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Health problems occurring in national-level female soccer players are different between leagues and throughout the season: a 6-month prospective cohort study

Anna Dettwiler,[1,2] Nora Wieloch [ORCID] ,[1,3] Stefan Fröhlich [ORCID] ,[1,3] Florian Imhoff,[4,5] Johannes Scherr,[1,3] Jörg Spörri [ORCID] [1,3]

ABSTRACT

Objectives This study investigated the prevalence and severity of health problems in national-level female soccer players with respect to league and seasonality.

Methods In a prospective cohort study, 46 female soccer players aged 22.8±3.9 years playing in the three highest leagues in Switzerland were surveyed biweekly using the Oslo Sports Trauma Research Centre health problem (OSTRC-H) questionnaire. All definitions and measures followed the OSTRC-H-specific recommendations. The 6-month observation period included parts of the off-season and one half of the match season.

Results The average 2-weekly health problem prevalence was 37.3% (illnesses: 8.8%; sudden onset injuries—both acute and repetitive mechanisms: 19.7%; repetitive gradual onset injuries: 12.4%) and 25.1% for substantial problems as defined in the OSTRC-H context (7.3%; 12.0% and 7.3%, respectively). The absolute injury rates amounted to 148 injuries per 100 players per half season, of which 96 injuries per 100 players per half season were substantial. Female players in the 2nd and 3rd highest national leagues showed more gradual onset injuries (p<0.001) and fewer illnesses than those in the top league (p<0.05). At the same time, there were no league-specific differences in sudden onset injuries. Such injuries had a higher cumulative severity score than gradual onset injuries. Among sudden onset injuries, the ankle was the most affected body part, while the thigh was affected by for gradual onset injuries. The average 2-weekly health problem prevalence values steadily increased during the match season.

Conclusion Among national-level female soccer players, the risk of health problems is relatively high and differs between leagues and across seasons.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ While most studies have focused on male soccer players and the international level, little is known about health problems in national-level female soccer players.

WHAT THIS STUDY ADDS

⇒ This study provides insights into the prevalence, severity and patterns of health problems in female soccer players playing in the three highest leagues in Switzerland. It reveals distinct differences between the leagues and across the season.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ This may imply that potential prevention strategies should be tailored to the different health problem patterns across leagues and throughout the year.

INTRODUCTION

With a rapidly growing number of over 13 million girls and women playing worldwide, soccer is the sport with the highest popularity among females.[1] An elite female soccer player suffers from at least one injury per season.[2] Female soccer players encounter a high risk of severe injuries (injury incidence rate of 15.3 per 1000 hours).[3] However, female soccer leagues have recently become increasingly professionalised and physically demanding,[4] and prospective observations depicting the current health situation of national-level female soccer players are scarce. While there is plenty of evidence on male soccer player epidemiology, these findings cannot be simply transferred to female soccer (especially not on lower levels than the top national leagues),[5] which differ in various aspects such as organisational settings or game patterns.

Knowing that the health problems of individual players may impact the game performance of the entire team[6] and may be decisive for the further sports careers of the players affected, player health protection should be a key strategy of professional male and female soccer clubs and their governing bodies. As part of a fundamental process towards risk mitigation, the first step is typically the description of the extent

and patterns of the occurring health problems. In this regard, the Oslo Sport Trauma Research questionnaire on health problems (OSTRC-H) offers the gold standard methodology for prospectively surveying health problems (ie, illnesses, sudden onset injuries, gradual onset injuries) based on player self-reporting.[7] Moreover, it fully aligns with the current International Olympic Committee recommendations on methods for recording and reporting epidemiological data on injury and illness in sports.[8]

Specifically, data on female soccer epidemiology within national leagues are completely absent. Accordingly, this study investigated the prevalence, severity and patterns of health problems in national-level female soccer players with respect to league and seasonality in Switzerland.

