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ORIGINAL RESEARCH

Reliability of an instrument to determine lower limb comfort in professional football

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Aims and Objectives: This study extends previous work in the field of injury awareness using a novel lower limb comfort index (LLCI), which was developed to assess comfort in professional football. Participants rated comfort for designated anatomical segments of the lower limb utilizing a seven point Likert scale. The aims of the study were (i) to assess the reliability of the LLCI in a competitive football environment (Australian Rules and Rugby League), and (ii) to assess whether LLCI measurements were responsive to changes in lower limb comfort over time.

Methods and Results: The reliability of the LLCI was observed in two professional football environments: Training Week (mean difference 0.1 point, intra-class correlation coefficient, ICC 0.99) for n = 41 participants; and Match Day (mean difference 0.2 points, ICC 0.97) for n = 22 players. Measurements of lower limb comfort were responsive to changes in comfort over time. Within-player differences were not significant for periods 0–8 hrs ($P > 0.05$) but, generally, significant for time periods 0–24 hrs ($P < 0.05$), and significant between 24–96 hrs ($P < 0.01$). The results indicate that the LLCI was reliable when tested for repeated measures and indicated how the index measures lower limb comfort changes over time.

Conclusion: This study shows that the use of a lower limb comfort index, when used in a competitive football environment, is both reliable and responsive to change during both a training week and under match day conditions.

Keywords: lower limb comfort, musculoskeletal, football, injury

Introduction

Lower limb injury reduction is an important consideration in professional football for numerous reasons ranging from performance-based criteria (player welfare, football skills, team cohesion without injury, winning games) to financial reasons (player payments, medical rehabilitation costs, club sponsorship based upon team success).[1,2] Injury statistics across a variety of running-based team sports (the rugby codes, football, Australian rules, and American football) indicate that the majority of injuries sustained occur in lower limbs. Lower limb injury (knee, shin, calf, foot, and ankle) in the Australian Football League over 10 years accounted for 40% of all injury,[3] with 46% for rugby league data assessed over 5 years,[4] 87% for football (soccer) over 5 seasons,[5] and 54% for 5 seasons of high school American Football.[6]

The cost of football injuries is significant in terms of financial considerations,[3,7,8] individual player considerations,[1] and retirement welfare.[3] Therefore, injury outcomes, injury prevention, and intervention methods in all codes of football have become an increasingly important focal point for researchers and clinicians.[10–15]

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An inherent difficulty in assessing lower limb injury risk factors in football is the complex, multifactorial nature of injury, which includes both extrinsic (environmental, ground surfaces, training methods, etc) and intrinsic (foot kinematics, foot/lower limb morphology, footwear) factors.[7,14,16,17] In its simplest form, injury can be classified as contact vs noncontact. Contact injuries are an accepted part of football, and are considered nonmodifiable within the boundaries of fair play and the use of protective equipment (eg, shin guards). Noncontact injuries are speculated upon to be modifiable with prevention programs. Examples of preventative measures include programs such as Translating Research into Injury Prevention Practice (TRIPP)[18] screening identification of anatomical risk factors,[19,20] prescriptive footwear,[21,22] proprioception drills, balance, agility, strength, and practicing of skills.[9] An integral part of injury management is the identification of risk factors that predispose an individual to injury.[23] However, because injuries are multifactorial, the inherent difficulty faced by researchers and clinicians is the vast number of risk factors that need to be measured. Therefore, many studies have been limited to the measurement of one or two isolated factors. For example, while the literature supports a strong scientific association between lower limb injury and foot kinematics,[24–28] there is little consensus between health professionals, and there is ongoing speculation about the intrinsic aetiology of lower limb injury.

An alternate approach to injury management is the prospective measurement of lower limb comfort, which provides a barometer to the health and well-being status of the lower limb. Regardless of the cause or mechanism of injury, the endpoint is the same, in that it is expressed as pain and discomfort. When one area of the body is distressed (pain, discomfort, or injury), pain inhibition responses and musculoskeletal compensations occur not only at the site of injury but also at adjacent anatomical structures, which may predispose other regions of the body to injury. An instrument to monitor overall and segmental lower limb comfort would enable the collection of prospective data that could be used to determine benchmark comfort for individuals. Such information would provide a clinical measure of future lower limb health, limb injury, and an insight into how musculoskeletal comfort might alter with the passage of time, dependent upon intensity of physical training and/or musculoskeletal injury. Such data would assist medical and rehabilitation staff of football teams to plan training and intervention plans for individuals based upon quantitative data.

