Analysis of hip strength and mobility as injury risk factors in amateur women's football: a pilot study

Antonio Maestro[1], Joaquín Lago[2], Gonzalo Revuelta[3], Pablo del Fueyo[4], Lorenzo del Pozo[5], Carlos Ayán[6], Vicente Martín[7]

[1]Servicios Médicos del Real Sporting de Gijón S.A.D. [2]Facultad de Ciencias de la Educación y del Deporte. Universidad de Vigo. [3]Real Sporting de Gijón S.A.D. [4]Real Sporting de Gijón S.A.D. [5]Real Sporting de Gijón S.A.D. [6]Facultad de Ciencias de la Educación y del Deporte. Universidad de Vigo. [7]Departamento de Ciencias Biomédicas. Universidad de León.

Received: 26.02.2016
Accepted: 11.05.2016

Summary

Objectives: The aims of the present study were to analize the incidence of overuse injuries of the lower limbs in an amateur women´s soccer club throughout a competitive season and to assess its relationship with hip abductors strength and hip external rotation mobility.
Material and methods: This research is an epidemiological, observational, analytical, prospective longitudinal study. The sample was selected by a non-random convenience sampling and it was composed of the 23 football players who made up the team of the E. F. Mareo in 2013-2014 season. Participant ages ranged between 14 and 33 years (x=22.5; s=5.7). The players were subjected to an evaluation of their hip abductors strength and hip extērnal rotation mobility in preseason and, then, they were followed until the end of the competitive period recording the injuries that were appearing.
Results: Statistically significant differences were observed between the dominant and non dominant limbs in hip abductors strength and hip external rotation mobility ($p < 0.01$). Along the season, 52.2% of the participants experienced some kind of overuse injury affecting the lower extremities. Regarding the type of injury, 53.8% were ligamentous injuries mainly affecting the ankle, only one of them involved the knee (ACL tear), 15.4% were tendinous injuries affecting the knee and the remaining 30.8% were tendinous injuries affecting the hip. No significant relationship was observed between overuse injury incidence and player's hip abductors strength or hip external rotation mobility.
Conclusions: More research is needed to achieve concluding evidence about the influence of hip abductor strength and hip external rotation mobility on overuse injuries of the lower extremities in women's soccer.

Key words:
Hip abductors. Hip external rotation. Injury risk. Joint injury. Overuse injury. Women soccer player.

Análisis de la fuerza y movilidad de la cadera como factores de riesgo de lesión en fútbol femenino amateur: un estudio piloto

Resumen

Objetivos: Los objetivos del presente estudio consisten en analizar la incidencia de lesiones no traumáticas de las extremidades inferiores en un equipo amateur femenino de fútbol y valorar su relación con la fuerza de la musculatura abductora y la movilidad en rotación externa de la cadera.
Material y método: La presente investigación consiste en un estudio epidemiológico, observacional, analítico, longitudinal prospectivo. La muestra se seleccionó mediante un muestreo por conveniencia quedando compuesta por las 23 jugadoras que compusieron la plantilla del E.F. Mareo en la temporada 2013-2014, equipo ubicado en la Segunda División Nacional Española. El rango de edad de las participantes fue de los 14 a los 33 años (x=22,5; s=5,7). Las jugadoras fueron evaluadas en pretemporada y posteriormente se las siguió hasta el final del período competitivo para registrar las lesiones aparecidas.
Resultados: Se apreciaron diferencias estadísticamente significativas entre la extremidad inferior dominante y la no dominante tanto en la fuerza de la musculatura abductora como en los rangos de movilidad en rotación externa de la cadera ($p < 0,01$). A lo largo de la temporada, el 52,2% de las participantes se vio afectado por alguna lesión no traumática en las extremidades inferiores. En cuanto a la tipología, el 53,8% fueron ligamentosas y afectaron principalmente al tobillo, con sólo una de ellas afectando a la rodilla (rotura de LCA), mientras que el 15,4% fueron lesiones tendinosas que afectaron a la rodilla y el 30,8% restante fueron lesiones tendinosas en la cadera. No se apreció relación de la fuerza de la musculatura abductora o de la movilidad en rotación externa de la cadera con la producción de lesiones.
Conclusiones: Resultan necesarias más investigaciones para alcanzar resultados concluyentes.

