Risk and consequences of osteoarthritis after a professional football career: a systematic review of the recent literature

V. GOUTTEBARGE 1, H. INKLAAR 2, M. H. W. FRINGS-DRESEN 1

Background. The aim of the present study was to assess whether previous injury is a risk determinant for knee and ankle osteoarthritis (OA) in former professional football players and to explore OA-related activity and work limitations.

Methods. To retrieve the relevant recent literature, the Medline, Embase and Sportdiscus databases were systematically searched for studies published from January 2000 to May 2012. Included studies must be primary studies that are written in English, Dutch, French or German and involve former professional football players; injury had to be studied as an independent variable; and knee/ankle OA, work participation or limited activities had to be described as an outcome. The data from included studies were extracted using a standardised extraction form, and the methodological quality was assessed.

Results. No studies were retrieved about injury as a risk determinant for knee/ankle OA in former professional football players. Four studies about OA-related activity and work limitations were included (three of high and one of moderate methodological quality). Up to 17% of former professional football players with knee/ankle OA reported suffering from joint pain and discomfort during activities such as squatting, walking and climbing stairs. Former professional football players with knee/ankle OA reported that their conditions were very painful, chronically painful and affected their daily lives, while 28% reported work-related limitations.

Conclusion. Knee and ankle OA in former professional football players causes joint pain and discomfort that has negative consequences for daily life and work activities. An OA health examination program should be developed to empower the sustainable health and functioning of professional football players.

Key words: Osteoarthritis, knee - Osteoarthritis, ankle - Football.

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In professional sports, athletes are exposed to intense and prolonged physical demands that regularly exceed normal health capacities during both training and competition. 1,2 This continuous excessive exposure, in combination with insufficient recovery time, has been suggested to lead to acute, chronic and/or recurrent injuries of the musculoskeletal system. 3,4 In professional football (i.e., soccer), the occurrence of musculoskeletal injuries has been explored worldwide. Among Argentine, English and Swedish professional football players, the incidence of injuries is high and primarily involves hamstrings, knees and ankles. 3,5-9 In the Netherlands, professional football players are also at risk for injuries to the lower limbs, 37% of whom report injuries of the knee and ankle (ligament, meniscus or cartilage injury). 10 As in other sports, these injuries are the main reason for sick leave: 10% of professional players are unable to work during either training or competition because of these short-term health problems. 9 Whether exposure to intense and prolonged physical demands during a professional football career also leads to long-term health problems remains unclear.

Scientific literature on the long-term health effects of professional sports is scarce, outdated and presents contradictory evidence. While former elite athletes appear to
have a lower risk of chronic diseases such as heart disease, heart failure, diabetes, asthma and bronchitis, compared to healthy individuals of similar age, professional athletes seem to suffer from other negative long-term health effects, especially osteoarthritis (OA). OA, or “degenerative joint disease”, is the most common rheumatic disease and results in irreversible pathologic changes in affected joints that can lead to negative symptoms (pain, stiffness, reduced function, instability, deformity and swelling crepitus) and activity limitations. OA is caused by the overuse of joint cartilage and appears in people over the age of 30; the hand, hip and knee joints are most commonly affected. OA is the leading cause of pain of the musculoskeletal system and is the 10th leading cause of disability in high-income countries, where it is responsible for 2.5% of the total disability adjusted life years (DALYs). Risk factors for developing OA are well known and include age, gender, obesity, joint injury and abnormal biochemical loads on joints. Several occupational activities, including squatting, kneeling and lifting, have been identified as risk factors for OA.

OA is a significant long-term health condition, especially in occupational sectors with physically demanding jobs: 34% of floor layers who are 50 years of age or older have been diagnosed with knee OA that might lead to activity limitations and related disability. Studies have suggested that former elite athletes from various disciplines (including football) have an increased risk of hip, knee and ankle OA despite having high bone density and good muscle function. Empirical studies have suggested that this increased risk of OA in former elite athletes is associated with the occurrence of knee and ankle injuries (ligament, meniscus or cartilage) during their careers. In a recent systematic review, we determined that the prevalence of knee (40-80%) and ankle (12-17%) OA in former professional football players was high compared to the general Dutch population (matched for age) and compared to construction workers. Whether knee and ankle OA has long-term effects on activities and work participation in former professional football players after retirement remains unclear.