The impetus for development and implementation of a lower limb comfort index (LLCI) evolved from (a) the lack of a clinically relevant tool to assess prospective lower limb health; (b) the high proportion of lower limb musculoskeletal injuries reported in the literature; (c) previous studies indicating good reliability and validity of limb comfort measures for various population groups (military, hospital, laboratory); (d) the lack of an instrument to measure lower limb comfort in a sporting environment; and (e) the anticipated benefit of a lower limb comfort measure for use in clinical and research settings. In a developmental study comprising 20 professional footballers from two codes (Rugby League and Australian Rules), we created a lower limb comfort index. The results demonstrated good face and construct validity as to the suitability of a comfort index for professional football, and ease of use of a numerical rating scale within a football environment. This provided confidence for further testing of the LLCI in a wider football environment.

Methods

Participants from an elite sporting environment comprising two codes of professional football were recruited to assess how repeatable the LLCI was over time, and the extent to which it responded to changes in comfort. One testing session (match day comfort) involved assessing comfort following competitive football matches in 22 players (age 26.1 years, standard deviation (SD) 4.4; height 183.0 cm, SD 6.3; weight 86.0 kg SD 8.2) from rugby league (n = 13) and Australian rules (n = 9).

A separate testing session (week day comfort) was implemented in 41 players (age 24.6 years, SD 4.1; height 185.7 cm, SD 6.6; weight 91.9 kg SD 10.2) from rugby league (n = 15) and Australian rules (n = 26) at the beginning of respective training weeks, approximately 36–48 hours post-game. Comparisons were made between time intervals for both week day and match day comfort scores to determine the reliability of the LLCI under normal sporting conditions, and the responsiveness of the LLCI to clinical changes in comfort. To test the hypothesis that the LLCI was a reliable tool to record repeated measures of lower limb comfort, the environment for players to record lower limb comfort remained stable, without interventions that would contaminate reliability testing. To ascertain responsiveness of the LLCI, comfort measures were taken during a regular training week for professional football, when the test environment was constantly changing.

Data collection took part at football club premises in an environment consistent and familiar to the players. Therefore, match day comfort was recorded at home game events only. Reserve or nonsenior players were recruited as match day participants because their matches were scheduled earlier in the day, players did not have media or sponsorship commitments, and they had an obligation to be present at the main game to support other teammates in following matches.

Test conditions for week day and match day reliability testing of the LLCI involved players scoring comfort measures using the format shown in Figure 1. Data for six anatomical segments (foot, ankle, calf-achilles, shin, knee, and football boot) were rated for comfort. The minimum score was 0 and the maximum score was 6 points for each segment. An overall sum of the six anatomical segments was calculated to provide a maximum score of 36 points.

For week day comfort, recordings of lower limb comfort were recorded for 5 weeks over a twenty-week period. For each week, five measures of lower limb comfort were collected and catergorized according to changes in the test environment (Table 1). Condition 1 represented the first measure that was recorded for week day comfort, at 24–36 hours post-match day. Condition 2 represented data collection 24 hours after Condition 1, and Condition 3 was 96 hours from Condition 1.

Repeatability was calculated from Condition 1, where there was no change to the test environment. Responsiveness to changes in comfort were assessed in Conditions 2 and 3, which where characterized by significant changes to the test environment. It was anticipated that each player would provide a maximum of 30 comfort measures over 5 testing sessions; suitable for reliability analyses and to test for differences in comfort over time.

For match day comfort testing, the same format applied, except the testing was performed over four test periods. Three comfort measures were taken over a 3-hour period. To test for repeatability of comfort scores, the data were collected in a stable environment where there was no physical or medical intervention. To ensure a stable test environment, the first set of comfort measures occurred 45–60 minutes post-match, once players had performed their match day cool down and rehabilitation (Table 1).

