</th>
<th>Normal maturers</th>
<th>Late maturers</th>
<th>All maturity groups</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total N</td>
<td>Mean</td>
<td>SD</td>
<td>95% CI</td>
</tr>
<tr>
<td>Injuries per player</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>146</td>
<td>2.6</td>
<td>1.7</td>
<td>2.1–3.0</td>
</tr>
<tr>
<td>Training</td>
<td>101</td>
<td>1.8</td>
<td>1.4</td>
<td>1.4–2.1</td>
</tr>
<tr>
<td>Match</td>
<td>45</td>
<td>0.8</td>
<td>0.9</td>
<td>0.6–1.1</td>
</tr>
<tr>
<td>Injuries/1000 h of football</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>146</td>
<td>5.7</td>
<td>3.7</td>
<td>4.6–6.5</td>
</tr>
<tr>
<td>Training</td>
<td>101</td>
<td>4.5</td>
<td>3.5</td>
<td>3.6–5.5</td>
</tr>
<tr>
<td>Match</td>
<td>45</td>
<td>13.2</td>
<td>15.6</td>
<td>9.3–17.6</td>
</tr>
<tr>
<td>Injuries/1000 h of football</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minor (1–3 days)</td>
<td>46</td>
<td>1.7</td>
<td>2.0</td>
<td>1.2–2.2</td>
</tr>
<tr>
<td>Mild (4–7 days)</td>
<td>49</td>
<td>2.0</td>
<td>2.1</td>
<td>1.5–2.6</td>
</tr>
<tr>
<td>Moderate</td>
<td>43</td>
<td>1.7</td>
<td>1.9</td>
<td>1.1–2.1</td>
</tr>
<tr>
<td>Major (&gt;4 weeks)</td>
<td>8</td>
<td>0.3</td>
<td>0.9</td>
<td>0.1–0.5</td>
</tr>
</tbody>
</table>

*Significant difference between maturity groups.

Table 3. Incidences of major injury according to player maturity

<table>
<thead>
<tr>
<th></th>
<th>Early maturers</th>
<th>Normal maturers</th>
<th>Late maturers</th>
<th>All maturity groups</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total N</td>
<td>%</td>
<td>Mean incidence</td>
<td>SD</td>
</tr>
<tr>
<td>Major injuries</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>8</td>
<td>100</td>
<td>0.3</td>
<td>2.7</td>
</tr>
<tr>
<td>Training</td>
<td>5</td>
<td>62.5</td>
<td>0.2</td>
<td>0.7</td>
</tr>
<tr>
<td>Match</td>
<td>3</td>
<td>37.5</td>
<td>0.9</td>
<td>3.8</td>
</tr>
</tbody>
</table>
including avulsion and stress fractures) and tendinopathies (8.1%). Of these major injuries, Osgood–Schlatter’s disease was the most common osteochrondal disorder (84.5%). Patella tendinitis (60.0%) and wrist/arm fractures (50%) were the most frequent tendinopathy and fracture, respectively.

Re-injuries

Across all groups, 18 injuries were classed as re-injuries (3.1% of total injuries), an incidence rate of 0.7. A significant difference ($P = 0.017$) was observed in the incidence of re-injuries between groups (early = 0.35 vs normal = 0.12 vs late = 0.08, post hoc early vs all groups, $P < 0.05$). Across all groups, sprains and strains made up 38.9% (57.7% affecting the ankle) and 11.1% (100% affecting the upper leg) of all re-injuries, respectively.

Seasonal disposition and injuries

In each maturity group, September was the predominant month for injuries sustained, whereas June had the least number of injuries. Match injuries peaked in September in all groups while training injuries peaked in September in normal and late matures and in January in the early matures. No significant differences were reported between maturity groups in injury incidence according to month.

Discussion

The most significant observations in this first study on biological maturity and injury in elite youth football were the higher incidence of tendinopathies, groin strains and re-injuries sustained in early-maturing players, the higher incidence of tendinopathies and osteochrondral disorders in normal-maturing players and the higher incidence of osteochrondral disorders and major injuries in late-maturing players. These results suggest that future studies of injury in elite youth football should allow for physical maturity when analyzing patterns of injury severity, type and location. No significant differences were found in overall injury incidence and seasonal disposition between players of differing maturity status. The results for overall injury incidence suggest that elite youth players of different maturity status can train and play together without increasing the risk of injury, although the breakdown of data to injury types and sites suggests that early and late matures may be vulnerable to different injuries.

Biological maturity status

In this study, the SA of players belonging to the under-14 age group was assessed in order to determine biological maturity. Within the cohort, 12.0% were classed as late maturers, 63.5% as normal maturers and 24.5% as early maturers. The average SA in years of late (11.8), normal (13.4) and early maturers (15.0) demonstrates the wide variation in maturity status in a cohort of elite under-14 youth football players. These results differ slightly from those in a study on elite 13- to 14-year-old Portuguese players where 7% of the group were classed as late, 55% as normal and 38% as early matures, respectively (Malina et al., 2000). This discrepancy may be due to differences in the selection policies (physical, technical and tactical skills) of elite development Centres. Nevertheless, these results indicate that like their Portuguese counterparts, elite French youth football players based at the INF tend not to be delayed in skeletal maturity.