METHODS
Participants and setting
Forty-six 'semi-elite' (as defined in Swann *et al*[9]) female soccer players who are playing in the three highest national soccer leagues in Switzerland participated in this prospective cohort study. The three highest leagues in descending order are the Women's Super League, the National League B (NLB) and the 1st League. Recruitment was performed based on personal inquiries at the soccer clubs of the highest three leagues. It included females between 17 and 35 years of age playing in one of Switzerland's aforementioned national soccer leagues. Exclusion criteria were any injuries at the beginning of the season in July 2021 that prevented the players from participating in regular training or games, as well as a previous history of anterior cruciate ligament tear or previous knee, hip or ankle surgeries. The observation period included the first half of the soccer season and started in July 2021. This included the 4 weeks before the match season started, and the observation period ended in December 2021, 2 weeks after the last game (ie, before the winter break). During those 6 months, the participants received 2-weekly online questionnaires regarding their health problems, as described below. Patients or the public were not involved in our research design, conduct, reporting, or dissemination plans.

Data collection
Baseline assessments
The following measures were collected at baseline: age, weight (with 0.1 kg steps) and height (with 1 cm intervals).

Prospective data collection by questionnaire
Health problems were systematically registered using the updated OSTRC-H questionnaire.[7] The OSTRC-H questionnaire is a validated illness and injury surveillance tool in which players prospectively and at regular intervals answer four basic questions about participation, training modification, performance and pain, and if reporting a health problem also indicate the type of problem (sudden-onset injury, gradual onset injury or illness), along with the body area injured or symptoms caused by the illness.

In the current study, OSTRC-H questionnaires were completed by the female soccer players at a 2-weekly frequency over half a season (ie, 6 months from July until December 2021). In each case, questions were asked about illnesses, sudden onset injuries and gradual onset injuries related to the last 14 days. The exact wording was based on a validated German translation of the OSTRC-H questionnaire.[10] All data were collected every second Monday using the secured electronic data capture and management tool REDcap.

Along with the OSTRC-H questionnaire, the participants reported the amount of played training and game time minutes over the past 14 days. If participants did not complete the questionnaire on the first attempt, the first reminder was automatically sent 2 days later. If an answer was still missing, the respective participants were contacted personally.

Data evaluation and measure calculations
Injury classification
From the responses to the OSTRC-H questionnaire, and in accordance with Clarsen *et al*,[11] health problems were divided into illnesses and injuries. Injuries were further classified into sudden onset (ie, both acute and repetitive mechanisms) or gradual onset injuries (ie, repetitive mechanism), as well as affected body regions. Sudden onset injuries were defined as those having a clear event linked to the onset.[11] To ascertain medical correctness, a physician was asked to reclassify the injuries in uncertain cases correctly. Health problems that led to moderate or severe reductions in training volume, moderate to severe reductions in sports performance or complete inability to participate in sports (answers 3, 4 and 5 in question 2 or 3 of the OSTRC-H questionnaire were selected) were defined as substantial.[11] A health problem was considered new if the players selected the 'first time documentation' box in the OSTRC-H.

Measure calculations
Prevalence was expressed as the average 2-weekly prevalence in which the number of players reporting at least one specific health problem over 2 weeks is divided by the total number of players who completed the questionnaire. This measure was calculated for all and substantial health problems accordingly. The absolute injury rate was defined as the total occurrence of injuries per 100 players over the observation period of half of one season, also known as clinical incidence.[12] A 2-weekly severity score from 0 to 100 was calculated for each health problem and added to a cumulative value, further divided by the number of surveys in which an injury was reported to receive the average 2-weekly severity score.[11] Cumulative severity scores were the accumulated 2-weekly severity

scores over the timeframe the corresponding health problem was reported.