Week day and match day statistical analysis

Reliability testing included calculating mean differences with SD for week day comfort (time span 0–8 hours) and post-match day comfort (time span 0–3 hours) for each week for players who provided data for both conditions (Table 2). Measurement error was calculated from the standard deviation of the differences using the methods of Bland and

Name	Place a score 0 to 6 in each box						
Lower limb comfort	**Foot**	**Ankle**	**Calf-Achilles**	**Shin**	**Knee**	**Footwear**	**Sum comfort**
Rank each body area from 0–6 using the comfort descriptors							36 maximum score

Comfort descriptors

0 = extremely uncomfortable (unable to run or jump)
1
2
3 = neither uncomfortable or comfortable
(more or less uncomfortable/comfortable)
4
5
6 = zero discomfort (extremely comfortable; best ever feel)

Figure 1 Lower limb comfort scoring format.

Notes: Lower limb comfort index shows a numeric rating scale with fixed anchor points at key positions on the scale. Visual descriptive explanations provide further interpretation of the anchors relevant to physical requirements participating in football.

Table 1 Time line for comfort data collection for match day and week day measures

Time of data collection	Environment
Match day LLCI comfort scores	
0–60 minutes following match (no data collection)	Warm down, stretch, ice baths, hydration, shower.
0 hours (data collection 1)	No change to test environment in terms of medical, rehabilitation or training intervention. Players rest, relax, eat.
90 minutes (data collection 2)	
3 hours (data collection 3)	
Week day LLCI comfort scores	
Condition 1 (36–48 hours post match)	Changes to test environment between match day and week day include recovery training, massage, medical intervention.
0 hours (data collection 1)	
4 hours (data collection 2)	No change to test environment 0–4 hours in terms of physical training or medical intervention. Activities for the day include investigation of any medical needs, team and coach meetings. and club events.
8 hours (data collection 3)	No change to test environment 0–4–8 hours in terms of physical, training, or medical intervention.
Condition 2	
24 hours from Condition 1	Changes to the environment include sleep, massage, yoga, anticipated reduction in muscle soreness.
Condition 3	
96 hours from Condition 1	Full week of physical training, rehabilitation, medical intervention.

Altman.[29] The measurement error indicates a range above and below any reported value, in which we can be 95% certain that the "true" value for a player lies. In addition, intra-class correlation coefficients for repeated comfort ratings for all individuals and sessions were computed from one-way analysis of variance using the method for fixed observers (because players self-reported their comfort scores). ICCs have previously been used in comfort studies,[22,30] and were calculated in this study for repeated comfort for two conditions: week day (0 hours and 8 hours), and match day (0 hours and 3 hours).

To test responsiveness, mean comfort scores with SD were also calculated for both week day and match day conditions (Table 3). Mean comfort scores were plotted (Figures 2 and 3) for week days and match days to investigate how comfort scores varied with time. General linear modelling (repeated measures analysis of variance) was used to assess the within-player significance of differences in lower limb comfort intra-week for both week day (Table 4) and match day (Table 5) comfort. Planned post hoc comparisons were computed using the least significant difference (LSD) method with mean differences and 95% confidence intervals. The Huynh-Feldt P value was used to assess the effect of time across each model because not all models conformed to the requirement of sphericity.

Results

The results indicate that the LLCI was reliable when tested for repeated measures and for the extent that lower limb comfort changes with time. Table 2 shows the reliability of the comfort scores for each week. Intra-class correlation coefficients for intra-test repeatability ranged between 0.994 and 0.999 for week day and 0.974 and 0.998 for match day conditions. The recording of lower limb comfort to calculate

Table 2 Week day and match day mean differences and the intra-class correlation coefficient (ICC)

	Week	Number	Mean difference (SD)	Measurement error	ICC
Week days	1	40	0.0 (0.16)	0.43	0.999
	2	38	0.1 (0.46)	1.28	0.994
	3	39	0.0 (0.26)	0.73	0.999
	4	39	0.0 (0.49)	1.37	0.996
	5	39	0.0 (0.35)	0.96	0.998
Match days	1	19	0.1 (0.33)	0.91	0.998
	2	18	–0.2 (0.45)	1.25	0.996
	3	19	0.1 (0.91)	2.53	0.974
	4	19	0.0 (0.57)	1.59	0.994

Table 3 Mean week day and match day comfort scores with standard deviations in brackets

