The Noncontact Lateral Ankle Sprain Injury in Indoor and Court Sports is not just the result of a “bad landing”

A Systematic Video Analysis of 145 Non-consecutive Case Series

Bagehorn, Timo; de Zee, Mark; Fong, Daniel T. P.; Thorborg, Kristian; Kersting, Uwe Gustav; Lysdal, Filip Gertz

Published in:
Proceedings of the 9th International Ankle Symposium

Publication date:
2022

Document Version
Publisher's PDF, also known as Version of record

Citation for published version (APA):
Bagehorn, T., de Zee, M., Fong, D. T. P., Thorborg, K., Kersting, U. G., & Lysdal, F. G. (2022). The Noncontact Lateral Ankle Sprain Injury in Indoor and Court Sports is not just the result of a “bad landing”: A Systematic Video Analysis of 145 Non-consecutive Case Series. In *Proceedings of the 9th International Ankle Symposium* (pp. 80-81). [31]


9th
International
Ankle
Symposium
in
Osaka
Japan
October 29th - November 27th, 2022
On-demand

Content

Forewords

Dear Friends and Colleagues,

On behalf of the local Organizing Committee, it is our great pleasure to welcome you to the 2022 International Ankle symposium (IAS). The local organizing committee, together with our sponsor and volunteers, had been prepared to welcome you in Osaka, Japan. However, unfortunately, we have made the difficult decision to hold our 9th IAS in a fully virtual format. On the virtual symposium platforms, you can access all the content the IAS offers. Our program has an outstanding line up for this scientific and clinical symposium. Our On-Demand viewing features gives you access to the entire program for a month. You do not need to worry about which session to see or skip due to scheduling conflicts and time difference between your location and Osaka, Japan. We understand that a virtual format reduces the opportunity to hallway chats that often take place at in-person symposium and enjoy wonderful Osaka. We have built two virtual symposium platforms to facilitate to face to face interaction. You can enter Gather.Town via the symposium platform (Whova). By joining us in Gather.Town, you will be able to bump into colleagues and friends and sightsee in Osaka, just like you would at an in-person symposium. You can select your avatar, search for specific attendees, or just walk around the 2D style space. The space will be available on a 24-hour basis from October 29th to November 27th. We hope that you enjoy this feature of the symposium and can explore virtual Osaka and catch up with your old and new friends. Once again, we are honored to host the 2022 IAS and hope that this format allows everyone full participation in our program that we do our best to bring you.

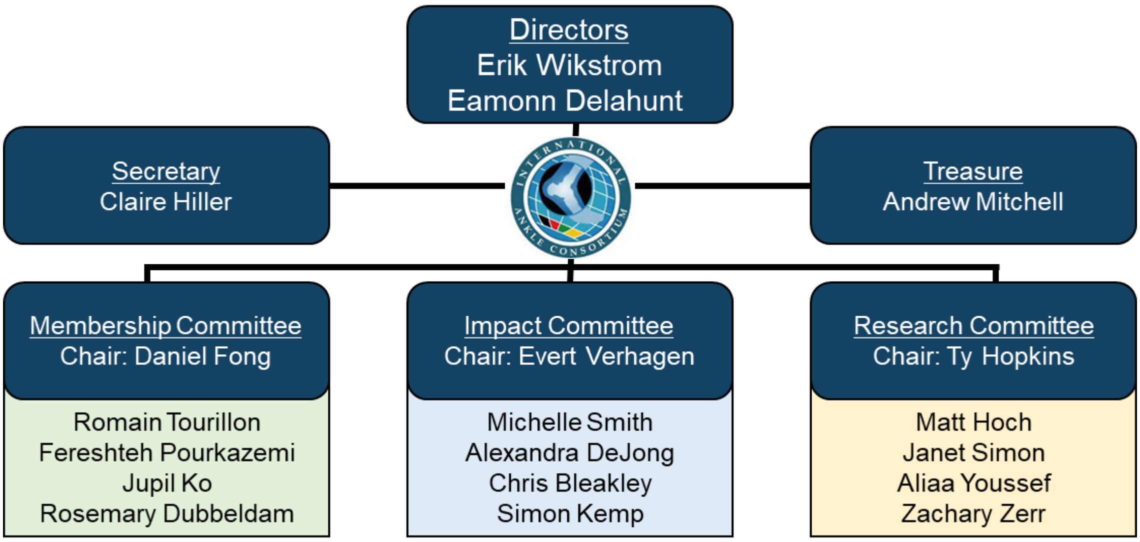
Masafumi Terada, PhD, ATC
Local Organizing Committee Chair

The International Ankle Consortium

The International Ankle Consortium (IAC) is an international non-profit organization which provides international networks and forums for researchers and clinicians who pursue to improve and keep developing the scientific and clinical evidence to clarify the characteristics and mechanisms of ankle injuries in effort to optimize interventions and improve the lives of affected patients. The IAC was formed in 2004 with the aim of establishing a platform for sharing the latest scientific and clinical knowledge on the prevention, assessment, and treatment of ankle injuries and disorders, especially lateral ankle sprains and chronic ankle instability, from interdisciplinary perspective.

The Current Leadership Structure of the IAC

The Executive Committee of the IAC was formed by Drs. Jay Hertel and Thomas Kaminski in 2012 and included Phillip Gribble, Chris Bleakley, Brian M Caulfield, Carrie L Docherty, François Fourchet, Daniel Fong, Jay Hertel, Claire Hiller, Thomas Kaminski, Patrick McKeon Kathryn Refshauge, Evert Verhagen, Bill Vicenzino, Erik Wikstrom, Eamonn Delahunt. The leadership of the IAC was realigned by Drs. Phillip Gribble and Eamonn Delahunt in 2019 to be more inclusive and to formalize membership. The current leadership team of the IAC have committed to promoting collaboration in ankle injury related research and education, elevating awareness of ankle sprain and instability, and advancing best practices in the prevention and intervention of ankle injuries disorders.



IAC Publications

The IAC have published consensus statements that shape evidence to provide utility to clinicians and researchers interested in improving outcomes of patients with ankle sprains and ankle instability. The followings are publications by the IAC Executive Committee:

1. Gribble PA, Delahunt E, Bleakley C, et al. Selection criteria for patients with chronic ankle instability in controlled research: a position statement of the International Ankle Consortium. J Orthop Sports Phys Ther. 2013;43(8):585–591.
2. Gribble PA, Delahunt E, Bleakley CM, et al. Selection criteria for patients with chronic ankle instability in controlled research: a position statement of the International Ankle Consortium. J Athl Train. 2014;49(1):121–127.
3. Gribble PA, Delahunt E, Bleakley C, et al. Selection criteria for patients with chronic ankle instability in controlled research: a position statement of the International Ankle Consortium. Br J Sports Med. 2014;48(13):1014–1018.
4. Gribble PA, Bleakley CM, Caulfield BM, et al. 2016 consensus statement of the International Ankle Consortium: prevalence, impact and long-term consequences of lateral ankle sprains. Br J Sports Med. 2016;50(24):1493–1495.
5. Gribble PA, Bleakley CM, Caulfield BM, et al. Evidence review for the 2016 International Ankle Consortium consensus statement on the prevalence, impact, and long-term consequences of lateral ankle sprains. Br J Sports Med. 2016;50(24):1496–1505.
6. Delahunt E, Bleakley CM, Bossard DS, et al. Clinical assessment of acute lateral ankle sprain injuries (ROAST): 2019 consensus statement and recommendations of the International Ankle Consor- tium. Br J Sports Med. 2018;52(20):1304–1310.
7. Delahunt E, Bleakley CM, Bossard DS, et al. Infographic. International Ankle Consortium rehabilitation-oriented assessment. Br J Sports Med. 2019;53:1248-1249. doi: 10.1136/bjsports-2018-099935.

Past International Ankle Symposia

2004: University of Delaware, USA
2006: University College-Dublin, IRL
2009: University of Sydney, AUS
2012: University of Kentucky, USA
2015: University College-Dublin, IRL
2017: University of North Carolina-Chapel Hill, USA
2019: Amsterdam, Netherlands

Organizing Committee

Program Committee Chair

Masafumi Terada

Junji Shinohara

Takumi Kobayashi

Shinshiro Mineta

Yuta Koshino

Shun Numasawa

Yuka Shimozawa

Yuki Kusagawa

Miyuki Hori

Practical Information

Website

Official IAS 2022 website: https://www.ias2022.japan.com

Social Media

Please share your conference experience on Twitter.
Join the IAS2022 Conversation - Use #IAS2022
Follow IAC for the latest on the Conference! @AnkleConsortium

Virtual Symposium Platform

The IAS 2022 On-demand is operating at "Whova" application.
You can install Whova app on your smartphone and make sure you create your login info and profile, and then access the contents via smartphone app and/or website on your PC.
Please go on to the next page to check the instration manual and join our session.