Based on this information, the aim of this study was to systematically review the recent literature to assess whether previous injury is a risk determinant for knee and ankle OA in former professional football players and to explore OA-related activity and work limitations. Two research questions were formulated: 1) do former professional football players who had ligament, meniscus or cartilage injuries to the knee or ankle during their careers have an increased risk of knee and ankle OA; and 2) what are the consequences of knee or ankle OA on the activity and work limitations of former professional football players?

**Materials and methods**

To build a highly sensitive search strategy and to provide a systematic search, several key words and their synonyms were divided into categories. The first category consisted of synonyms for “elite football players”; the second category consisted of synonyms for “knee and/or ankle osteoarthritis”; the third category consisted of synonyms for “injury”; and the last category consisted of synonyms for “activity and work limitations”. Within each category, different synonyms were combined by the Boolean command OR.

For our first research question, the electronic databases Medline (biomedical literature) via PubMed, Embase (biomedical and pharmaceutical literature) via Ovid and SPORTDiscus (sports and sports medicine literature) via EBCoHost were searched with the relevant categories “elite football players”, “knee and/or ankle osteoarthritis” and “injury” linked by the Boolean command AND. For our second research question, the electronic databases Medline and Embase were searched, with the relevant categories “elite football players” “knee and/or ankle osteoarthritis” and “activity and work limitations” linked by the Boolean command AND.

All databases were search for the past 12 years (from January 2000 to May 2012), and the literature was limited to human studies and to the English, French, German and Dutch languages. In Medline, we strived to use existing medical subject headings [MeSH]. For terms that did not have a medical subject heading, we searched the text [tw] or title and/or abstract [tiab]. In Embase, we used the same search terms as in Medline in combination with the term “football” and the addition of the terms used in the medical subject headings and their synonyms as listed in the MeSH database. Finally, we conducted a more sensitive search strategy in SPORTDiscus.
because this database is smaller than the others. To truncate the search terms and find all of the terms that begin with a specific word, we used a * symbol in Medline and a $ symbol in Embase and SPORTDiscus. The exact search strategy is available upon request.

The inclusion criteria were defined and used to acquire all relevant literature. To be eligible for inclusion in our review with regard to the first research question, the following criteria needed to be met:
1. the article must be an original, i.e., a primary study;
2. the article must be written in English, Dutch, French or German;
3. the population of interest must be composed of former professional (soccer) football players;
4. a comparison group (former professional football players) must be involved in the study;
5. injury must be studied as an independent variable;
6. OA of the knee or ankle must be described as an outcome.

To be eligible for inclusion in our review with regard to the second research question, the following criteria needed to be met:
1. the article must be an original, i.e., a primary study;
2. the article must be written in English, Dutch, French or German;
3. the population of interest must be composed of former professional football (soccer) players suffering from OA of the knee or ankle;
4. activity or work limitations must be described as an outcome.

After identifying and deleting all duplicates, two authors (VG and MFD) independently applied the inclusion criteria to the titles and abstracts of the studies to identify potentially relevant articles. Studies were included for full text selection if they met the inclusion criteria or if the title and abstract did not provide sufficient information to determine whether the inclusion criteria were met. Then, full articles of these studies were obtained, and the inclusion criteria were applied to the full text independently by the same two authors. Any disagreements regarding the inclusion or exclusion of full articles were resolved by consensus. To avoid missing any relevant publications, the references of included studies and/or retrieved literature reviews were screened.