Statistical analysis

SPSS software V.28.0 was used for statistical data analysis. Baseline characteristics, as well as training/game time, were reported as the mean±SD. Prevalence data are presented as the mean values with 95% CIs across the entire 6-month observation period. To investigate subgroup differences (eg, Super League vs NLB/1st League; sudden onset vs gradual onset injuries), unpaired sample t-tests were performed. Wherever the data deviated from the normal distribution (ie, the severity of health problems), medians with IQRs of 25% and 75% were used, and Mann-Whitney U tests were applied to compare the different types of health problems (illness, sudden onset injuries and gradual onset injuries). The level of statistical significance was set at $p < 0.05$. Regarding injury location, the number of all and substantial injuries per body location was reported. For longitudinal illustration purposes, average 2-weekly prevalence and training time values were plotted over time.

RESULTS
Baseline characteristics, training/game time and response rate

The baseline characteristics, the average training/game time and the cohorts' response rates are presented in table 1. Of the 46 female soccer players, 27 played in the Super League and 19 in the NLB and 1st League. While player weight, height and body mass index were comparable across the leagues, age and training time differed. Super League players were, on average, 4.4 years younger and trained 11 hours within 2 weeks, which is more than double the amount of time compared with the NLB/1st League. The 2-weekly game times were also slightly lower in the NLB/1st League than in the Super League. The overall response rate across the observation period of 6 months was 97%.

Prevalence of health problems

Overall, 535 responses were recorded by the OSTRC-H questionnaire. Thirty-eight players completed every questionnaire. An overview of the average 2-weekly prevalence is given in table 2. At any 2 weeks time point throughout the observed period of 6 months, 37.3% of the total cohort suffered from a health problem, with sudden onset injuries showing the highest average 2-weekly prevalence among all injuries and substantial injuries. The average 2-weekly prevalence of substantial problems was 25.1%. NLB/1st League players showed a significantly higher average 2-weekly prevalence of gradual onset injuries than Super League players ($p < 0.001$) and a significantly lower average 2-weekly prevalence of illnesses ($p < 0.05$). The absolute injury rates amounted to 74 sudden onset injuries and 74 gradual onset injuries per 100 players per half season, resulting in a total of 148 injuries per 100 players per half season. Ninety-six per 100 players per half season were substantial.

Number of incidents and severity of health problems encountered

In total, 100 health problems were reported. Of these, 32 were illnesses, 34 were sudden onset injuries and 34 were gradual onset injuries. As shown in table 3, illness had a significantly higher average 2-weekly severity score than sudden onset and gradual onset injuries. The cumulative severity score was higher for illnesses and sudden onset injuries than for gradual onset injuries. A total of 38.2% of all injuries were injuries with no time lost during match or training.

Injury location

Most sudden onset injuries were found in the ankle (26.5%), foot/toe (17.6%), knee (11.8%) and head (11.8%), with the most substantial sudden onset injuries in the ankle and foot/toe. The most affected body parts for gradual onset injuries were the thigh (23.5%), the knee (17.6%) and the tibia (17.6%), with the most substantial gradual onset injuries in the same regions. During this observation period, no injuries occurred to

Table 1 Baseline characteristics of the participants, training/game time and response rate

	Overall (n=46)	Super League (n=27)	National League B/1st League (n=19)
Age (years)	22.8±3.9	21.0±2.6	25.4±4.1
Height (m)*	1.67±0.06	1.66±0.06	1.67±0.06
Weight (kg)*	64.5±9.2	62.7±7.8	67.8±10.7
BMI (kg/m²)*	23.18±2.95	22.63±2.50	24.24±3.41
Training time (hours/2 weeks)	8.5±6.0	11.0±6.1	5.1±3.8
Game time (hours/2 weeks)	1.2±1.2	1.4±1.3	1.1±1.2
Response rate OSTRC-H (%)	97	95	99

Data are presented as the mean±SD.
*Missing data of one Super League player and three National League B/1st League players.
BMI, body mass index; OSTRC-H, Oslo Sports Trauma Research Centre health problem.