Online Interactive Activation Application

The IAS 2022 is also operating interactive activation platform "Gather.Town" for all our participants.
Attendees can talk freely with each other while your avatar is walking on the Maps.
You can also find some popular places in area of Osaka on the Maps.
Please check the installation manual page 27 and enjoy the meeting with participants.

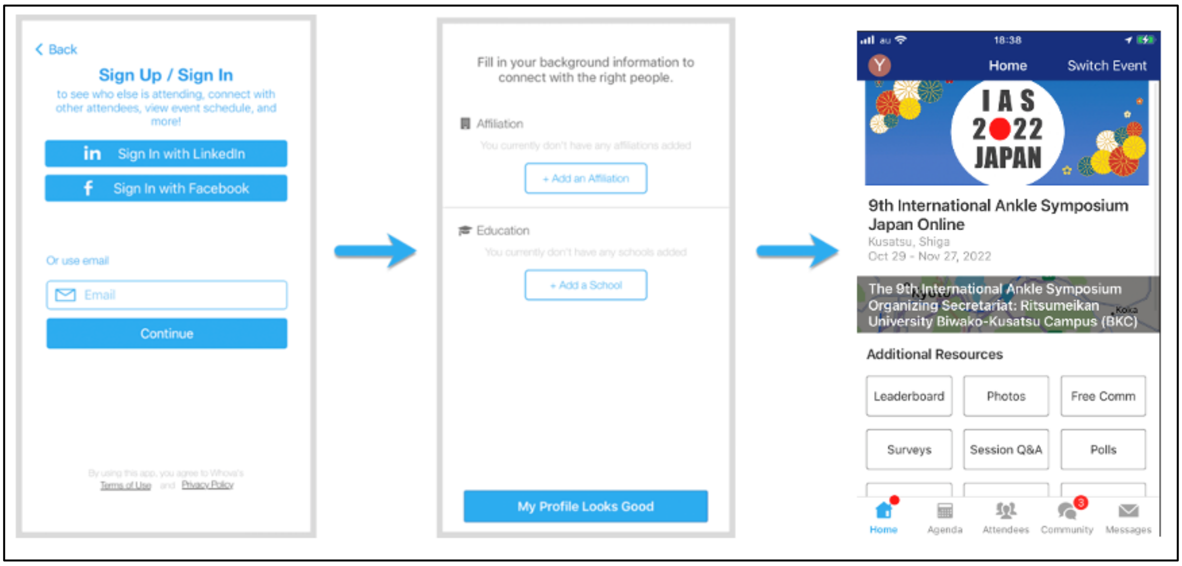
Sign in to Whova

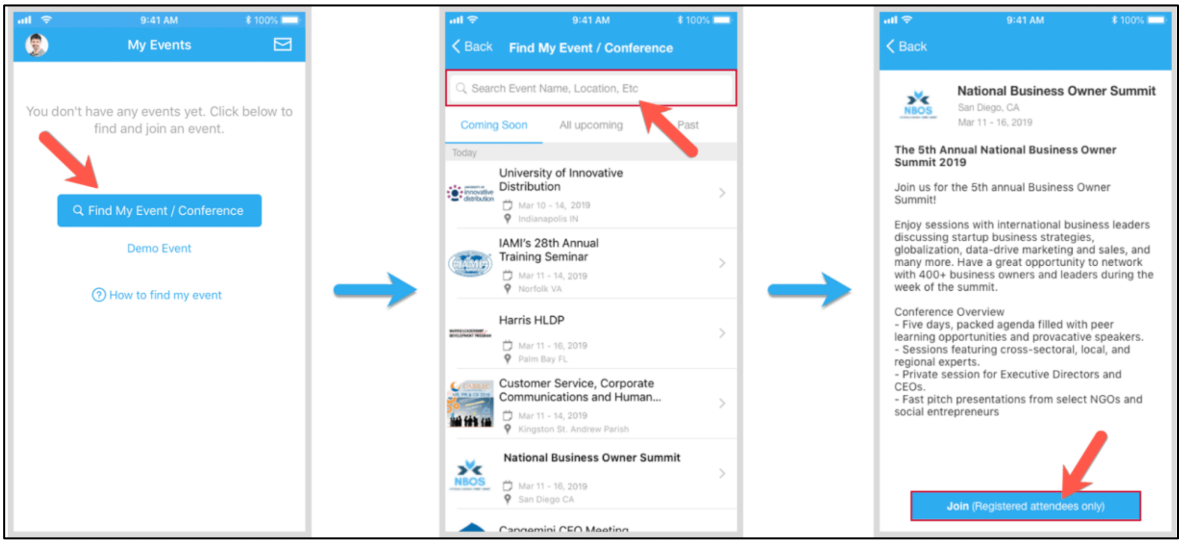
On mobile app

1. Enter the email address you used for event registration or use your social media account.

> **To automatically log in to your event, please make sure to use the email you used when registering for the event.**

2. Create a password and type in your name
3. Edit your profile. Other attendees will use this to network with you. So make it look nice ☺
4. The app will take you to your event page automatically if the organizers have updated the app with your registration information.





If your event doesn't show up automatically, **search** for it. Then, click the **join** button on the bottom of the event description page, and enter the **event invitation code** the organizers sent you.

On web portal

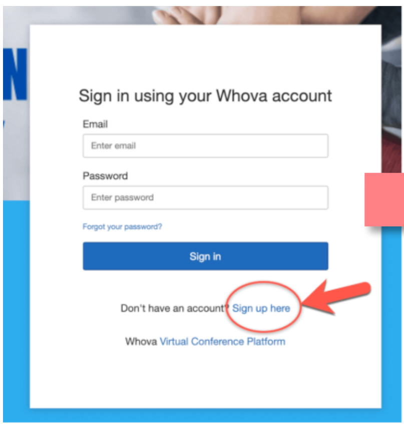
If your event has live streaming for sessions, we suggest that you use Chrome browser for the web portal. Some streaming software may have compatibility issues with other browsers.

https://whova.com/portal/webapp/ias_202210/

1. Please access the web portal from the link below.

2. **To automatically log in to your event**, please make sure to use **the email you used when registering for the event**. **Also, to log in the web version, first you need to download the Whova app on your smartphone and set up your password to log in from the web version.**
3. The app will automatically take you to the event main page.

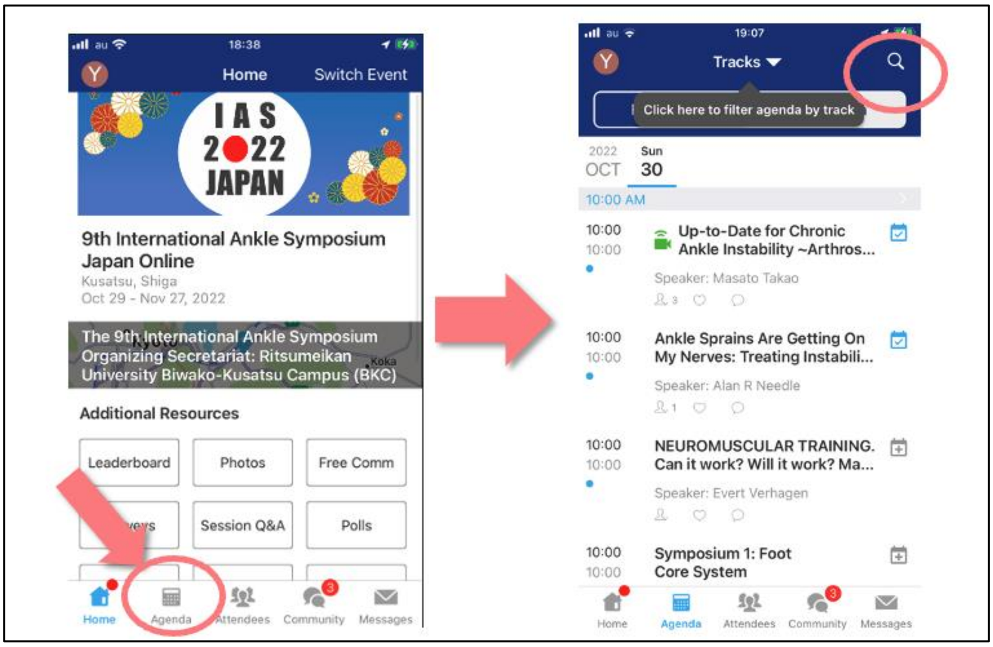
   *Note that if you are not using the registered email, you will be prompted to enter the event invitation code. The invitation code is **adhlco5qa3.**