Data were extracted from the original articles by one author (VG) with a standardised extraction form and independently checked by another author (HI). Depending on the research question, the following topics were included:
- article information (author, year, country, reference number);
- information about the study population (population size, age, sex, nationality, duration of professional soccer career, method/sources of selection);
- study design and information about the comparison group (if applicable);
- definition and measurement of injury (if applicable);
- definition and measurement of knee and/or ankle OA (instrument);
- definition and measurement of activity and work limitations (if applicable);
- main result(s) of the study (risk, association, descriptive analyses).

The methodological quality of all included articles was assessed by one author (VG) and independently checked by another author (HI). The quality assessment was based on existing criteria that were adapted to better suit the purpose of our review: 11 criteria with regard to the first research question and nine criteria with regard to the second research question. All criteria are presented in Table I and refer to the following aspects: selection and description of the participants (two criteria), study design and (if applicable) related control group (two or three criteria), definition of independent variable (injury/knee and/or ankle OA) and its measurement (two criteria); definition of outcome (knee and/or ankle OA/activity and work limitations) and its measurement (two criteria); data presentation and (if applicable) confounders (one or two criteria). If possible, each item was qualified as "positive", "negative" or "unclear".

Any disagreements were resolved by consensus. A total quality score was calculated for each study by summing all positive criteria (maximum score of 11 with regard to the first research question and 9 with regard to the second research question). Studies with more than seven or six (with regard to the first and second research question, respectively) positive criteria were considered to be of high quality; those with four to six (first research question) or three to five (second research question) positive criteria were considered to be of moderate quality, and those with
TABLE I.—Criteria for methodological quality.25-27

1a. Participants selection
+ Sources and selection methods of participants were clearly described.
- No description of sources or selection methods of participants.

1b. Participants description
+ A minimum of four of the following characteristics of participants were presented: number, age, sex, nationality, duration of professional career, time en quantitative exposure to knee and/or ankle activities between end career and study, post-career medical treatment.
- Less than four characteristics of participants were presented.

2a. Study design
+ The study design is clearly stated.
- The study design is not clearly stated.

2b. Drop outs (if applicable)
+ Information about drop-outs were presented.
- No Information about drop-outs were presented.

2c. Control group (if applicable)
+ A minimum of three of the following characteristics of the control group were presented: number, age, sex, nationality, duration of professional career.
- Less than three characteristics of the control group were presented.

3a. Definition of independent variable (injury / knee and/or ankle osteoarthritis)
+ Independent variable was defined.
- Independent variable was not defined.

3b. Measurement of independent variable (injury / knee and/or ankle osteoarthritis)
+ The instrument to assess the independent variable was valid or had been previously used in a peer-review.
- The instrument to assess the independent variable was not valid or had not been previously used in a peer-review.

? Unclear if instrument to assess the independent variable was valid.

4a. Definition of outcome (knee/ankle osteoarthritis/ activity and work limitation)
+ The outcome (knee/ankle osteoarthritis/ activity and work limitation) was defined.
- The outcome (knee/ankle osteoarthritis/ activity and work limitation) was not defined.

4b. Measurement of outcome (knee/ankle osteoarthritis/ work participation and limited activities)
+ The instrument to measure the outcome (knee/ankle osteoarthritis/ activity and work limitation) was valid or had been previously used in a peer-review.
- The instrument to measure the outcome (knee/ankle osteoarthritis/ activity and work limitation) was not valid or had not been previously used in a peer-review.

? Unclear if instrument to measure the outcome (knee/ankle osteoarthritis/ activity and work limitation) was valid.

5a. Data presentation
+ The results of the data analyses were clearly presented.
- The results of the data analyses were not clearly presented.

5b. Confounders (if applicable)
+ Potential confounders were described and involved in the analyses.
- Potential confounders were not described and not involved in the analyses.

less than four (first research question) or three (second research question) positive criteria were considered to be of low quality.

Results

For our first research question, a total of 90 potentially relevant citations were retrieved from our literature searches of Medline, Embase and SPORTDis-
Table II.—Results of the methodological quality description.