Table 2 Average 2-weekly prevalence of all and substantial health problems across the 6-month observation period for the entire cohort, as well as differentiated by the league

	Overall (n=46)	Super League (n=27)	National League B/1st League (n=19)
All health problems (%)	37.3 (33.4 to 41.2)	32.9 (27.8 to 38.0)	43.6 (37.9 to 49.2)*
Illness (%)	8.8 (7.0 to 10.6)	10.8 (7.6 to 14.0)	5.9 (3.8 to 8.0)*
Sudden onset injury (%)	19.7 (17.5 to 21.9)	19.2 (16.0 to 22.3)	20.4 (17.3 to 23.6)
Gradual onset injury (%)	12.4 (9.3 to 15.5)	7.4 (4.3 to 10.5)	19.5 (15.7 to 23.3)***
Substantial health problems (%)	25.1 (22.1 to 28.1)	25.6 (21.5 to 29.7)	24.5 (19.1 to 29.8)
Illness (%)	7.3 (5.5 to 9.0)	9.5 (6.7 to 12.3)	4.1 (2.2 to 5.9)**
Sudden onset injury (%)	12.0 (9.6 to 14.5)	13.8 (10.7 to 16.9)	9.5 (5.8 to 13.2)
Gradual onset injury (%)	7.3 (5.4 to 9.3)	4.8 (2.7 to 7.0)	10.9 (8.0 to 13.9)**

The Super League represents the highest national league; the National League B/1st League are Switzerland's second and third highest national leagues. Prevalence data are presented as the mean values with 95% CIs across the entire 6-month observation period. Level of significance based on unpaired sample t-tests.
*p<0.05, **p<0.01, ***p<0.001.
Substantial health problems were defined following Clarsen et al.[11]

the upper arm, forearm, thorax/rib, abdomen or thoracic spine. A full overview of the number of all and substantial sudden onset and gradual onset injuries per body location encountered in the entire cohort of 46 female soccer players can be found in online supplemental material 1.

Health problems and training time across the season

As illustrated in figure 1, the average 2-weekly prevalence of health problems increased during the match season and decreased again after the last game in week 22, while the training time remained relatively constant during the match season, only decreasing in the off-season. The same holds for the Super League and the NLB/1st League.

DISCUSSION

The main findings of this study were as follows: (1) The average 2-weekly prevalence among all participants amounted to 37.3% for all health problems and 25.1% for substantial health problems. Among the different injury types, sudden onset injuries had the highest average 2-weekly prevalence of all health problems (19.7%) and substantial health problems (12.0%). The absolute injury rate during the observation period was 148 injuries per 100 players per half season (74 injuries per 100 players per half season

with sudden-onset and 74 injuries per 100 players per half season with gradual-onset). Ninety-six injuries per 100 players per half season were substantial. (2) Comparing the leagues, the NLB/1st League showed a higher average 2-weekly prevalence of gradual onset injuries than the Super League but not sudden onset injuries and a significantly lower prevalence of illnesses. Another difference between the leagues was the training time, with the Super League training more than twice as long (11.0 hours) as the NLB/1st League (5.1 hours). (3) Illnesses had a significantly higher average 2-weekly severity score than sudden onset and gradual onset injuries, and the cumulative severity score was higher for illnesses and sudden onset injuries than for gradual onset injuries. A total of 38.2% of all injuries were without a time loss.

Health problem prevalence in national-level female soccer players

The results of this study support the relatively high occurrence of health problems within the group of female soccer players in the three highest leagues in Switzerland, with sudden onset injuries being more frequent than gradual onset injuries. A recent systematic review used data from Sweden, Germany, Norway, Spain, USA, Nigeria and Trinidad and Tobago and

Table 3 Number of incidents and severity of health problems encountered in the entire cohort of 46 female soccer players

	Illness	Sudden onset injury	Gradual onset injury
Number of incidents (n)	32	34	34
Average 2-weekly severity score (-)	84 (58–100)	62 (38–82)*	48 (25–66)###
Cumulative severity score (-)	100 (82–100)	100 (52–331)	57 (34–100)#+