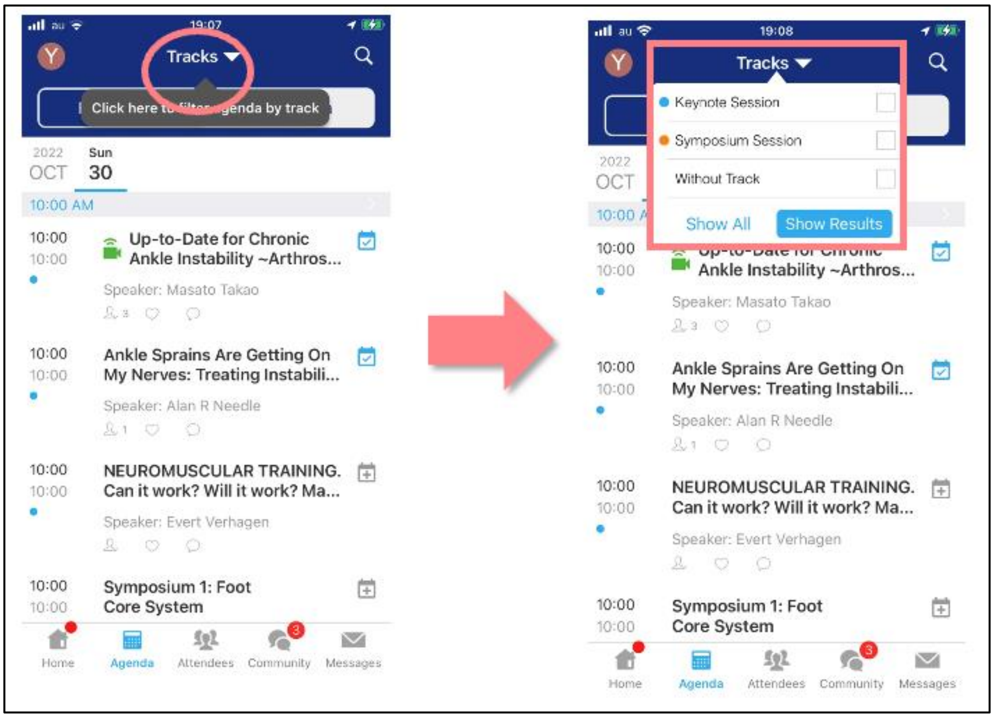
View the agenda and plan your schedule

On mobile app

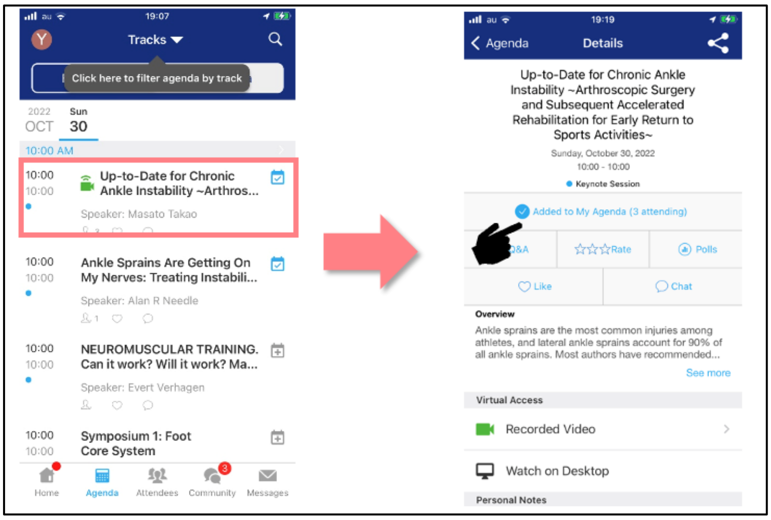
1. Find **the Agenda tab** at the bottom of the screen. You should see a list of sessions for that day.
2. Browse or search for sessions on the top bar.



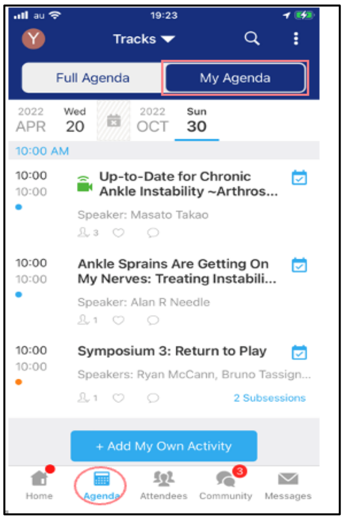
3. You can also search sessions by clicking **Tracks** on top of the page.



4. Once you find the session you want to access, tap on it.

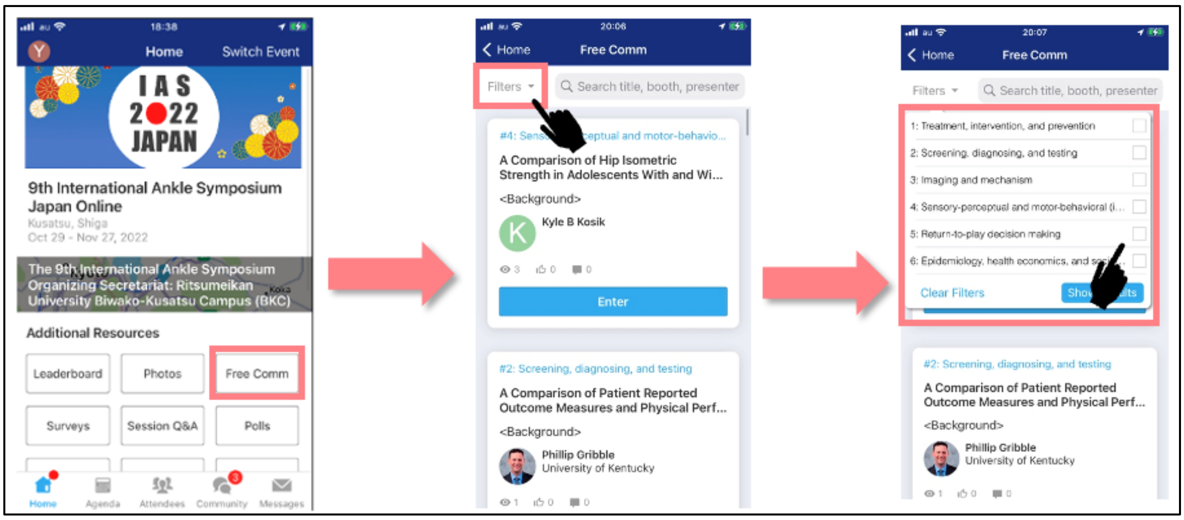


5. You can click Add to **My Agenda** to put the session on your own personal agenda and set a reminder.



Free Communication can be found in the Additional Resources on the top page.

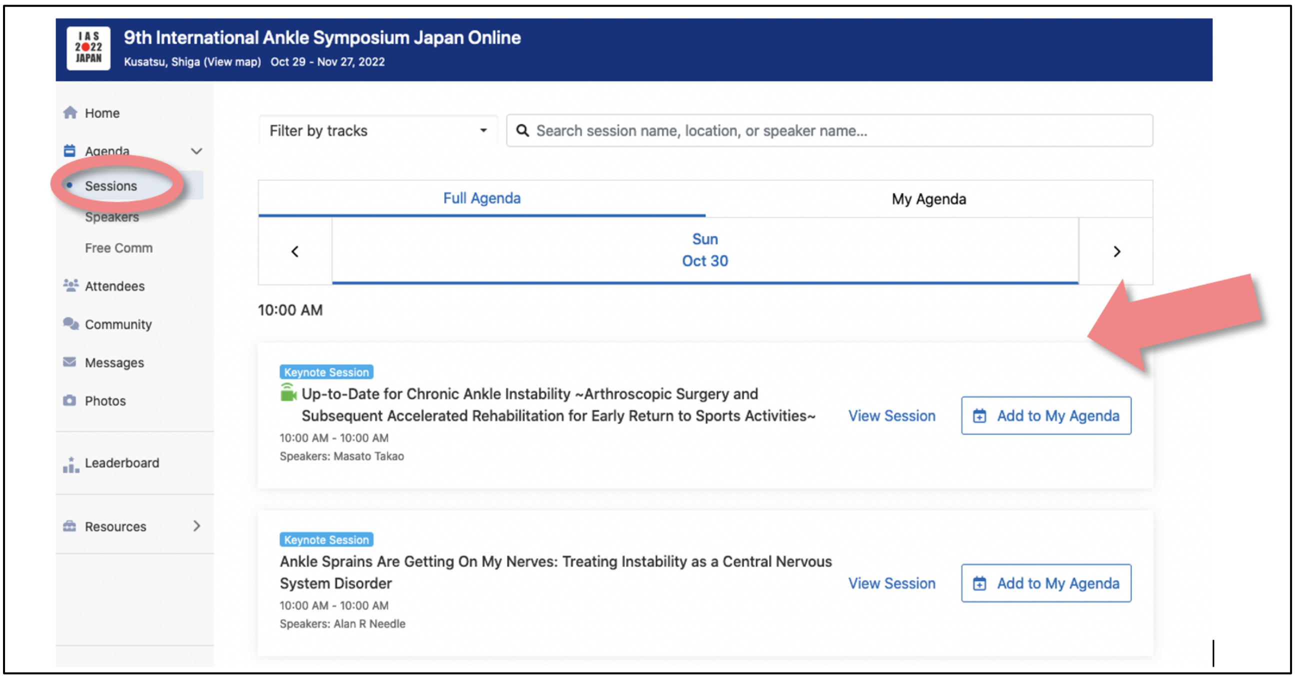
You can scroll, filter the free communication sessions by category.