<table>
<thead>
<tr>
<th>Authors</th>
<th>Participants</th>
<th>Design</th>
<th>Independent variable</th>
<th>Outcome</th>
<th>Data presentation</th>
</tr>
</thead>
<tbody>
<tr>
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<td>1a 1b 2a 2b 2c</td>
<td>3a 3b 4a 4b 5a 5b</td>
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<tr>
<td>Drawer 28</td>
<td>+</td>
<td>+</td>
<td>+ - n/a</td>
<td>- - + ? + n/a</td>
<td></td>
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<tr>
<td>Elleuch 29</td>
<td>+</td>
<td>+</td>
<td>+ - n/a</td>
<td>+ + + + n/a</td>
<td></td>
</tr>
<tr>
<td>Turner 30</td>
<td>+</td>
<td>+</td>
<td>+ - n/a</td>
<td>+ - + + n/a</td>
<td></td>
</tr>
<tr>
<td>Turner 31</td>
<td>+</td>
<td>+</td>
<td>+ - n/a</td>
<td>+ - + ? + n/a</td>
<td></td>
</tr>
</tbody>
</table>

Comparison group (N.=1), injury was not studied as an independent variable (N.=3), knee and/or ankle OA was not the subject of interest (N.=2), and no risk outcome between injury and OA was presented (N.=1). The reference check of the 12 literature reviews retrieved two additional original studies to check for inclusion; however, neither full text met our inclusion criteria. The flowchart of our search procedure is available upon request.

For our second research question, a total of 48 potentially relevant citations were retrieved from the literature searches of Medline and Embase. After checking for duplicates and applying the inclusion criteria to the titles and abstracts, three literature reviews were identified, and 11 potentially relevant original studies were included for the full text review. From these full texts, seven were excluded for one or more of the following reasons: the article was not written in English, Dutch, French or German (N.=2), the population of interest did not consist of former professional (soccer) football players with knee or ankle OA (N.=10), or work participation or activity limitations was not the subject of interest (N.=5). The reference check of the three literature reviews and four included studies did not result in any recent primary studies. The flowchart of our search procedure is available upon request.

Finally, as a result of our systematic search strategy for our second research question, four original studies were included; outcomes related to activity limitations were presented in all four studies, and outcomes related to work limitations were presented in two of the four studies.28-31 Based on our methodological quality assessment, three studies were evaluated as having high methodological quality, while one study had moderate methodological quality. The results of the methodological quality assessment are presented in Table II, and the complete data extraction of the four included studies is presented in Table III.

Drawer et al. used a cross-sectional design and distributed a questionnaire to 500 retired English professional soccer players who were registered with the English Professional Footballers’ Association (PFA).28 The mean age (SD) of the 185 responders was 47.6 (13.2) years, and their professional careers had a mean duration of 14.3 years. Fifty-nine respondents (32%) reported that they had been diagnosed by a medical specialist with OA in hip, knee and/or ankle. The mean age (SD) at diagnosis was 36.1 (12.8) years for the right knee, 35.2 (11.5) years for the left knee, 29.5 (4.2) years for the right ankle and 31.6 (5.8) years for the left ankle. Of the former professional football players with knee OA, nearly 17% reported that they suffer from knee pain during any activity of daily life. Almost 15% suffer from knee pain during squatting, 11% during walking more than one kilometre and climbing stairs and nearly 8% during getting up, sitting and standing.28 Of the former professional football players with ankle OA, less than 3% reported that they suffer from ankle pain during any activity of daily life. Almost 2% suffer from ankle pain if they walk more than one kilometre, 1.5% if they get up and standing, and more than 1% if they squat.28

Elleuch et al. used a cross-sectional design to study the pain level and functional disability in 50 male former top-level soccer players from a first division local club in Tunisia, 40 (80%) of whom suffered from knee OA based on radiographic examinations.29 Their mean age (SD) was 49.2 (3.8) years, and the mean total duration (SD) of their professional careers was 10.7 (4.6) years. Pain levels were assessed by a visual analogue scale (VAS), and functional disability was assessed by the Lequesne index (from 0 to 24, with a higher score indicating more impairment). The mean (SD) pain level score reported by the former professional football players with knee OA was 2.5% (0.6) while the Lequesne index score was 0.4 (1.3).29
### Table III: Activity and work limitation related to knee and ankle osteoarthritis: data extraction from included studies.