Injury incidence and severity

To evaluate the injury risk in a certain sport, the exposure factor needs to be considered. This study on elite French youth players indicates an overall injury rate of acquisition ranging from 4.6 to 5.7/1000 h playing exposure for the three maturity groups concerned. Exposure time in the present study was calculated per player on an estimate of 1.5 match hours/week. To calculate the exact incidence of injury, real exposure time should be documented for each player (Hagglund et al., 2005). Collecting match exposure on a team basis rather than for individual players does not take into account exposure time lost because players are temporarily or permanently absent (Fuller et al., 2006). Therefore, the match exposure time of the present players may have been overestimated and the real incidence of injury may be underestimated as injury rate varies according to the quantity of football played (Junge & Dvorak, 2000). It is often impractical to record individual exposure time in elite youth football because of the working practices of academies and certain footballers play for different clubs, causing difficulties in reliable data-collection procedures. Therefore, previous reports on elite youth football have either omitted exposure time (Volpi et al., 2003; Price et al., 2004) or have used estimates (Le Gall et al., 2006) as was done in the present study. Nevertheless, the injury rates sustained by the present players are within the range of incidences previously reported in studies on youth football players (0.9–29.9/1000 h play) reported by Price et al. (2004).

Up to now, the maturity status of youth participants has not been systematically related to injury in football and the available data are inconsistent (Malina, 2001). In the present study, no significant difference in the general incidence of injury was reported between elite youth players classed into
groups according to individual maturity status. Similarly, no difference was reported between groups in the incidence of both training or match injury. These results are in accordance with the conclusions from the study by Backous et al. (1988) on youth players participating in an amateur summer football camp. The authors reported that maturity status does not seem to be an important discriminator of who gets injured playing football. The lack of significant difference reported in the present study in the incidence of both training or match injury between players varying in maturity status would refute the idea that coaching and medical staff involved in elite youth football should match players according to maturity status to avoid increasing the risk of injury.

A higher incidence of injury was reported in the more mature, biologically older players compared with players belonging to the late-maturing group, although this result did not reach statistical significance. Previous reports have shown that injury increases with age in adolescent players (Backous et al., 1988; Inklaar, 1994; Schmikili & Bol, 1995; Volpi et al., 2003; Price et al., 2004; Emery et al., 2005; Le Gall et al., 2006). It has been suggested that injury rates in youth football increase with age due to the greater competitiveness of older players (Price et al., 2004), and more aggressive play and greater risk taking are associated with increased maturity (Backous et al., 1988). The risk of injury in football is directly related to playing actions and incidents (Andersen et al., 2003) and the possible willingness of more mature players to engage in such contests may lead to a higher occurrence of injury.

The impact of an injury can be considered in relation to its severity, and age has been shown to be a significant factor in severe injury (Chomiak et al., 2000). Both early and normal matures sustained a non-significant higher incidence of moderate injuries compared with late matures. In contrast, a significantly higher incidence of major injuries was reported in late matures compared with early matures. These observations demonstrate that whatever the maturity status of elite youth players, they are susceptible to moderate and/or serious injury whenever they compete. However, the overall percentage of severe injury across all groups may be considered as being relatively low when compared with the study of Price et al. (2004) on elite English youth players (10% vs 22%), and the majority of major injuries were non-traumatic and classed as overuse. This discrepancy in severe injuries compared with the English players may be due to differences in playing style and intensity as regional differences exist in injury in elite football (Walden et al., 2005b).

In elite youth football, the impact of injury has to be considered from the point of view of the player’s development and skill acquisition (Charness, 1985). In the present study, both normal- and late-maturing players reported a longer average layoff time per injury and were absent from training and competition for a longer time than early matures. Normal and late matures therefore lost a larger percentage of development time to injury compared with early matures (early = 8.0% vs normal = 11.1% vs late = 9.9%). The impact of this greater proportion of development time lost to injury could be damaging for a more immature elite player’s chances of signing a contract as a full-time professional. A study comparing injury incidence and maturity in elite youth players who did not acquire a professional contract against those who succeeded in signing a contract as a full-time professional may be warranted.

Re-injuries

Re-injury has been found to be accountable for 3% of all documented injuries in elite English and French youth players (Price et al., 2004; Le Gall et al., 2006) and 7% in English senior professional players (Hawkins et al., 2001), respectively. These results compare with 3.1% of all documented injuries in the present study. As in these studies, the majority of re-injuries were sprains and strains, suggesting inadequate rehabilitation and premature return to football (Hagglund et al., 2005). Early-developing players sustained a significantly greater incidence of re-injury compared with normal and late developers. There is a necessity for controlled rehabilitation program and strict adherence to these program (Hawkins et al., 2001), which may be more difficult in youth players who want to return to play as quickly as possible, regardless of the consequences. When returning to play following injury, factors such as the importance of a game or practice, pain tolerance, motivation and personality may also play a part in how quickly a player can come back (Emery et al., 2005). Any one or a combination of these factors could explain the differences in re-injury reported in the present study. However, the reasons for this difference in re-injury rates between maturity groups remain to be clarified and further investigation is warranted into links with previous injury, current rehabilitation policies and injury reoccurrence.