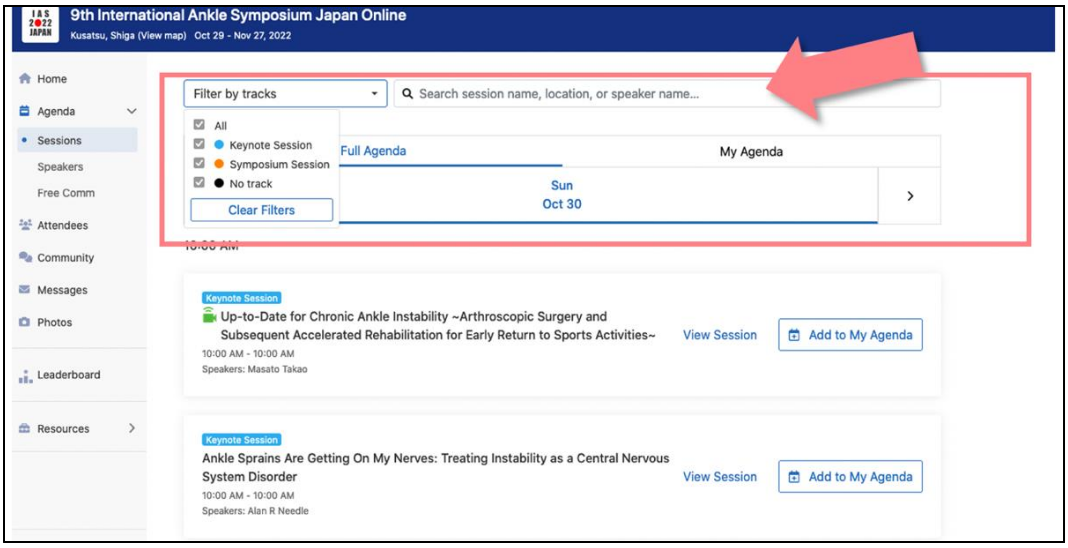
On web portal

1. Find **the Agenda tab** on the side of the screen.

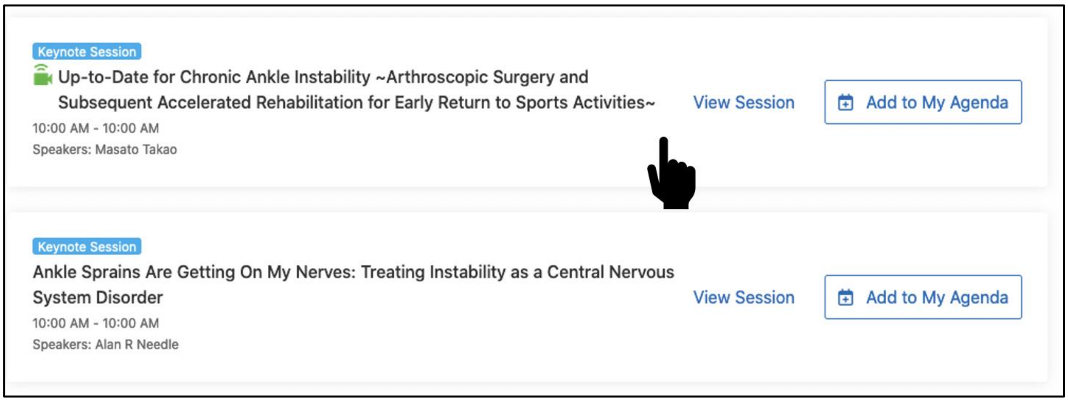
2. You can find lists of all the sessions including Keynote speakers and Symposiums.



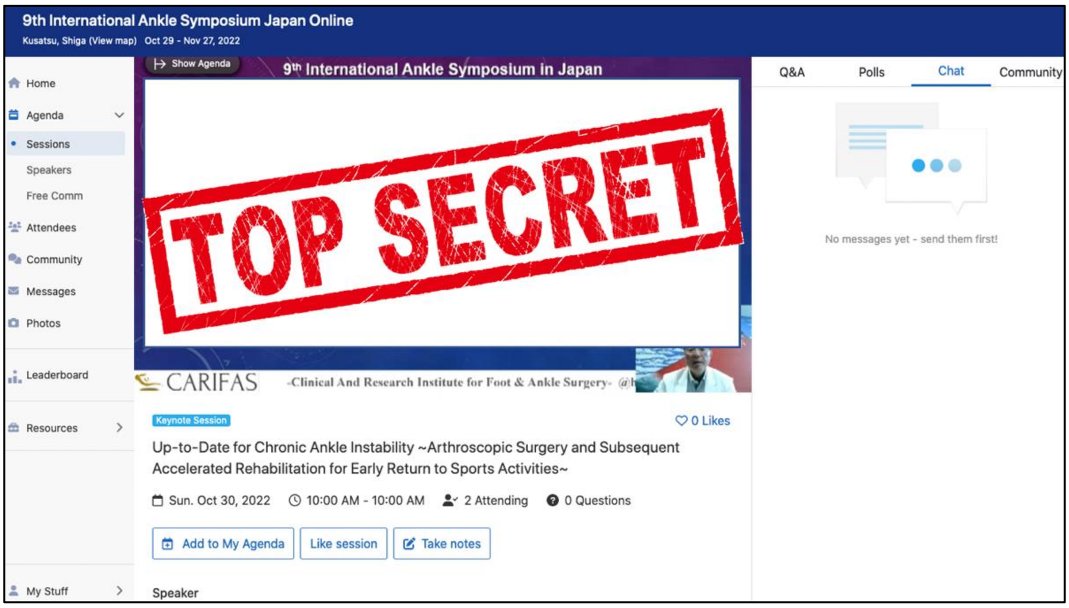
3. You can browse or search for sessions on the top bar.



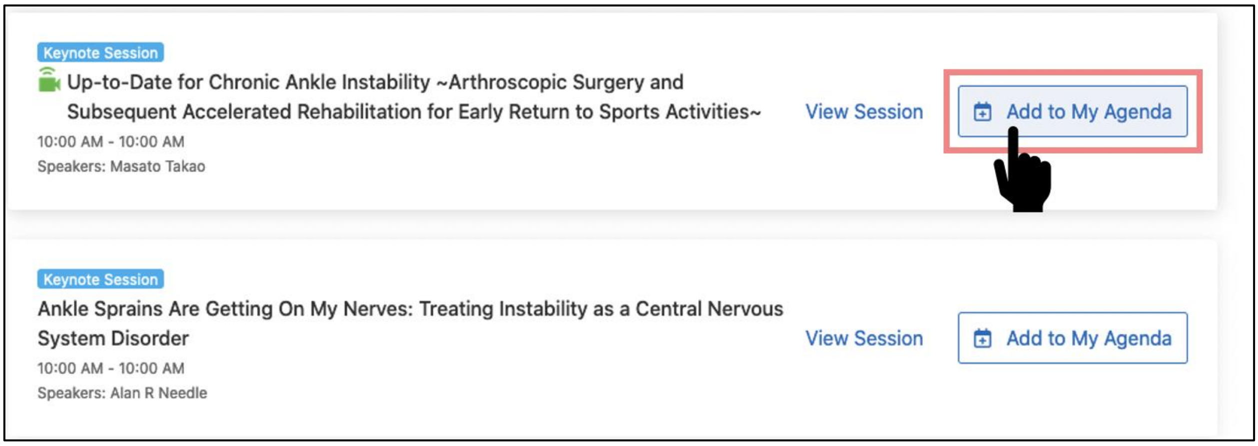
4. Once you find the session you want to access, tap on it.



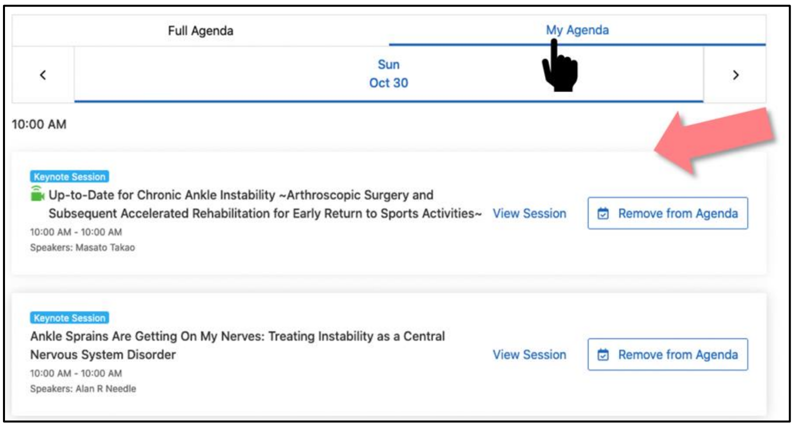
It should take you to **the Session page**.