Palabras clave:
Abductores de la cadera. Rotación externa de la cadera. Riesgo lesional. Lesión articular. Lesión no traumática. Mujer futbolista.

Correspondence: Joaquín Lago-Ballesteros
E-mail: jlagob@uvigo.es

Introduction

The importance of women's football in the world sporting scene has seen a drastic increase over the past two decades[1]. During this period, both the number of players and the level of professionalisation have risen[2], and consequently, changes have occurred to the performance profile of the sport, with possible repercussions on the rate and patterns of injuries[1].

Based on existing scientific literature, it can be concluded that women's football has a high level of injury rate[3-9], which mainly affects the joints and muscles in the lower limbs[3,4,7,10-13], and that, despite a large proportion of injuries being caused by some kind of trauma[6,13,14], another large proportion arise with no contact whatsoever[6,15], which accentuates the relevance of preventive work.

Some research studies have aimed to objectify predisposing factors to suffering an injury that can constitute key variables when considering the prevention process[15], but evidence is still scarce and in particular deals with the professional field of women's football. As such, a link has been established between joint laxity and a greater risk of injury to the lower limbs[12,16]. Likewise, arthromuscular imbalances between the halves of the body may constitute a predisposing factor to non-traumatic injuries[17]. It has also been suggested that the injuries suffered to the lower limbs may be caused not only by existing problems in the local injured area, but also due to other alterations in nearby areas that transmit their influence via the kinetic chain to distal areas[18,19]. Finally, in studies that seek to explain the high tendency of females athletes to suffer anterior cruciate ligament injuries (ACL) in comparison with their male counterparts, anatomical and hormonal factors are indicated, as well as alterations in the dynamic of load distribution and the existing differences in the neuromuscular activation patterns as underlying mechanisms[19,20], particularly highlighting the heightened risk of knee valgus (because the Q angle of the knee is greater in women than in men) that occurs during rapid direction changes or when landing from a jump[21,22]. In this respect, it has been indicated that shortcomings in strength in the abductor muscles of the hips may predispose female footballers to dynamic knee valgus, and therefore they could be linked to the risk of injuries to the lower extremities[23].

As a result, this study aims to analyse the rate of non-traumatic injuries to the lower extremities throughout a season in an amateur women's football team and to assess the relationship between this incidence rate and the strength of the abductor muscles and the external rotation mobility of the hips.

Material and method

Study design and participants

This research study consisted in an epidemiological, observational, analytical and prospective longitudinal study. The sample was selected using a non-random convenience sample and was composed of 23 football players in the team of Mareo Football School during the 2013-2014 season, a team positioned in the Spanish National Second Division. The study was carried out following the principles, standards and procedures stipulated in the Helsinki Declaration.

Procedure

All the participants underwent a final assessment at the end of the pre-season, in which their abductor muscle strength and external rotation mobility of the hips on both lower limbs were assessed. In this assessment session data was also taken regarding the age, height and weight of the players. The assessments were performed in the Mareo Football School facilities, the club's training headquarters. All the assessment tests were preceded with 10-15 minutes of warm-up, consisting in a low-intensity jog and stretching exercises of the lower limb muscles. Likewise, all the participants had previously been suitably familiarised with the procedure and the assessment instruments, and had provided their informed written consent for their participation in the study.

To assess the isometric strength of the abductor muscles, a manual dynamometer was used (Chatillon CSD 300, Amteck, Inc., Largo, FL)[24]. Following the recommendations of Hislop *et al.*[25], the participants were positioned lying on their side with the extremity to be assessed facing up and completely extended. The hip and knee on the opposite lower extremity were bent to provide greater stability. To begin the test, the lower extremity to be analysed was positioned in abduction and was slightly extended compared to the average line, with the pelvis slightly rotated forwards. For this, participants were asked to lift their extremities in the air as far as possible and to hold this position, preventing the examiner from pushing the leg down. The examiner held the dynamometer against the leg near the lateral malleolus and pushed directly down. Participants received a verbal stimulus to hold a maximum contraction. All the participants were assessed this way by the same assessor and they were required to hold the contraction for 5 seconds. Three attempts with 1 minute rest were provided, so as to minimise the effect of fatigue, and the best attempt was recorded.