<table>
<thead>
<tr>
<th>Article information</th>
<th>Study population</th>
<th>Study design</th>
<th>OA definition and measurement</th>
<th>Activity and work limitation</th>
<th>Main results</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Author: Drawer</strong></td>
<td><strong>N = 185, within 59 (32%) with OA in hip, knee and/or ankle</strong>&lt;br&gt;N = male&lt;br&gt;Nat = ?&lt;br&gt;PC = 14.3 yr&lt;br&gt;M = English Professional Footballers' association&lt;br&gt;T = 15.1 yr&lt;br&gt;E = ?&lt;br&gt;MT = ?</td>
<td>Cross-sectional based on self-report. Cross-sectional based on self-report.</td>
<td>OA of the lower limbs; not defined. Measurement: questionnaire based on established knowledge and criteria for assessing the presence of OA; data obtained when a medical specialist first officially diagnosed OA.</td>
<td>Current joint pain during (static and dynamic) daily activities. Measurement: questionnaire used in previous study and validated for joint pain.</td>
<td>Proportion of knee joints pain:&lt;br&gt;- any daily activity: 16.8%&lt;br&gt;- sleeping: 4.6%&lt;br&gt;- getting up: 7.8%&lt;br&gt;- sitting: 8.1%&lt;br&gt;- standing: 7.6%&lt;br&gt;- climbing stairs: 10.7%&lt;br&gt;- walking &gt; 1 km: 11.0%&lt;br&gt;- squatting: 14.8% Proportion of ankle joints pain:&lt;br&gt;- any daily activity: 2.6%&lt;br&gt;- sleeping: 0.3%&lt;br&gt;- getting up: 1.5%&lt;br&gt;- sitting: 0.6%&lt;br&gt;- standing: 1.7%&lt;br&gt;- climbing stairs: 1.2%&lt;br&gt;- walking &gt; 1 km: 1.8%&lt;br&gt;- squatting: 1.2%</td>
</tr>
<tr>
<td><strong>Country: United Kingdom</strong></td>
<td><strong>Reference: 28</strong></td>
<td></td>
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</tbody>
</table>

| **Author: Elleuch**  | **N = 50, within 40 (80%) with OA in knee**<br>A = 49.2 yr (SD = 3.8)<br>S = male<br>Nat = ?<br>PC = 10.7 yr<br>M = Local clubs<br>T = ≥ 20 yr<br>E = ?<br>MT = ? | OA of the knee based on standard radiological criteria (Kellgren and Lawrence). Measurement: Radiographic examination (front and side views when standing with slight flexion and femoropatellar view with 45° flexion). | Pain level and functional disability Measurement: - Visual analogue scale (VAS) for pain level (from 0 to 10). - Lequesne index for functional disability (from 0 to 24; higher scores meaning more impairment). | VAS: 2.54 (SD=0.63) Lequesne index: 0.38 (SD=1.27) | |
| **Country: Tunisia** | **Reference: 29** | | | | |