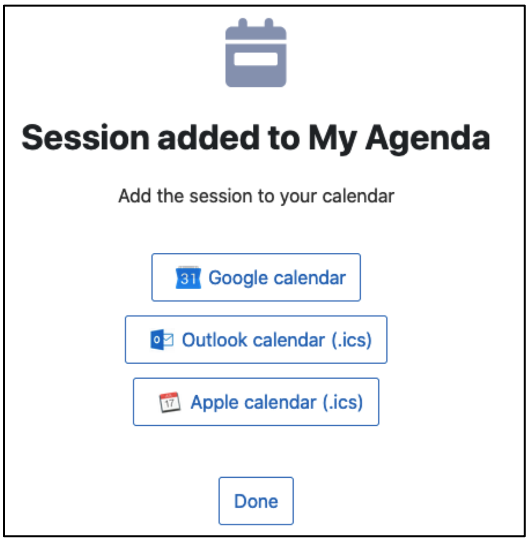
5. You can click "**Add to My Agenda**" to put the session on your own personal agenda.



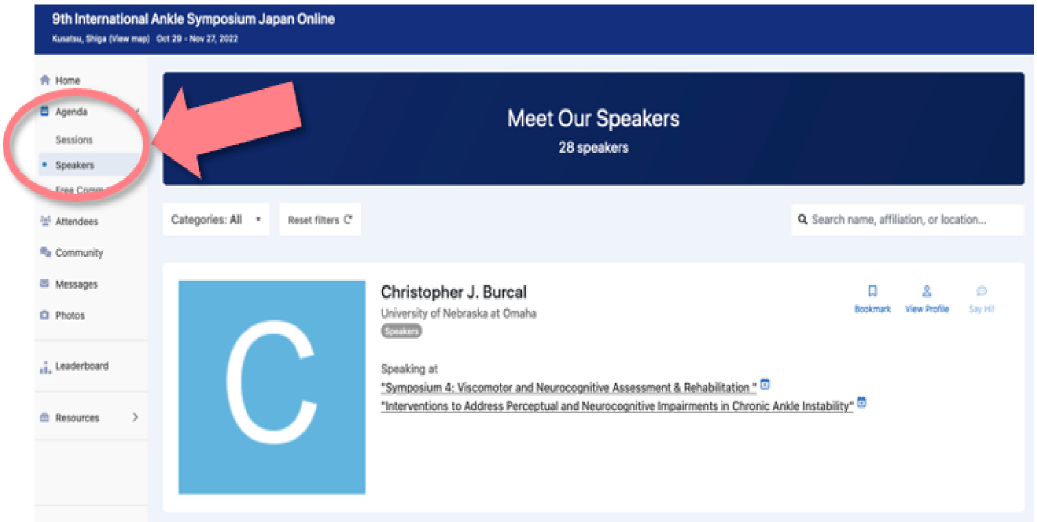
When you click "My Agenda", you can see all the sessions you select.



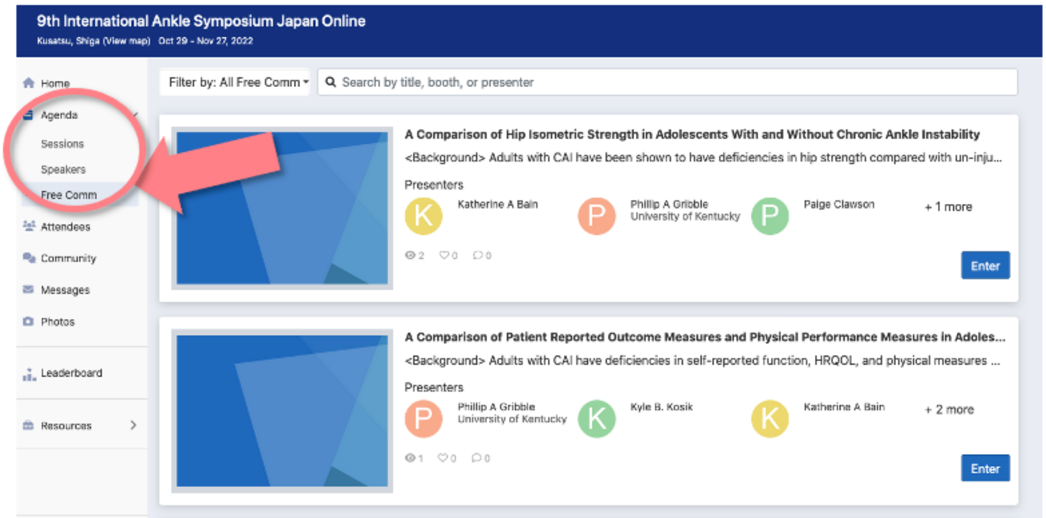
When you click "**Add to My Agenda**", you can also add the session to your calendar.



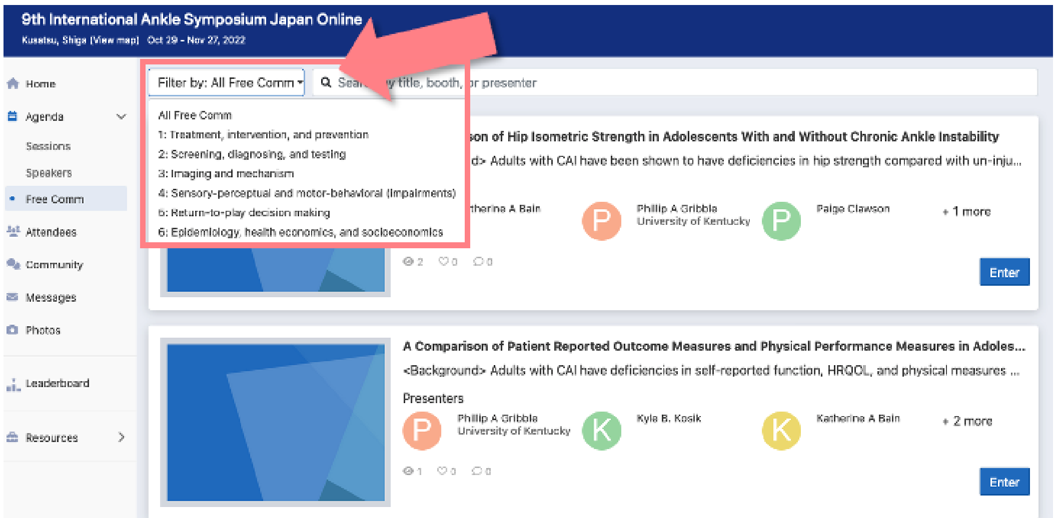
*You can also search the sessions by speakers.



Free Communication is also accessible from the left tab.



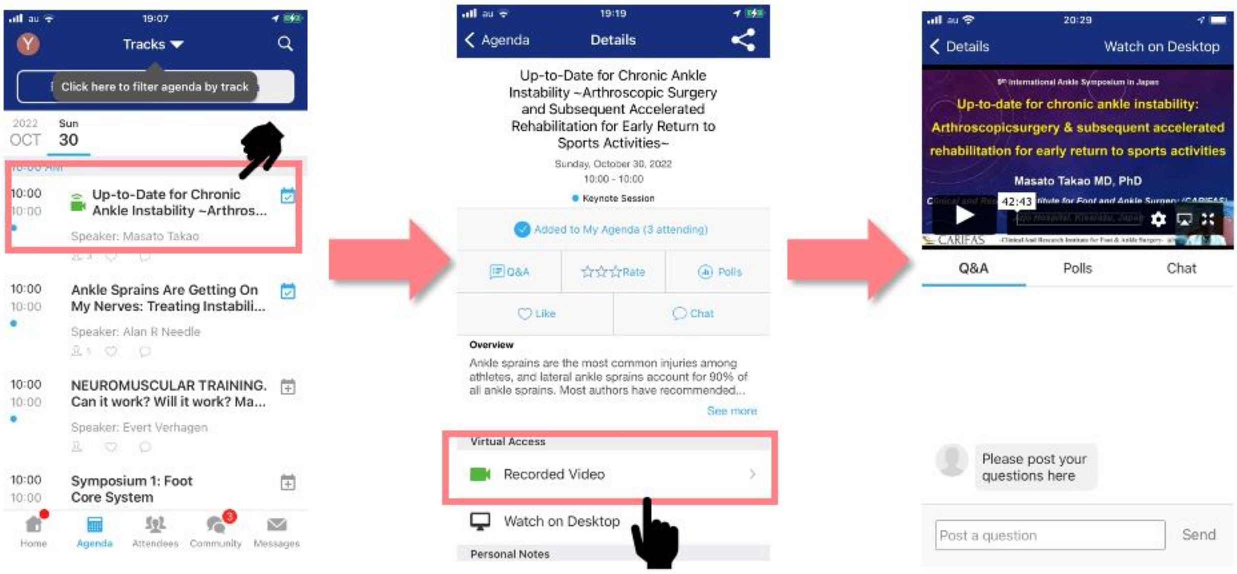
You can filter Free Communication presentations by the category as well.