Type and location of injuries

In late- and normal-maturing players, the knee was the most common location for injury/1000 h exposure compared with the thigh in early matures. One explanation for this result was an increased number of osteochondral knee disorders in both the late and normal groups. A significantly higher incidence of groin injuries was reported in early compared with
late maturers. This result was due to an increased incidence of strains to this location. Otherwise, no other statistical differences in injury location were reported between groups. Although the general lack of significant difference in injury location between maturity groups in the present report is in accordance with that previously presented for different age groups (Inklaar, 1994), the pattern of injury location in elite under-14 players seems to vary according to maturity status.

The most common types of injury in this study were contusions, sprains and strains, a finding similar to the results obtained by Price et al. (2004) and Le Gall et al. (2006) on elite English and French youth football players, respectively. The incidence according to the type of overuse injuries varied significantly between maturity groups. A higher incidence of tendinopathies was reported in normal- and early-maturing players, whereas the highest incidence of osteochondral disorders (in particular, Osgood–Schlatter’s disease) was sustained in late and normal maturers. These findings demonstrate that elite French under-14 players are at risk of incurring overuse injuries whatever their individual maturity status. Comparable results were obtained in a study on injury in elite Italian youth players (Volpi et al., 2003), in which a higher prevalence of osteochondroses was reported in younger players, while more tendinopathies were observed in older players. The immaturity of the musculo-skeletal systems of youth football players (Schmikili & Bol, 1995) and the use of training schedules that are too intensive (Le Gall et al., 2006) have been discussed as reasons for the increased incidence of overuse injury in youth football. Furthermore, the pubertal growth spurts experienced by players can lead to a loss of flexibility due to the uneven development of bone and soft tissue and may also be a contributing factor in overuse injuries (Hodson, 1988). These findings indicate the importance of identifying the onset of growth spurts to start effective early treatment and management or even prevention of these injuries (Price et al., 2004).

In the present study, a significantly higher incidence of groin sprains was reported in early-maturing players compared with other groups. Several reasons may be suggested for this higher rate of groin strains. An increased risk of leg muscle strains in players with a higher body mass was reported in a study on Australian Rules Footballers (Orchard, 2001) and body mass tends to be greater in more mature players (Malina & Bouchard, 1991). Arnason et al. (2004), using a multivariate model to investigate intrinsic factors associated with injury in elite senior Icelandic football players, showed increased age and a trend toward less hip adductor flexibility to be significant risk factors in groin strains. As youth players advanced in maturity are biologically older than their peers, age may already be considered as a risk factor in sustaining groin injuries. A study on the relationship between hip adductor flexibility and groin strains in the present elite youth footballers could be helpful. Finally, it has also been suggested that the increased rate of groin strains in elite football is due to its evolution into a faster, more demanding game (Arnason et al., 2004). More mature players may try to play the game at a faster pace, take more risks and consequently increase the chance of injury. More work is needed to identify the causes of this increased incidence of muscle strains in the more mature players. One omission from the present study is the mechanism (contact or non-contact) of injury in training and match play, especially as preventive strategies specific to football rely on having detailed information on the injury mechanisms involved (Andersen et al., 2003). The higher incidence of groin strains reported in early-maturing players is an example where a closer look at injury mechanisms in both training and matches could be addressed.

Seasonal disposition and injuries

The seasonal disposition has been linked to injury incidence in elite football (Hawkins et al., 2001; Walden et al., 2005a; Le Gall et al. 2006). In the present study, no significant differences were found in monthly injury incidence, type and location between maturity groups. This finding suggests that injury rate according to maturity status is generally not affected by seasonal disposition. In all maturity groups, injuries peaked in September, the month after pre-season training. It has been suggested that a sharp increase in early season injury rates in elite youth football is due to an overintense training program that does not allow adaptation to occur (Price et al., 2004).

Perspectives

Preventative measures are based on epidemiological research and this first study on injury and biological maturity in elite youth football provides an opportunity to appraise current prophylactic and prehabilitation strategies. Through focusing on the maturity and injury relationship, it has also highlighted a number of areas warranting further research.

As injury rates generally increase with increasing CA, we feel it would be pertinent to examine how injury incidence and patterns evolve in elite youth players according to maturity status when under-14 groups progress to under-15 and under-16 levels. There also remains a need to investigate further the
primary intrinsic and extrinsic factors associated with injury in elite youth football. A multivariate model combining other risk factors with maturity status could be helpful in understanding the contribution of the various factors in injury etiology and to explore their interrelationship (Meeuwisse, 1994).

Both exposure time and the lack of information on injury mechanisms have been discussed as limitations of the present study. Work with the youth clubs where the footballers in the present study play is underway to agree on a common injury-reporting protocol based on the recent UEFA model (Hagglund et al., 2005) and injury consensus statement (Fuller et al., 2006) to record exposure and epidemiological data during matches.

Key words: football, injury, maturity, youth, incidence.

References