| **Author: Turner**  | **N = 284, within 138 with OA in any location, 82 with OA in right knee, 62 with OA in left knee, 33 with OA in right ankle, 20 with OA in left ankle**<br>A = 56.1 yr (SD = 11.8)<br>S = male<br>Nat = ?<br>PC = 13.5 yr (SD = 5.3)<br>M = Former Players Associations<br>T = 23.8 yr<br>E = ?<br>MT = surgery, physiotherapy, acupuncture, medication | Cross-sectional based on self-report. | OA; not defined. Measurement: questionnaire in which respondents were asked if they had been diagnosed with OA and at what age they were diagnosed. | Health related quality of life in terms of current and future health, and work disability. Measurement: - questionnaire EuroQol (EQ-5D) for pain/discomfort, mobility, usual activities, anxiety/depression and self care (from 0, death, to 1, perfect health); validated for arthritis. - Visual analogue scale (VAS) for current and future health (from 0 to 100; higher scores meaning better health). - Open ended question | EQ-5D:<br>- overall: 0.58 (SD=0.31)<br>- pain/discomfort: 89%<br>- mobility: 68%<br>- usual activities: 61%<br>- anxiety/depression: 37%<br>- self care: 17%<br>VAS:<br>- current health: 56.4 (SD=25.6)<br>- future health: 60.2 (SD=23.3) Work related problems: 28% | |
| **Year: 2000** | **Reference: 30** | | | | | (Continued) |
### Table III.—Activity and work limitation related to knee and ankle osteoarthritis: data extraction from included studies.

<table>
<thead>
<tr>
<th>Article information</th>
<th>Study population</th>
<th>Study design</th>
<th>OA definition and measurement</th>
<th>Activity and work limitation</th>
<th>Main results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Author: Turner</td>
<td>N = 12 with OA in</td>
<td>Qualitative study</td>
<td>OA; not defined.</td>
<td>Impact of OA in terms of pain, restricted mobility and movement, employment, emotional distress.</td>
<td>Pain:</td>
</tr>
<tr>
<td>Year: 2002</td>
<td>hip, knee and/or ankle, 9 with OA in knees, 2 with OA in ankles</td>
<td>based on telephone interviews.</td>
<td>Measurement: medical evidence about OA diagnostic.</td>
<td></td>
<td>- “I went down and my legs were killing me.”</td>
</tr>
<tr>
<td>Country: United Kingdom</td>
<td>A = 62.4 yr (SD = 8.2)</td>
<td></td>
<td>Measurement: self-reported based on interviews.</td>
<td></td>
<td>- “It’s very painful actually, all day everyday.”</td>
</tr>
<tr>
<td>Reference: 31</td>
<td>S = male</td>
<td></td>
<td></td>
<td></td>
<td>- “So it’s really affected life really”</td>
</tr>
<tr>
<td></td>
<td>Nat = ?</td>
<td></td>
<td></td>
<td></td>
<td>Restricted mobility and movement:</td>
</tr>
<tr>
<td></td>
<td>PC = ?</td>
<td></td>
<td></td>
<td></td>
<td>- “I can’t bend down”</td>
</tr>
<tr>
<td></td>
<td>M = Former Players Associations</td>
<td></td>
<td></td>
<td></td>
<td>- “That’s the main thing, your lack of mobility”</td>
</tr>
<tr>
<td></td>
<td>T = 31 yr</td>
<td></td>
<td></td>
<td></td>
<td>- “I can’t move hardly. I can’t get down”</td>
</tr>
<tr>
<td></td>
<td>E = ?</td>
<td></td>
<td></td>
<td></td>
<td>Employment:</td>
</tr>
<tr>
<td></td>
<td>MT = surgery, medication</td>
<td></td>
<td></td>
<td></td>
<td>- “Nobody wants you with a bad limp”</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- “They want a guy that’s health and fit”</td>
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<td></td>
<td>- “There’s not a lot we can do... my only advice is, if it’s possible, is to give yourself early retirement” (doctor)</td>
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<td></td>
<td>- “That’s why I had to finish my job because I couldn’t kneel down”</td>
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<td></td>
<td></td>
<td>Emotional distress:</td>
</tr>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td>- “I am more bad tempered. I have always been sort of happy you know. Mix with everybody and joke with everybody. I don’t do that now”</td>
</tr>
</tbody>
</table>

N: number; OA: osteoarthritis; A: mean age; yr: years; SD: standard deviation; S: sex; ?: unknown/unclear; Nat: nationality; PC: mean total length of professional career; M: method of participant selection; T: time between end career and study; E: post-career exposure; MT: post-career medical treatment; km: kilometer.