In terms of assessing the external rotation mobility of the hip, the measurements were carried out with a manual goniometer, positioning participants in the prone position on a bed with their hips straight and using a tape around the pelvis to stabilise it, fixing their position to the bed. The knee of the lower extremity assessed was positioned at a 90º bend. The assessor was positioned looking straight on at the knees and aligned the goniometric centre with the centre of the knee, with the fixed arm of the goniometer in the direction of the contra-lateral knee and the movable arm towards the ankle, following the front of the leg[26].

Next, the participants were followed-up during the entire competition season, recording the hours of individual exposure to the non-traumatic injuries that affected the joints of the lower extremities. This record was performed by the team doctor.

Data analysis

First a descriptive analysis was performed of the characterisation of the sample in terms of age, height, weight and exposure to competition.

Next a descriptive analysis was carried out of the strength values in the abductor muscles and of external rotation mobility of the hip displayed by the participants in each of the lower extremities, both dominant and non-dominant. The records of both sides were also compared to check for any differences between the sides of the body. With this objective, after checking the cases of normality and homoscedasticity, the Student t test was used for dependent samples, in the case of the abductor muscle strength, and a Wilcoxon signed-rank test to discover the external rotation mobility.

Thirdly, using percentages, the non-traumatic injury rate of the lower extremities was described, specifically noting the type of injury, its location and the laterality of the condition.

Finally, the values of the abductor muscle strength and the mobility in the external rotation of the hip were compared in players that had injuries against those without injuries. To do this, considering the result of the normality and homoscedasticity tests, a Student t test was used to check the hypothesis that strength in the abductor muscles in both lower extremities was the same in both groups of players. However, in terms of external rotation mobility of the hip, as the variable was not distributed normally, the alternative non-parametric Mann Whitney U test was used.

All the analyses were performed using the statistics package SPSS (v22.0; IBM SPSS Statistics for Macintosh, Armonk, NY) and the level of statistical significance was set at $p < 0.05$.

Results

The study participants presented an age ranging between 14 and 33 years ($\bar{x} = 22.5$; $s = 5.7$). Their weight oscillated between 1.54 and 1.77 m ($\bar{x} = 1.63$; $s = 0.05$) and their weight between 48 and 93 kg ($\bar{x} = 61.5$; $s = 9.3$). The football playing history of 23 of the players (92%) was over 10 years and the two other players had between 5 and 10 years of practice. In terms of exposure to competition, the total minutes played by each player varied from 900 to 2,195 ($\bar{x} = 1,626.1$; $s = 493.5$).

The analysis of the tests carried out in the pre-season reveal that the strength values in the abductor muscles of the hip are distributed between 147 and 253 N ($\bar{x} = 190.8$; $s = 30.1$) in the dominant lower extremity, and between 157 and 241 N ($\bar{x} = 169.9$; $s = 39.9$) in the non-dominant lower extremity, with the differences between both lower extremities being statistically significant, $t(22) = 3.452$, $p < 0.01$, so that 2 players presented similar values in both sides of the body, 3 players displayed higher values in the non-dominant side of the body, and the 18 remaining players revealed greater strength in the muscles of the dominant side of the body. In terms of the external rotation mobility of the hip, the values of the dominant side oscillated between 40º and 45º ($\bar{x} = 43.0$; $s = 2.5$) and those of the non-dominant side 45º and 50º ($\bar{x} = 47.8$; $s = 2.5$), with the Wilcoxon signed-rank test revealing statistically significant differences between both sides ($p < 0.01$), in that 4 of the 23 players obtained similar external rotation mobility of the hip values, whilst the remaining 19 players displayed worse values in the dominant hip.

Table 1. Description of the non-traumatic injuries to the lower limb joints.

n	Type	Location	Laterality
3	Ligament	Ankle	Non-dominant
3	Ligament	Ankle	Dominant
1	Ligament	Knee	Dominant
2	Tendon	Knee	Dominant
1	Tendon	Hip	Non-dominant
3	Tendon	Hip	Dominant

Throughout the season, 52.2% of the team were affected by some kind of non-traumatic injury to the joints of the lower extremities, as 13 injuries occurred that affected 12 of the players (Table 1). In terms of typology, 53.8% were ligament injuries, and mainly affected the ankle, with only one of them affecting the knee (ACT rupture), whilst 15.4% were tendon injuries that affected the knee, and the remaining 30.8% were hip tendon injuries. In terms of laterality, the majority of the injuries - 69.2% - affected the dominant side, but the differences between both sides in the injury rate were not statistically significant ($\chi^2 = 1.923$; $p = 0.166$).