Data are presented as medians with the 25%–75% IQR. Level of significance based on Mann-Whitney U tests.
*p<0.05 for differences between illnesses and sudden onset injuries.
#p<0.05 and ###p<0.001 for differences between illnesses and gradual onset injuries.
+p<0.05 for differences between sudden onset and gradual onset injuries.
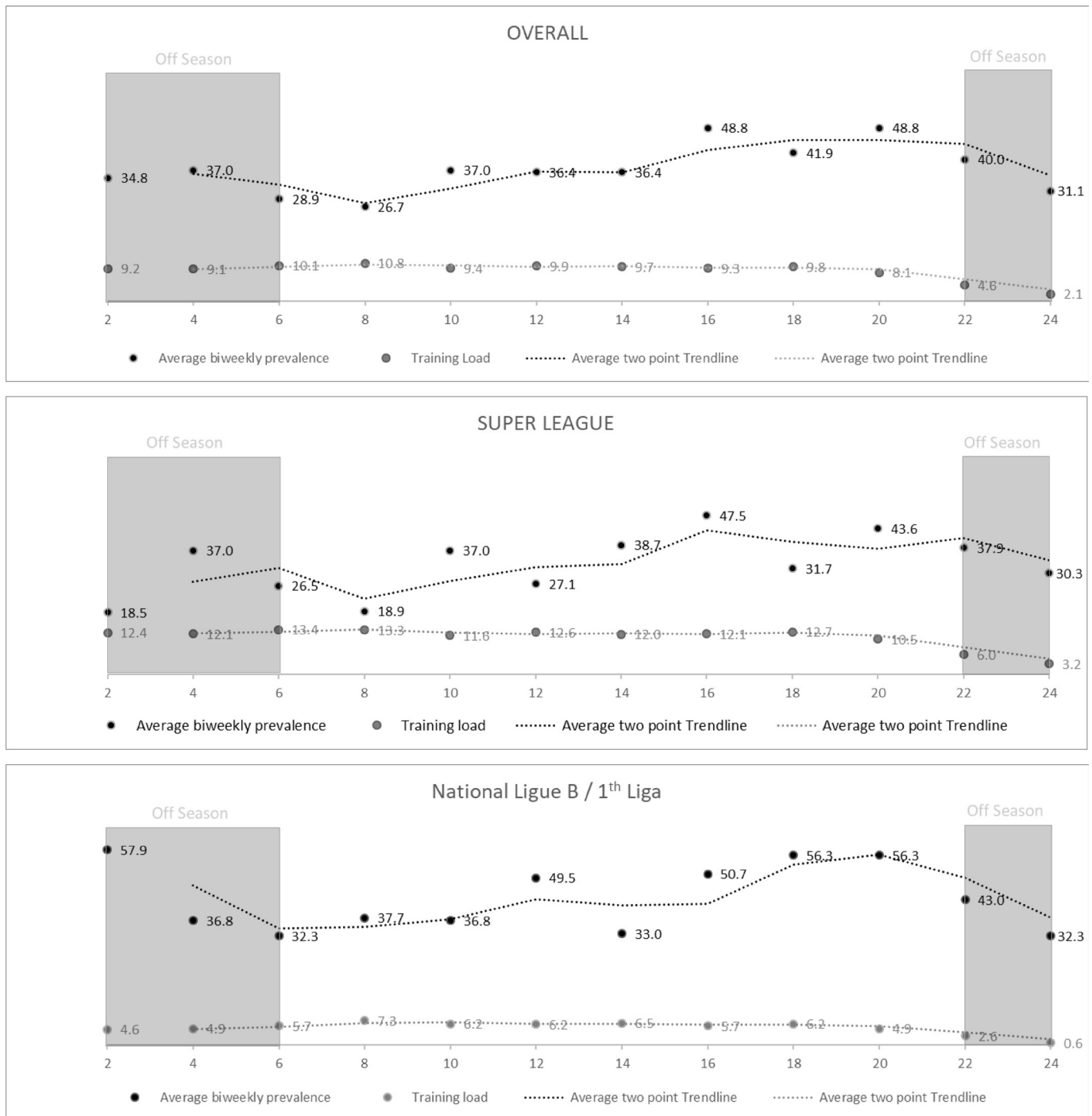
Figure 1 Average 2-weekly prevalence of health problems during the 6-month observation period in black individuals, with the corresponding average training time in grey. The dotted line represents a two-point average trendline, and the grey area shows the off-season weeks.