Turner et al. conducted a cross-sectional survey in the United Kingdom (UK) and distributed 515 questionnaires through the Former Player Associations (FPAs), 284 of which were returned.30 The mean age (SD) of the participants was 56.1 (11.8) years, and the mean length (SD) of their professional careers was 13.5 (5.3) years. Of these former professional football players, 138 suffered from OA in a lower limb joint, 82 from OA in the right knee, 62 from OA in the left knee, 33 from OA in the right ankle and 20 from OA in the left ankle. Health-related quality of life was assessed in terms of current and future health and work disability with the EuroQol questionnaire for pain and discomfort, mobility, usual activities, anxiety/depression, and self care (0 to 100, with a lower score indicating better health); the
visual analogue scale for current and future health (0 to 100, with a higher score indicating better health); and open-ended questions (yes/no) for work-related problems due to a professional football career. The pain and discomfort average score was 89, the mobility score was 68, the usual activities score was 61, and the anxiety/depression and self-care scores were 37 and 17, respectively. Current health scores were 56.4, and future health scores were 60.2. A total of 28% reported having work-related problems or limitations due to their professional football careers.\(^{30}\)

Turner et al. conducted a qualitative study and interviewed 12 former professional football players by telephone who were suffering from hip, knee and/or ankle OA; 9 suffered from knee OA, and 2 suffered from ankle OA.\(^{31}\) Telephone interviews were used to explore the impact of OA in terms of pain, restricted mobility and movement, employment, and emotional distress. With regard to pain, some former professional football players reported that their conditions were very painful and chronically painful and that the pain significantly affected their lives. With regard to restricted mobility and movement, some former professional football players reported that the lack of mobility is a major issue in their lives and that moving is hardly possible, especially bending down. With regard to employment, some former professional football players reported that no employer wanted to employ them with their conditions and that they abandoned their jobs for this reason. A physician declared that he could not do much to help and advised early retirement. With regard to emotional distress, some former professional football players reported that they were bad-tempered and unhappy.\(^{31}\)

**Discussion**

The aim of this study was to systematically review the recent literature to assess whether previous injury is a risk determinant for knee and ankle OA in former professional football players and to explore their OA-related activity and work limitations. Our search strategy and study selection found no recent study with regard to injury as a risk determinant for knee and ankle OA in former professional football players. Four studies about activity or work limitations related to knee and ankle OA in former professional football players were identified. From these studies, up to 17% of former professional football players with knee and/or ankle OA report suffering from joint pain and discomfort during activities such as squatting, walking or climbing stairs, and 28% report having work-related problems.

Our systematic review retrieved no recent studies in which the association between previous injury and knee and ankle OA was investigated among former professional football players (both study and control groups). However, older studies or studies that were performed among athletes from other sports disciplines have shown that the occurrence of knee or ankle injuries (ligament, meniscus or cartilage) is a relevant determinant for OA.

Larsen et al. showed that OA (as determined by radiographic examination) was present in 63% of injured knees and 33% of injured ankles among former footballers from the Danish national team.\(^{20}\) A study by Kujala et al. found that former Scandinavian professional athletes from several sports disciplines (runners, soccer players and weightlifters) have, 10 to 20 years after an anterior cruciate ligament or meniscus injury, an increased risk (odds ratio of 4.73) of developing early knee OA compared to professional athletes who had no ligament or meniscus injuries during their careers.\(^{23}\) In addition, surgery related to knee and/or ankle injury has been identified as a risk factor for OA.\(^{21,\ 32}\) The association between early knee and/or ankle OA and cumulative exposure to professional football and related activities is unknown. A study by Vrezas et al. found a positive dose–response relationship between the cumulative duration of football play (1600 to 7800 hours) and the diagnosis of knee OA (OR ranging from to 2.0 to 2.2).\(^{33}\)

Considering these findings, it seems that a professional football player who suffered from knee and/or ankle injuries during his career is at risk for (early) knee and/or ankle AO, even more when the injuries required surgery and when his professional football career and related activity exposure is ongoing. Consequently, the occurrence of injuries, related surgery and cumulative exposure to professional football should be monitored during a career to obtain insight into the long-term risk for (early) knee and/or ankle AO in former professional football players.