Week day	N	0 hrs	4 hrs	8 hrs	24 hrs	96 hrs
Week 1	41	27.6 (3.4)	27.6 (3.4)	27.7 (3.4)	28.0 (3.4)	29.5 (3.2)
Week 2	35	27.4 (3.2)	27.4 (3.2)	27.5 (3.3)	27.7 (3.1)	29.1 (2.7)
Week 3	37	27.6 (4.6)	27.6 (4.6)	27.7 (4.5)	28.0 (4.3)	29.0 (4.3)
Week 4	38	26.6 (3.6)	26.6 (3.6)	26.7 (3.6)	26.8 (3.5)	28.1 (3.7)
Week 5	34	26.4 (4.2)	26.4 (4.1)	26.3 (4.2)	26.6 (4.8)	28.7 (4.3)
Match day	**N**	**0 hrs**	**90 mins**	**3 hrs**	**36 hrs**	
Week 1	19	23.8 (3.8)	23.8 (3.8)	23.9 (3.9)	26.9 (3.8)	
Week 2	18	23.3 (4.4)	23.3 (4.4)	23.1 (4.3)	25.9 (3.0)	
Week 3	19	24.0 (3.0)	24.0 (3.0)	24.1 (2.8)	27.5 (3.6)	
Week 4	19	24.1 (3.6)	24.1 (3.5)	24.1 (3.9)	27.3 (3.7)	

ICCs occurred at 0 hours and 8 hours for the week day condition, and zero hours and 3 hours for match day. For both test conditions, the environment was stable, where there were no interventions to affect repeatability testings.

For week day results, the mean within-player differences were either zero or very small, at 0.1 in week 2, indicating strong reliability. The measurement error indicates the range either side of a given measurement in which we can be 95% certain that the "true" value for a player lies. For weeks 1, 3, and 4 the measurement error was less than 1 point, indicating excellent reliability. For weeks 2 and 4, the measurement error was less than 1.5 points, indicating very good reliability. The ICC, which indicates the proportion of variance in within-player measurements that can be attributed to true differences between players, was extremely high on all days. The ICC values over 0.99 indicate that over 99% of the variance is due to true variation between players and less than 1% of the variance is due to measurement error in the LLCI.

For match day, the measurement error was small at 0.9 to 1.6 points on days 1, 2, and 4, when the second score for all participants was within 0–2 points of their original score. On day 3, the measurement error was larger at 2.5 points, with one player rating 3 points higher than their original score. The ICC values were high, indicating that on days 1, 2 and 4, over 99% of the variance was due to true variation between players, and less than 1% due to measurement error. On day 3, over 97% of the variance in the LLCI was due to true variation between players, and less than 3% due to measurement error.

Table 3 show the mean comfort scores for week day and match day conditions. Week day measures were taken at four time points over 24 hours and 96 hours for the five weeks of measurement. The mean values are plotted in Figures 3 and 4 respectively. For week day results, the mean scores remained fairly constant, at 0, 4, 8, and 24 hours but increased at 96 hours in all weeks. The mean scores in week 4 and week 5 were approximately one point below the mean scores recorded in weeks 1, 2, and 3, and indicated comfort variations between testing weeks.

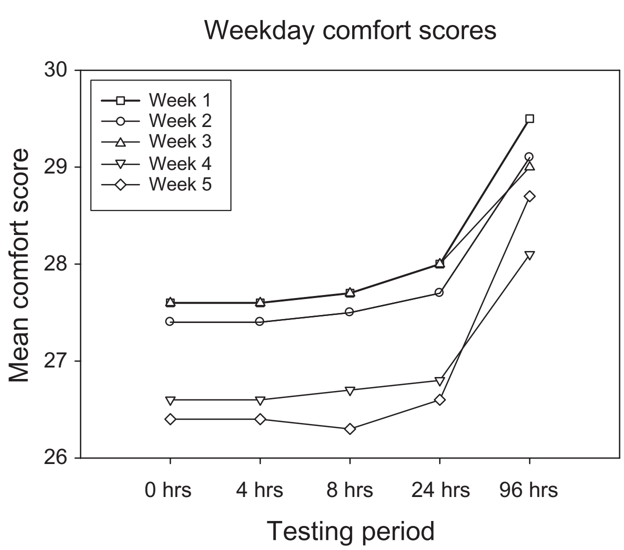

Figure 2 Week day mean comfort.