Regarding the influence of strength of the hip abductor muscles on non-traumatic injuries in the lower extremities, no statistically significant differences were found in the values shown by the players that suffered injuries during the season when compared to their non-injured team-mates, both on the dominant and non-dominant side (Table 2).

Finally, regarding the influence of strength of the hip abductor muscles on non-traumatic injuries in the joints of the lower extremities,

Table 2. Differences in the strength of the abductor muscles of the hip in injured and uninjured players ($\bar{x} \pm s$).

	Injury (n=12)	No injury (n=11)	$t_{(21)}$	p	Effect size*
Strength of the hip abductors on the dominant side	193.64 ± 36.22	188.17 ± 24.55	0.43	0.674	0.18
Strength of the hip abductors on the non-dominant side	178.64 ± 34.95	161.83 ± 43.82	1.01	0.324	0.42

* *d* by Cohen.

Table 3. Differences in the external rotation mobility of the hip in injured and uninjured players ($\bar{x}$ ±s).

	Injury (n=12)	No injury (n=11)	U	*p*	Effect size*
External rotation mobility of the dominant hip	42.73 ± 2.61	43.33 ± 2.46	58.0	0.561	0.44
External rotation mobility of the non-dominant hip	47.73 ± 2.61	47.92 ± 2.57	63.5	0.858	0.48

*$\theta = U/m \times n$.

no statistically significant differences were found in the values shown by the players that suffered injuries during the season when compared to their non-injured team-mates, both on the dominant and non-dominant side (Table 3).

Discussion

This study analysed the non-traumatic injury rate in the joints of the lower extremities in a women's football team, considering the strength of the abductor muscles of the hip and the external rotation mobility of this joint as potential intrinsic factors in the injury risk.

Among the main results obtained, a statistically significant difference was observed in the strength of the abductor muscle of the hip with higher values in the dominant side compared to the non-dominant side. This result contrasts with the lack of appreciable differences between the sides of the body in previously written literature about women's football[27]. Considering the possible implications of the differences in strength observed, some other works have indicated that the arthromuscular imbalances between the sides of the body may constitute a predisposing factor to non-traumatic injuries[11] and that shortcomings in strength in the abductor muscles of the hip could be linked to the risk of injury to the lower extremities[23], but no differences were observed in this study between the strength values of the injured players and those that did not suffer injuries. It has also been suggested that lateral dominance could represent a contributing factor to the differences between sexes in the non-traumatic injury risk to the ACL, as men tend to suffer from this kind of injury in the dominant leg and women in the non-dominant[26]. However, in this study, no significant differences were observed in the injury frequency in each of the sides. More studies are needed to draw conclusions regarding the importance of lateral dominance and strength imbalances between the sides of the body as predisposing factors to non-traumatic injuries in women's football.

In terms of the external rotation mobility of the hip, the values observed are higher than those reported in the literature for elite players[27]. Likewise, following the criteria of the American Academy of Orthopaedic Surgeons[29], which indicates 45º as the normal value for the external rotation of the hip, the average of the values observed in the dominant hip are below the normal value, in contrast to those of the values observed in the non-dominant hip, which are above. These lateral differences revealed statistical significance, but no differences at all were found between the mobility values of players that suffered injuries and those that did not. In previous studies a link has been established between players with joint laxity and a greater risk of injury to the lower extremities[12,16], and in accordance with this, it would be expected to see a greater number of injuries in the non-dominant side, but, as already mentioned, no significant differences were found in the number of injuries depending on laterality. It should be considered that as well as due to joint laxity, ligament injuries in footballers with a prolonged history of practice can also occur due to joint impingement.