reported more than one injury per season for every female soccer player, with more sudden onset injuries than gradual onset injuries.[2] In European professional men's soccer, two injuries per season were reported on average.[13] In our investigation, however, we found markedly higher absolute injury rates for Swiss female soccer players (1.48 injuries per player per half season). According to the ranking by the Union of European Football Associations,[14] most

countries mentioned above are within the European female top leagues, which could explain the lower number of injuries due to more professionalism in prevention, training and medical care.

Health problems and training time according to different leagues

Female NLB/1st players showed a significantly higher average 2-weekly prevalence of gradual onset injuries

than Super League players. This finding contradicts the assumption of previous studies,[2] which stated that the risk of injuries increases with playing in a more physically demanding league. In our data, the higher average 2-week prevalence of gradual onset injuries in the lower NLB/1st leagues could be explained by a limited overall fitness level/load tolerance during matches, as the training time in these leagues is substantially smaller. Other explanations could be that the NLB/1st League players may have slightly more limited medical/physiotherapeutic team support and, at an average of 25.4 years, are 4.4 years older than the Super League players, with older age being a potential risk factor.[15] The significantly higher average 2-weekly prevalence of illnesses in the Super League could be explained through the training time, as a higher training time over a longer period increases the risk of illness[16]; therefore, monitoring the training time during the season could prevent certain illnesses.

The severity of sudden onset and gradual onset injuries
In our study at the semi-elite national level, sudden onset injuries in female soccer players were found to have higher average 2-week and cumulative severity scores than gradual onset injuries. This is in line with the findings of previous studies in elite female soccer, which reported markedly higher rates of sudden onset injuries than gradual onset injuries.[17 18] However, in our study, most sudden onset injuries affected the ankle, foot/toe and knee and not the thigh. Most were substantial injuries, so the higher severity scores appear comprehensible. Another important key finding of our study was that 38.2% of all injuries were not time-loss injuries, further highlighting the importance of using any complaint injury definition to capture the true extent of the health problems in female soccer. This is important to note since earlier studies often used a time-loss injury definition,[17 18] and thus missed these kinds of minor injuries not resulting in an absence of training or matches, but still representing a major burden for female soccer players.

Injury location
The lower extremities were most frequently affected by both sudden onset and gradual onset injuries.[13] More specifically, we found the ankle, followed by the foot/toe and the knee, to be frequently affected by sudden onset injuries, with the most substantial sudden onset injuries in the ankle and foot/toe supporting previous findings.[2 19] The most affected body parts for gradual onset injuries were the thigh, the knee and the tibia, with the most substantial gradual onset injuries in the same regions. These results align with a previous study that used the same OSTRC-H questionnaire to measure health problems in talented female athletes.[20] The affected body parts observed in this study are comparable to men's soccer, as the region most affected in male soccer seems to be the thigh, followed by the knee and ankle.[13] The biggest difference seems to be that women present with

three times fewer hip and groin injuries. Whereas the reason for this is still unclear, it may be through anatomical reasons, as the female pelvis is wider and lighter, which may transfer the strength forces differently to the lower extremities.[21] In general, these results suggest the importance of prevention programmes focusing on the lower extremity, especially on the thigh, ankle and knee, to prevent injuries in the future.

Lopez-Valenciano *et al*[2] highlighted that head injuries such as concussions or mild traumatic brain injuries are worryingly high, which is supported by our study, with 11.2% of all sudden onset injuries being head injuries. In this context, it is known that females are more likely to suffer a concussion from contact with an object (eg, a ball or goalpost), while males are more likely to suffer a concussion from contact with other players.[22]

Health problems and training time throughout the season
Regardless of the league, the average 2-weekly prevalence was lower during the off-season and steadily increased during the match season. During the off-season, the training and game time exposure was lower than during the match season; accordingly, the lower exposure time could explain the lower average 2-weekly prevalence of health problems during the off-season.[5] Furthermore, match injury incidence is typically six times higher than during training,[2] and it is plausible that there are more intense games during the competition period. Another explanation could be that the demands required in female soccer are increasing faster than the players can adapt during the transition from lower to higher leagues.