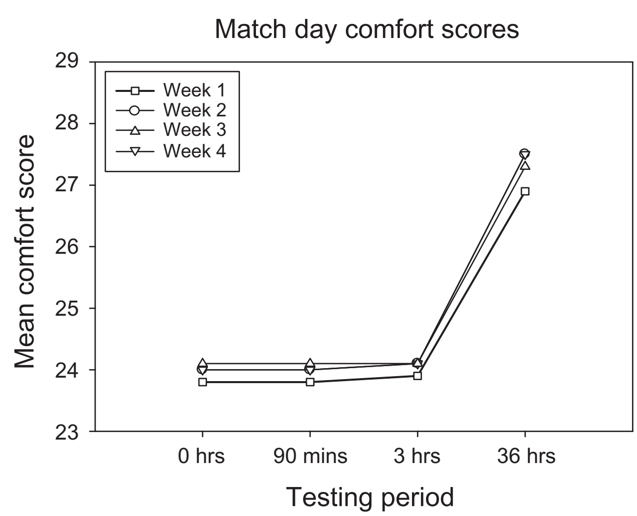

Figure 3 Match Day mean comfort.

Table 4 Match day within-player differences

Time zone		Number	*P* value (Time)	Mean difference and 95% confidence interval	*P* value for planned contrast
Week 1		41	<0.0001		
	0 vs 4 hrs			0.0 (0.0, 0.0)	1.0
	0 vs 8 hrs			–0.02 (–0.07, 0.03)	0.32
	0 vs 24 hrs			–0.35 (–0.61, –0.10)	0.008
	0 vs 96 hrs			–1.86 (–2.64, –1.07)	<0.0001
	4 hrs vs 8 hrs			–0.02 (–0.07, 0.02)	0.32
	24 hrs vs 96 hrs			–1.50 (–2.20, 0.80)	<0.0001
Week 2		35	0.001		
	0 vs 4 hrs			0.0 (0.0, 0.0)	1.0
	0 vs 8 hrs			0.11 (–0.05, 0.28)	0.17
	0 vs 24 hrs			0.37 (0.03, 0.71)	0.03
	0 vs 96 hrs			1.76 (0.74, 2.77)	0.001
	4 hrs vs 8 hrs			0.11 (–0.05, 0.28)	0.17
	24 hrs vs 96 hrs			1.39 (0.37, 2.40)	0.009
Week 3		37	0.073		
	0 vs 4 hrs			0.0 (0.0, 0.0)	1.0
	0 vs 8 hrs			–0.04 (–0.13, 0.05)	0.37
	0 vs 24 hrs			–0.34 (–1.51, 0.83)	0.56
	0 vs 96 hrs			–1.41 (–2.75, –0.07)	0.04
	4 hrs vs 8 hrs			–0.04 (–0.12, 0.05)	0.37
	24 hrs vs 96 hrs			–1.07 (–2.07, –0.06)	0.04
Week 4		38	0.004		
	0 vs 4 hrs			0.0 (0.0, 0.0)	1.0
	0 vs 8 hrs			–0.05 (–0.18, 0.07)	0.40
	0 vs 24 hrs			–0.21 (–0.42, 0.01)	0.05
	0 vs 96 hrs			–1.45 (–2.40, –0.50)	0.004
	4 hrs vs 8 hrs			–0.05 (–0.17, 0.07)	0.40
	24 hrs vs 96 hrs			–1.24 (–2.14, –0.34)	0.01
Week 5		34	<0.0001		
	0 vs 4 hrs			–0.03 (–0.09, 0.03)	0.33
	0 vs 8 hrs			0.06 (–0.07, 0.19)	0.35
	0 vs 24 hrs			–0.21 (–0.90, 0.49)	0.55
	0 vs 96 hrs			–2.34 (–3.54, –1.14)	<0.0001
	4 hrs vs 8 hrs			0.06 (–0.06, 0.18))	0.30
	24 hrs vs 96 hrs			–2.13 (–3.64, –0.62)	0.007

For match day, there was little variation in mean scores, at baseline, 90 minutes, and 3 hours, but a large increase in scores at 36 hours. Data were also collected for a further week for match day analysis (week 5), but involved only 9 participants, and therefore these results were not used in the statistical analysis. However, the data were consistent with the other testing weeks (weeks 1–4) highlighting no difference in mean sum comfort scores for time periods 0 hours and 90 minutes and larger differences between 3 hours and 36 hours.

To test whether the differences in scores between time points were statistically significant, repeated measures ANOVA was used to examine within-player differences. The results for week day and match day are shown in Tables 4 and 5.