Among the limitations of this study, particularly noteworthy are the reduced size of the sample and that exposure to training and competitions have not been considered as predisposing factors to injuries. Nor was there a control of the existence of previously existing injuries that could predispose relapse. Furthermore, only strength values of one isolated muscle group - the hip abductors - have been taken, making it impossible to consider agonist-antagonist imbalances as a predisposing factor to injury. In terms of the assessment time, it was undertaken at just one point in the season, at the end of the preparatory period, analogously to the procedure used in previous prospective studies[12]. The reason that justifies the choice of this sole time for assessment is that, in accordance with the training methodology of team sports, during the preparatory (pre-season) period, the aim is to increase physical condition to reach the optimum values for competing, and from there, during the competitive period, the aim of training is to maintain these values, therefore no major oscillations are expected in these values during the rest of the season. However, when performing control assessments over the competition period, it cannot be ensured that the strength and mobility values have remained unaltered during the injury recording period. Finally, when recording the non-traumatic injuries, only those that affected a joint were considered, excluding muscle injuries, which could have conditioned the results obtained.

To conclude, this study has enabled a preliminary exploration of the relationship between the external rotation mobility of the hip and abductor muscle strength in the occurrence of injuries in amateur female football players. More and better studies are required to achieve definitive results.

References

1. Datson N, Hulton A, Andersson H, Lewis T, Weston M, Drust B, *et al.* Applied physiology of female soccer: an update. *Sports Med.* 2014;44(9):1225-40.
2. Fahmy M. Increase participation and competitions. 5th FIFA Women´s Football Symposium; 15-17 July; Frankfurt 2011. Disponible en: https://www.fifa.com/mm/document/footballdevelopment/women/01/51/51/64/presentation_increaseparticipation_e.pdf

3. Jacobson I, Tegner Y. Injuries among Swedish female elite football players: a prospective population study. *Scand J Med Sci Sports.* 2007;17(1):84-91.
4. Tegnander A, Olsen OE, Moholdt TT, Engebretsen L, Bahr R. Injuries in Norwegian female elite soccer: a prospective one-season cohort study. *Knee Surg Sports Traumatol Arthrosc.* 2008;16(2):194-8.
5. Le Gall F, Carling C, Reilly T. Injuries in Young Elite Female Soccer Players An 8-Season Prospective Study. *Am J Sports Med.* 2008;36(2):276-84.
6. Faude O, Junge A, Kindermann W, Dvorak J. Injuries in female soccer players a prospective study in the german national league. *Am J Sports Med.* 2005;33(11):1694-700.
7. Giza E, Mithöfer K, Farrell L, Zarins B, Gill T. Injuries in women's professional soccer. *Br J Sports Med.* 2005;39(4):212-6.
8. Fuller CW, Dick RW, Corlette J, Schmalz R. Comparison of the incidence, nature and cause of injuries sustained on grass and new generation artificial turf by male and female football players. Part 1: match injuries. *Br J Sports Med.* 2007;41(suppl 1):i20-i6.
9. Fuller CW, Dick RW, Corlette J, Schmalz R. Comparison of the incidence, nature and cause of injuries sustained on grass and new generation artificial turf by male and female football players. Part 2: training injuries. *Br J Sports Med.* 2007;41(suppl 1):i27-i32.
10. Junge A, Dvorak J. Soccer injuries. *Sports Med.* 2004;34(13):929-38.
11. Hägglund M, Waldén M, Ekstrand J. UEFA injury study–an injury audit at European Championships 2006 to 2008. *Br J Sports Med.* 2009;43(7):483-9.
12. Östenberg A, Roos H. Injury risk factors in female European football. A prospective study of 123 players during one season. *Scand J Med Sci Sports.* 2000;10(5):279-85.
13. Junge A, Dvorak J. Injuries in female football players in top-level international tournaments. *Br J Sports Med.* 2007;41(suppl 1):i3-i7.
14. Dick R, Putukian M, Agel J, Evans TA, Marshall SW. Descriptive epidemiology of collegiate women's soccer injuries: National Collegiate Athletic Association Injury Surveillance System, 1988–1989 through 2002–2003. *J Athl Train.* 2007;42(2):278.
15. Murphy D, Connolly D, Beynnon B. Risk factors for lower extremity injury: a review of the literature. *Br J Sports Med*. 2003;37(1):13-29.
16. Myer GD, Ford KR, Paterno MV, Nick TG, Hewett TE. The effects of generalized joint laxity on risk of anterior cruciate ligament injury in young female athletes. *Am J Sports Med.* 2008;36(6):1073-80.
17. Söderman K, Alfredson H, Pietilä T, Werner S. Risk factors for leg injuries in female soccer players: a prospective investigation during one out-door season. *Knee Surg Sports Traumatol Arthrosc*. 2001;9(5):313-21.
18. Zazulak BT, Hewett TE, Reeves NP, Goldberg B, Cholewicki J. Deficits in neuromuscular control of the trunk predict knee injury risk a prospective biomechanical-epidemiologic study. *Am J Sports Med*. 2007;35(7):1123-30.
19. Sutton KM, Bullock JM. Anterior cruciate ligament rupture: differences between males and females. *J Am Acad Orthop Surg*. 2013;21(1):41-50.
20. Hewett TE, Myer GD, Ford KR. Anterior cruciate ligament injuries in female athletes part 1, mechanisms and risk factors. *Am J Sports Med.* 2006;34(2):299-311.
21. Hewett TE, Myer GD, Ford KR, Heidt RS, Colosimo AJ, McLean SG, *et al.* Biomechanical measures of neuromuscular control and valgus loading of the knee predict anterior cruciate ligament injury risk in female athletes. A prospective study. *Am J Sports Med.* 2005;33(4):492-501.
22. Malinzak RA, Colby SM, Kirkendall DT, Yu B, Garrett WE. A comparison of knee joint motion patterns between men and women in selected athletic tasks. *Clin Biomech*. 2001;16(5):438-45.
23. Wallace BJ, Kernozek TW, Mikat RP, Wright GA, Simons SZ, Wallace KL. A comparison between back squat exercise and vertical jump kinematics: implications for determining anterior cruciate ligament injury risk. *J Strength Cond Res*. 2008;22(4):1249-58.
24. Fulcher ML, Hanna CM, Elley CR. Reliability of handheld dynamometry in assessment of hip strength in adult male football players. *J Sci Med Sport.* 2010;13(1):80-4.
25. Hislop H, Avers D, Brown M. *Daniels and Worthingham's muscle testing: Techniques of manual examination and performance testing.* 9 ed. St. Louis, MI: Elsevier; 2014. 223.
26. Norkin CC, White DJ. *Measurement of joint motion: a guide to goniometry.* 4 ed. Philadelphia, PA: FA Davis; 2009.
27. Chiaia TA, Maschi RA, Stuhr RM, Rogers JR, Sheridan MA, Callahan LR, *et al.* A musculoskeletal profile of elite female soccer players. *HSS J.* 2009;5(2):186-95.
28. Brophy R, Silvers HJ, Gonzales T, Mandelbaum BR. Gender influences: the role of leg dominance in ACL injury among soccer players. *Br J Sports Med*. 2010;44(10):694-7.
29. American Academy of Orthopaedic Surgeons. *Joint motion: method of measuring and recording.* Edinburgh: Churchill Livingstone; 2011. 87.