Clinical implications
Awareness of the high prevalence of injuries in female soccer players might help physicians to better recognise and understand the specific health problems of female soccer players. Moreover, knowledge of the patterns of injury occurrence and localisation could also help in developing effective and tailored preventive measures. Since the lower leagues have a higher risk of injury, as shown in this study, targeting lower league stakeholders would be one way to raise awareness and reinforce the importance of medical support and control measures for loads and health problems.

Methodological considerations
Several limitations must be considered when interpreting those results. First, the OSTRC-H data consist of self-reported health problems and are thus at risk of a potential recall bias. In addition, the classification of injuries depends on the players' judgments. To ascertain medical correctness, as already mentioned above, a physician was asked to reclassify the injuries in uncertain cases correctly. Second, it is important to highlight that to keep the response rates high over the entire 6-month prospective observation period (ie, 97% in our study), we decided to distribute the questionnaires every 14 days instead of the 7 days originally proposed by Clarsen and colleagues,[7]

and explicitly asked about the health problems occurring in the preceding 14 days. Such an approach, however, may have the following implications that need to be considered when interpreting the current study findings: (1) there may be a slightly higher risk of recall bias with a 14-day distribution frequency than with a 7-day distribution frequency; (2) when asking about health problems in the last 14 days, the average prevalence values are not directly comparable to the values resulting from the question about the problems occurring in the last 7 days. Third, based on the use of the OSTRC-H questionnaire without any further clinical assessments, it was not possible to investigate any specific diagnoses or assess anatomical structures. Fourth, another limitation could be that players from nine different teams participated in the study, and their league/team affiliation was slightly unbalanced, that is, five teams of the Super League and two teams of the NBL and two teams of the 1st League. The relatively small proportion of players from several Super League teams who participated in the study could have influenced the results (eg, if players who were frequently injured had recognised the relevance of the project and therefore decided to participate). In contrast, the larger number of players from only two teams each from the NLB and 1st League could have limited the representativeness of the results to a certain extent. Fifth, the coronavirus pandemic may have influenced the players' physical conditions at baseline in the current study and, therefore, could have slightly affected the occurrence of both sudden onset and gradual onset injuries in this study. The restrictions of training and competitions to contain the virus in Switzerland took place between October 2020 and May 2021; therefore, the normal amount of training and competition started 2 months before the baseline measurement of this study started in July 2021.

CONCLUSION

Among national-level female soccer players, the risk of suffering from health problems is relatively high and revealed to be different between leagues and across seasons. In particular, gradual onset injuries were more frequent in the lower leagues than in the top leagues. During the match season, the average 2-weekly prevalence values of all health problems steadily increased. Potential prevention strategies should be tailored more specifically to the different patterns of health problems in different leagues and throughout the year.

Author affiliations
[1]Sports Medical Research Group, Department of Orthopaedics, Balgrist University Hospital, University of Zurich, Zurich, Switzerland
[2]School of Health Professions, Institute of Physiotherapy, Zurich University of Applied Sciences, Winterthur, Switzerland
[3]University Centre for Prevention and Sports Medicine, Department of Orthopaedics, Balgrist University Hospital, University of Zurich, Zurich, Switzerland
[4]Knee Surgery, Department of Orthopaedics, Balgrist University Hospital, University of Zurich, Zurich, Switzerland
[5]Praxisklinik Rennbahn AG, Muttenz, Switzerland

ORCID iDs
Nora Wieloch http://orcid.org/0000-0001-8658-0760
Stefan Fröhlich http://orcid.org/0000-0001-7187-2074
Jörg Spörri http://orcid.org/0000-0002-0353-1021

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