Figure 2 graphs the results tabulated for week day lower limb comfort score. For time zones 0 hours, 4 hours, and 8 hours, where the environment was stable. there was no significant change in comfort scores, although week 5 illustrates a reduction in comfort between 4 hours and 8 hours. The reason for this is that week 5 was the only week where comfort dropped for this time period; however, by less than 0.5 comfort points. When the environment changed, at 24 hours and 96 hours, comfort changed significantly in an upward trend.

Figure 3 illustrates match day comfort. Zero hours represents the first recording of comfort. The data were captured 45–60 minutes post-match, enabling a sufficient period of time for players to rest following high-intensity physical activity. It was considered that any comfort data captured prior to a state of relative relaxation would affect comfort scores, due to physical and psychological factors. During the period before match day data was collected, the regular routine was for players to warm-down, shower, hydrate, and relax. Over a 3-hour period, there was no significant change in musculoskeletal comfort. Significant changes to lower limb comfort did not occur until 36 hours following 3-hour data collection, indicating that with the passage of time following physical exertion, comfort improves. This increase in comfort was the greatest change to comfort over all the time periods collected.

A comparison between Figures 2 and 3 indicates that the greatest change in comfort occurs at 36 hours in match day data collection, which is attributed to the high-intensity demands placed upon the musculoskeletal system during professional football, and how the body resets comfort with the passage of time when the physical exertion is removed. Further comparisons between match day and week day scores are indicated by the baseline scores, which show lower limb comfort for all weeks was almost 2 points less for match day scores than for week day scores. This further highlights the magnitude of post-match discomfort compared to other times, where comfort is assessed throughout the training week, for both professional rugby league and Australian rules players.

Table 4 shows that there were no statistically significant differences in the scores recorded at time points 0, 4, and 8 hours. The absolute difference in mean scores between these time points was very small, varying from 0.00 to only 0.11. There were differences in scores between times points 0 and 24 hours. Although these differences were significant in weeks 1, 2, and 4, the absolute difference in mean scores between 0 and 24 hours varied between only 0.21 and 0.37 points.

The differences in scores between baseline and 24 hours were statistically significant for all weeks, with mean within-player differences ranging from1.4 to 2.3 points. There were also large differences between 24 hours and 96 hours. These differences, which ranged from 1.1 to 2.3 points, were all statistically significant.

Table 5 shows the mean within-player differences from match day scores. The mean within-player differences in scores were small, and not statistically significant between time points 0, 90 minutes, and 3 hours, in that they ranged from zero to 0.21 points. However, between zero and 36 hours there were large increases in the comfort score, ranging from 2.6 to 3.5 points, which were all statistically significant.

Discussion

The results indicate that the LLCI, when used in a competitive football environment, is both reliable and responsive to change during both a training week and under match day conditions. The instrument developed to assess lower limb comfort used a Likert scale of zero to six, with written prompts for progressively greater comfort at six anatomical sites of the lower limb (foot, ankle, calf-achilles, shin, knee, football boot), totalling 36 points. The instrument was validated in a pilot study with similar-level athletes from the specified football codes. This measure of lower

Table 5 Match day within-player differences

	Number	*P* value (time)	Mean difference and 95% confidence interval	*P* value for planned contrast
Week 1	19	0.001		
0 vs 90 mins			0.0 (0.0, 0.0)	1.0
0 vs 3 hrs			–0.11 (–0.27, 0.05)	0.16
0 vs 36 hrs			–3.15 (–4.73, –1.58)	0.001
Week 2	19	<0.0001		
0 vs 90 mins			0.0 (0.0, 0.0)	1.0
0 vs 3 hrs			0.21 (–0.01, 0.43)	0.06
0 vs 36 hrs			–2.63 (–4.00, –1.27)	0.001
Week 3	20	<0.0001		
0 vs 90 mins			0.0 (0.0, 0.0)	1.0
0 vs 3 hrs			–0.10 (–0.53, 0.33)	0.63
0 vs 36 hrs			–3.50 (–4.96, –2.04)	<0.0001
Week 4	20	<0.0001		
0 vs 90 mins			0.05 (–0.06, 0.16)	0.33
0 vs 3 hrs			–0.01 (–0.27, 0.26)	0.96
0 vs 36 hrs			–3.19 (–4.43, –1.95)	<0.0001

limb comfort was intended to provide a tool for clinicians and athletes to (a) prospectively monitor lower limb comfort at multiple anatomical regions, (b) create a baseline for comfort norms for individual players for future assessment, and (c) to use prospectively in the event of injury to monitor rehabilitation progress. The results indicate that measures of lower limb comfort using the LLCI are reliable under stable conditions, and are also responsive to clinical changes over time and therefore have an important potential in the context of monitoring player welfare. In the absence of any quantifiable scale, subtle changes in lower limb comfort currently go undetected.