POSTGRADOS OFICIALES:
SALUD Y DEPORTE

UCAM
UNIVERSIDAD
CATÓLICA DE MURCIA

- **Actividad Física Terapéutica** *(2)*
- **Alto Rendimiento Deportivo: Fuerza y Acondicionamiento Físico** *(2)*
- **Performance Sport: Strength and Conditioning** *(1)*
- **Audiología** *(2)*
- **Balneoterapia e Hidroterapia** *(1)*
- **Desarrollos Avanzados de Oncología Personalizada Multidisciplinar** *(1)*
- **Enfermería de Salud Laboral** *(2)*
- **Enfermería de Urgencias, Emergencias y Cuidados Especiales** *(1)*
- **Fisioterapia en el Deporte** *(1)*
- **Geriatría y Gerontología: Atención a la dependencia** *(2)*
- **Gestión y Planificación de Servicios Sanitarios** *(2)*
- **Gestión Integral del Riesgo Cardiovascular** *(2)*
- **Ingeniería Biomédica** *(1)*
- **Investigación en Ciencias Sociosanitarias** *(2)*
- **Investigación en Educación Física y Salud** *(2)*
- **Neuro-Rehabilitación** *(1)*
- **Nutrición Clínica** *(1)*
- **Nutrición y Seguridad Alimentaria** *(2)*
- **Nutrición en la Actividad Física y Deporte** *(1)*
- **Osteopatía y Terapia Manual** *(2)*
- **Patología Molecular Humana** *(2)*
- **Psicología General Sanitaria** *(1)*

(1) Presencial *(2) Semipresencial*

MÁS INFORMACIÓN: **968 27 88 01** · **ucam.edu**