Access session videos

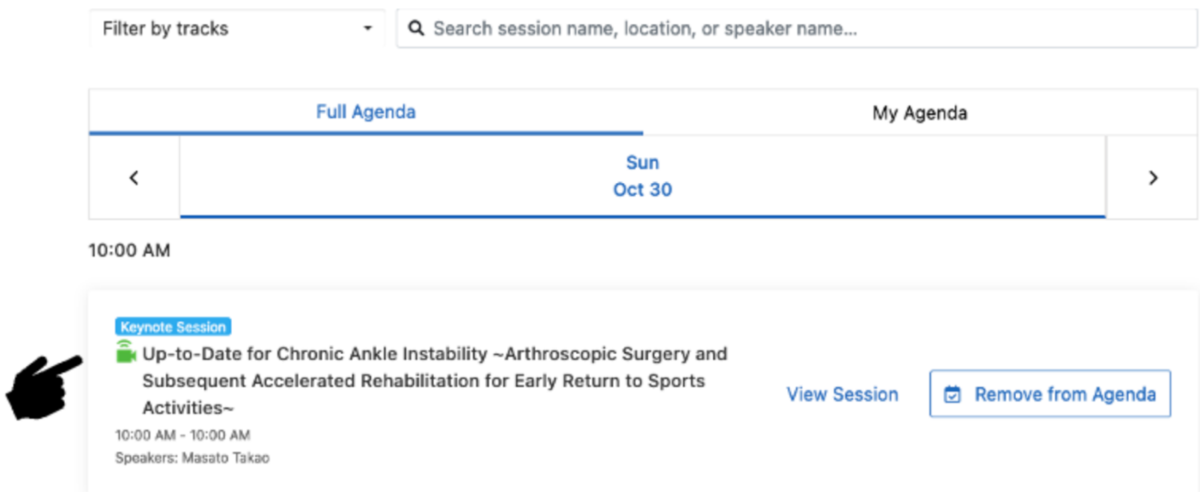
On mobile app

You can watch videos directly through the agenda item. Once you've accessed the agenda item, click on one of the options beneath Virtual Access: **Recorded video**.



On web portal

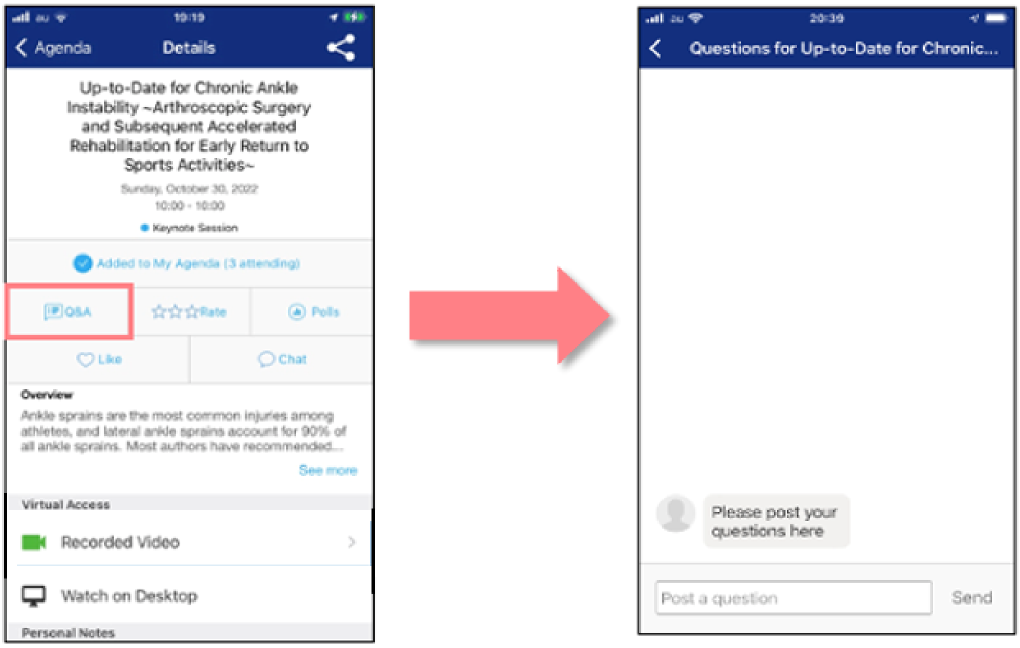
From the agenda list, click the session you would like to watch the video. There is a green camera icon for the sessions with video.