For two separate football-specific test conditions, week day and match day, when the testing environment was stable and measured over multiple weeks, the measurement errors for all weeks were small, and the ICCs > 0.9 provide a high level of confidence in the reliability of the method when used under identical test conditions (Table 2). The test-retest results indicate good repeatability for all time points examined, and provide confidence that the LLCI for measuring lower limb comfort is reliable in players within a wide range of experience, and when used under different conditions.

An unexpected outcome of the study was the clinical application of the instrument to catalogue the responsiveness of the LLCI to detect changes in comfort over time. Both for match day and week day comfort testing, significant changes occurred. The application of the information indicated that the LLCI could be used in a football environment as an instrument responsive to changes in the status of musculoskeletal comfort. The advantage for clinicians and athletes is that lower limb comfort can be monitored over time to enable specific interventions for a given individual, rather than a group. For example, the test period 0–36 hours following match day will provide information on how an individual responded to the amount of game time participation and to the intensity of a match. It is speculated that a younger player with low professional football experience would have lower comfort scores than a more seasoned player. Over a period of time of catalogued events, a library of player information can be obtained to assist with planning recovery strategies. The period 0–24 hours (week day comfort) will aid rehabilitation staff and medical personnel to ascertain the musculoskeletal wellness of each member of the team in order to implement medical intervention strategies and to assist in training plans for groups and individuals. The test period 0–96 hours (pregame measure) will allow evaluation of how an individual player has progressed during the week, identify any new musculoskeletal conditions, and enable pregame intervention strategies. It is speculated the LLCI may even be used as an instrument to assess selection for a match. This is based on a nontested hypothesis that lower limb discomfort may affect performance, an area which will be scrutinized in future studies. Such specific data on lower limb wellness provides quantitative measures of an individual player's lower limb comfort, which may prove useful in advancing the decision-making capabilities of medical and rehabilitation staff, and provides players with a mechanism to monitor their musculoskeletal health.

Current best practice for treating musculoskeletal injury within sporting organizations is for the medical staff to assess players for injury which is known. There is also an implied responsibility for individual players to report any ailments. In large sporting organizations, such a policy, while well intended, does not result in full medical coverage. For example, senior players often command more attention than younger players. Thus, a measurement tool that is simple to administer, and which covers lower limb well-being for an entire squad, allows all players to be monitored effectively, and below-comfort thresholds can be indentified by medical and conditioning staff for pre-emptive interventions. The nature of injury necessitates focusing upon the site of musculoskeletal distress. However, compensation at adjacent regions also occurs. Often, treatment intervention of the primary area does not address subtle changes and compensatory functions that occur at other musculoskeletal linkages. Use of the LLCI model enables monitoring of not only the primary area of concern but also of any changes to adjacent musculoskeletal areas and thus enables monitoring of the entire lower limb, as individual segments and as a whole unit.

Summary

The reliability of the LLCI provides both individual and organizational confidence that the data collected were not random but consistent with the status of lower limb comfort. Collecting LLCI data will benefit individual players by setting benchmark comfort scores against which to compare future discomfort. Recording benchmark comfort will also assist medical staff by quantifying the degree of comfort; an area of medicine which, to date, has not evolved in the football codes.

Lower limb injury management is an important component of sports medicine in both team and individual settings. The importance of comfort as a viable method to aid health and well-being is recognized as a viable method of assessing pain and discomfort. However, very few pre-emptive methods exist to detect discomfort. The use of measuring multiple anatomical areas to derive an overall lower limb comfort score provides a new method for measuring lower limb well-being.

This study shows the LLCI to be a reliable instrument to record lower limb comfort in a football environment, and offers an instrument that is responsive to lower limb comfort changes. It is anticipated that the index is not limited to professional football but is to have application to other sports as well as to clinical practice for general physicians, physiotherapists, podiatrists, and those engaged in the management of lower limb musculoskeletal injury.

Disclosure

The authors report no conflicts of interest in this work.

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