With regard to the consequences of knee and/or ankle OA for activity and work limitations among former professional players, our systematic review of the recent literature showed that former professional foot-
ball players with knee and/or ankle OA suffered from joint pain and discomfort during activities such as walking more than one kilometre, climbing stairs, squatting, getting up, sitting and standing. These players reported that their conditions were very painful, chronically painful and affected both their daily lives and their work participation.

These findings are not surprising given that OA is the most important cause of pain of the musculoskeletal system and is the leading cause of disability in Europe and the United States. Among the Dutch population, Bieleman et al. showed that occupational limitations and reduced work capacity or job effectiveness were reported more frequently by workers with OA than by controls and that OA was a significant factor in long-term disability statistics. Other studies also highlighted that most people with OA have poor health status and related disability, suggesting that OA should be specifically addressed in health programs and should be considered as a routine part of medical care.

While players with acute injuries and related health complaints generally recover and return to their sports, overuse and recurrent or severe injuries have more drastic physical and psychological (i.e., mental health) consequences during a career that might even lead to early retirement or employment restrictions. Those injuries might cause long-term adverse effects on health and functioning at the time of or following retirement from professional football. In addition, retirement itself has been recognised as a potential risk factor for post-retirement psychosocial and mental health complaints in athletes. Therefore, maintaining sustainable health and functioning during and after a professional football career should be an unequivocal priority within this occupational sector, especially with regard to post-sports life, i.e., social status and second vocational careers.

As stated by the World Health Organization and the International Labour Organization, “protection, promotion, surveillance and maintenance of the highest degree of physical, mental and social well-being of workers in all occupations long after they enter their retirement years” is a labour right and a fundamental human right that should be facilitated by social partners and stakeholders. Accordingly, and with regard to its high prevalence and related consequences, a surveillance program focusing on knee and ankle OA should be developed and implemented in professional football, ideally from the start of a career to the time of retirement (Akturk A, Inklaar H, Gouttebarge V, Frings-Dresen MHW. Medical care and support during and after a career in professional football, submitted). Such an OA surveillance program could enable one to periodically monitor knee and ankle joint (re-)injury and neuromuscular (i.e., proprioceptive) functions, allowing the early detection of players who at risk and the early application of (secondary) preventive measures. For knee OA, specific individualised exercise programs that are designed to increase muscular and neuromuscular (i.e., proprioceptive) functions around the knee and ankle have been recently promoted in the primary and secondary prevention of (re-)injury, especially for anterior cruciate ligament injuries. For ankle OA, ankle taping, braces, neuromuscular training that is meant to enhance both coordination and proprioception (sense of joint and muscular position) and/or injury awareness have been suggested for the primary and/or secondary prevention of ankle (re)injuries.

Such an OA surveillance program should also involve an end-career health examination, during which recently retired professional football players are informed about their medical conditions and potential hazardous daily life and work activities related to knee and/or ankle OA (e.g., occupational activities such as squatting, kneeling, lifting and carrying). This end-career health examination should aim to empower recently retired professional football players and give them advice about active lifestyles and relevant physical activities that might be performed (non-weight-bearing rather than weight-bearing activities) to prevent an increase in body mass and a decrease in muscular and neuromuscular function.

Conclusions

The present review of the recent literature was unable to retrieve information about injury as a risk determinant for knee/ankle OA in former professional football players but has shown that knee and ankle OA in former professional football players causes joint pain and discomfort that affect the activities of daily life and work. With regard to these findings, an OA surveillance program dealing with knee and ankle OA monitoring and related interventions should be developed.
and implemented, ideally from the start of a sports career to the time of retirement, that focuses on the promotion, protection, surveillance and maintenance of the highest degree of physical and social well-being of professional football players during and long after their careers.

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