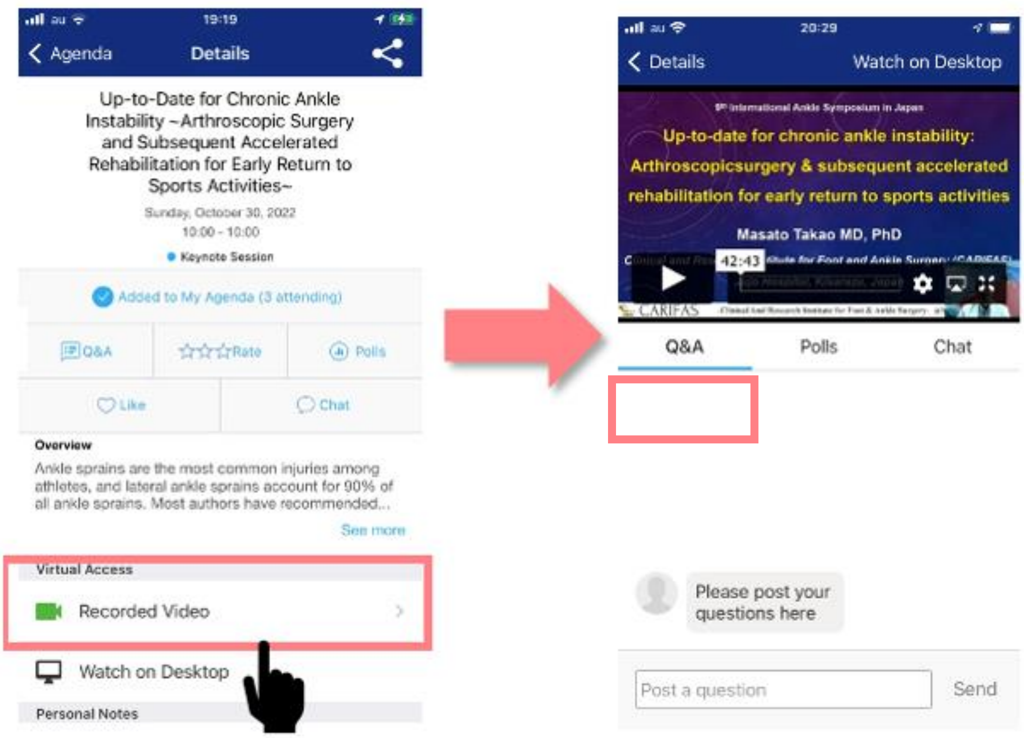
Use session Q&A

On mobile app

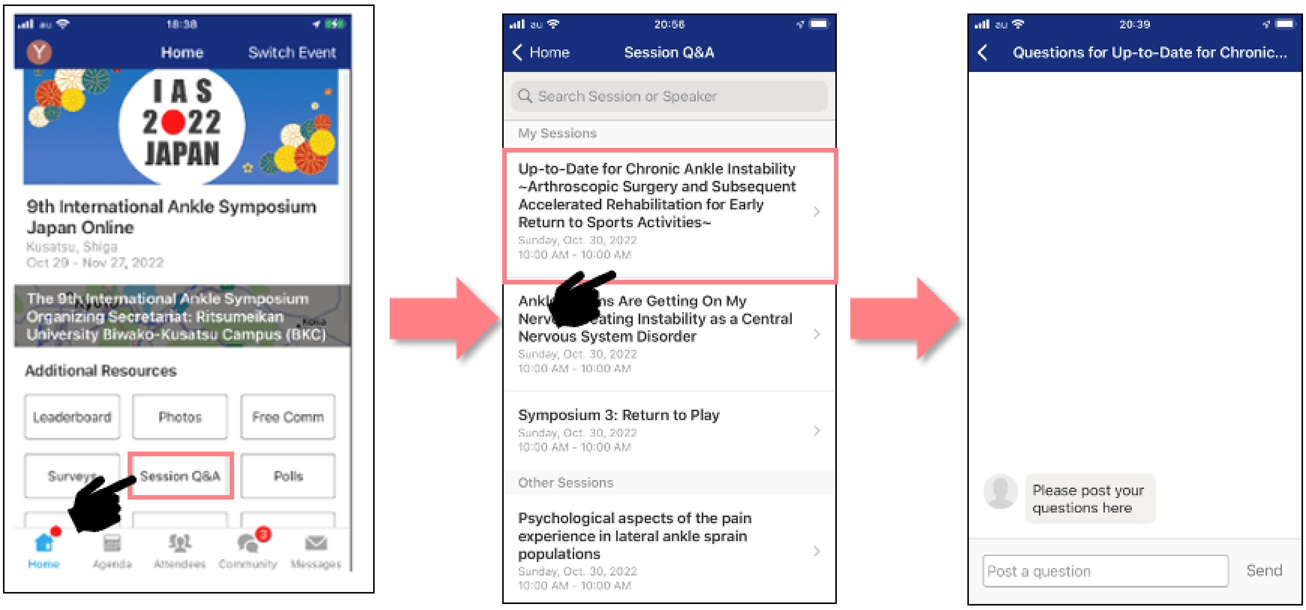
- Option 1: On the session detail page, tap the **"Q&A"** button; on the next page, view the existing questions, vote on the questions you are interested in, or click "**Ask a Question**" to ask a new one



- Option 2: On the session detail page, tap the Recorded video. It will take you to the presentation and you can ask questions by clicking **Q &A** tab.

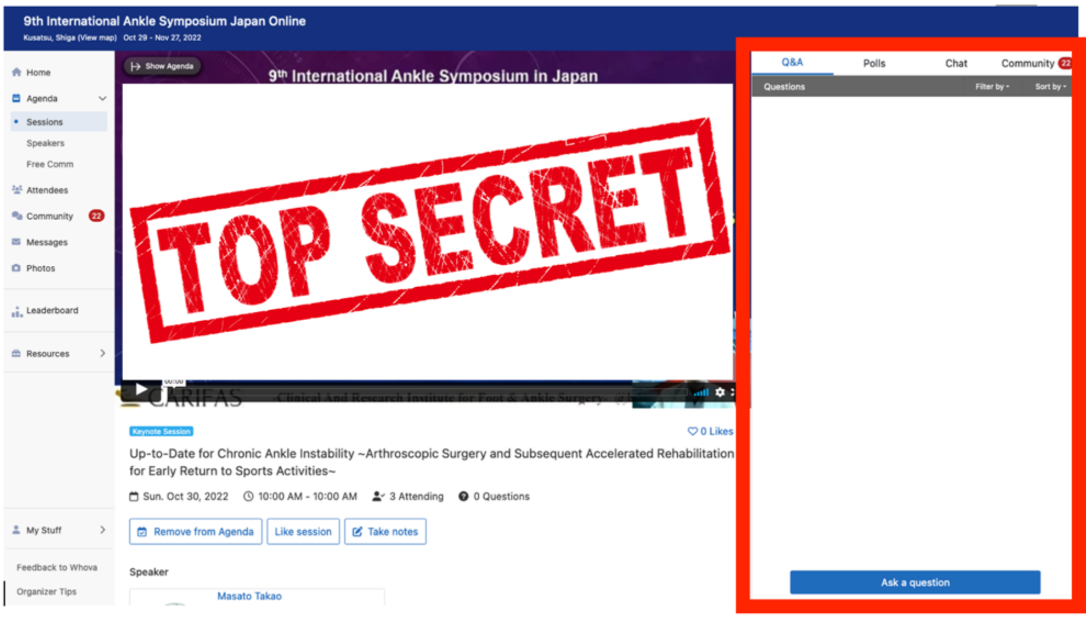


- Option 3: On the event main page, tap “**Session Q&A**” button; find the session you want to ask questions in, and tap on it.

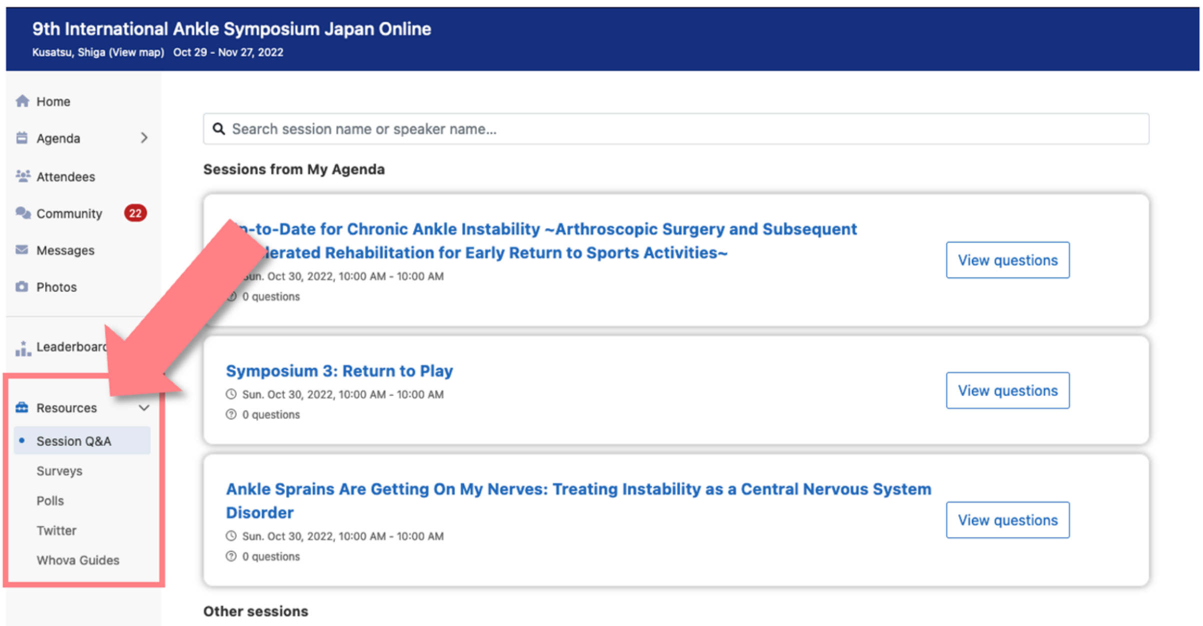


On web portal

1. Option 1: You can access three tabs on the right hand side of the virtual session: Session Q&A, Chat, and Community. You can submit questions for the presenter through Session Q&A, participate in ongoing discussions with the other attendees viewing the session through Chat, and browse the Community Board function through Community



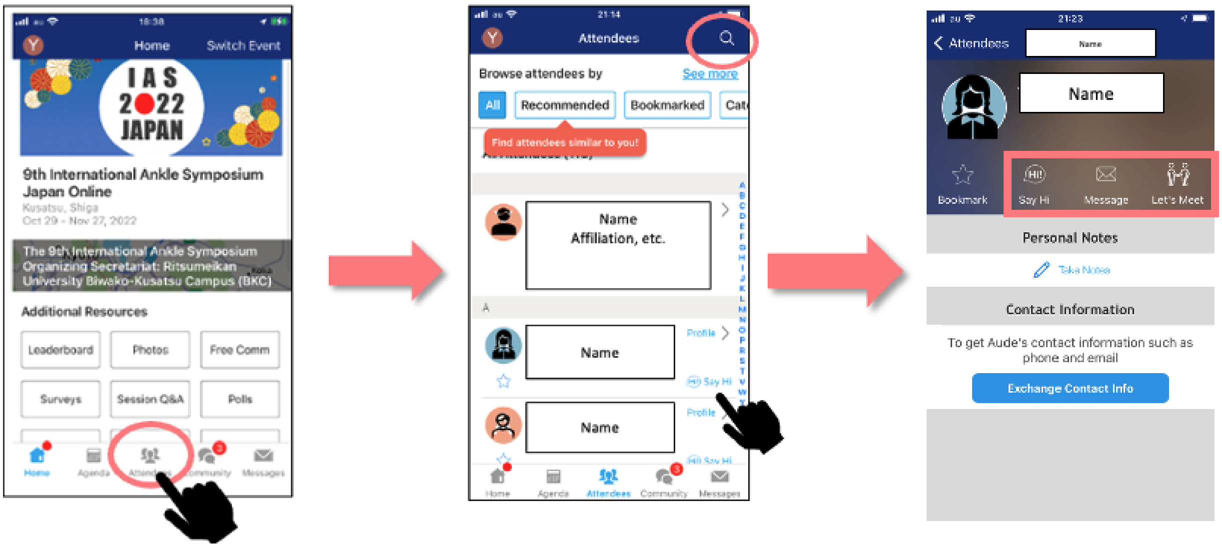
2. Option 2: You can use this function through the "**Session Q&A**" tab on the left hand sidebar underneath Resources.



See who is attending the event

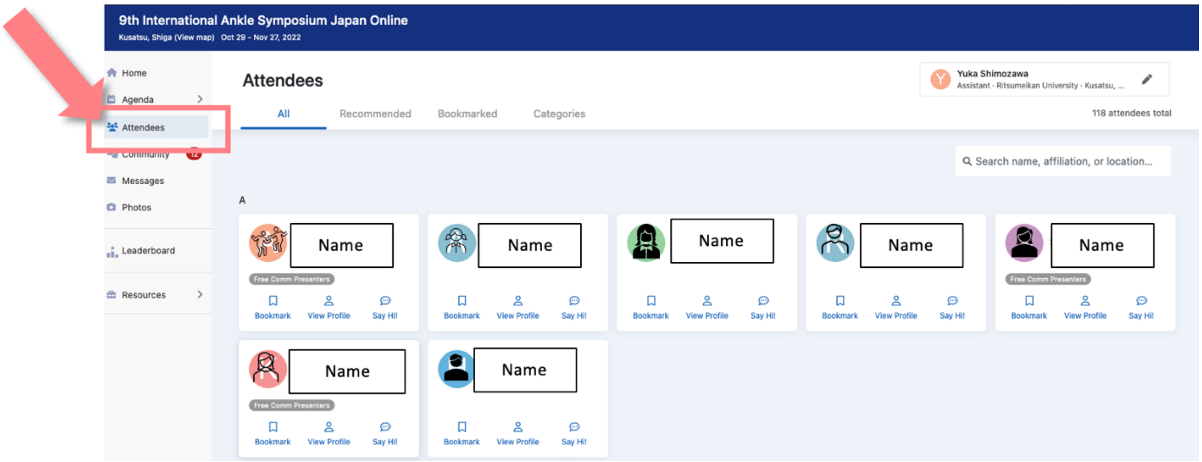
On mobile app

1. Click the "**Attendees**" tab on the bottom of the screen to browse the attendee list.
2. At the top of the page, you can search attendees by keywords such as company name or title. In their professional profiles, you can take notes or request contact information.
3. To find people with common backgrounds and interests, click the Recommended tab on the top of the Attendees list to find Whova's recommendations about people you may be interested in networking with. Click into each item to see attendees who come from the same city or have the same affiliations, educational background, or interests as you.
4. Say Hi with one click or start a private chat by clicking the Message button. You can convert it to a private group chat by inviting more people.



On web portal

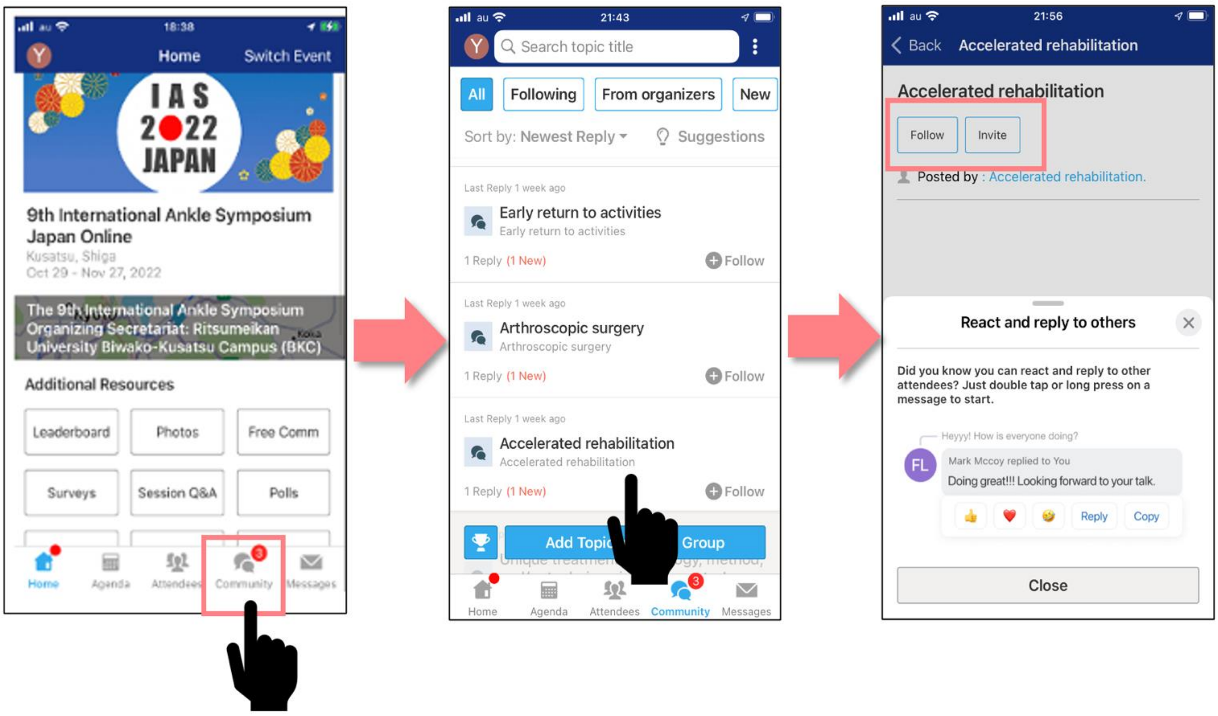
1. Click the "**Attendees**" tab on the left side of the screen under Main Navigation.
2. At the top of the page, you can search attendees by keywords such as company name or title.
3. To start a conversation, click **Send Message** to begin a chat.



Join discussion on the community board

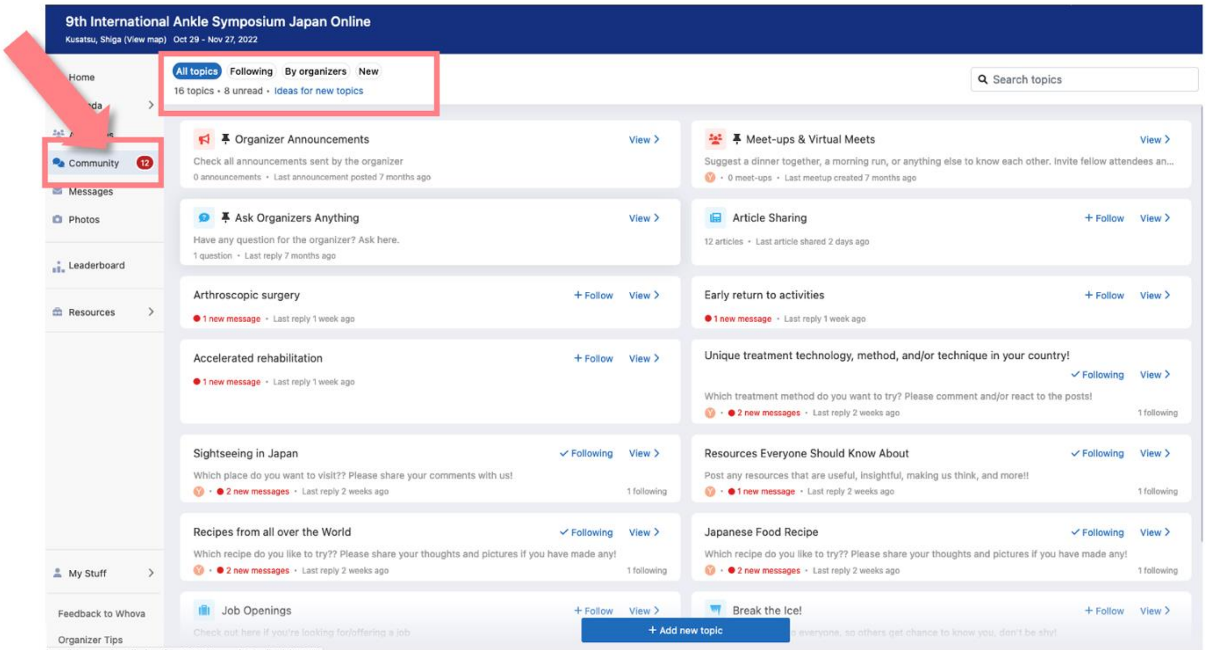
On mobile app

1. Click the **Community** tab (on the bottom of the screen and on the left hand side on desktop)
2. Create a new conversation topic, or tap the topic to join existing topics like "**Meet-ups**." Please feel free to make any new ones!!
3. Click Follow directly next to the topics on the Community Board that you want to stay up to date with. To find the topics you're following, choose between three tabs near the top of the page: All Topics, Followed, and New Topics.



On web portal

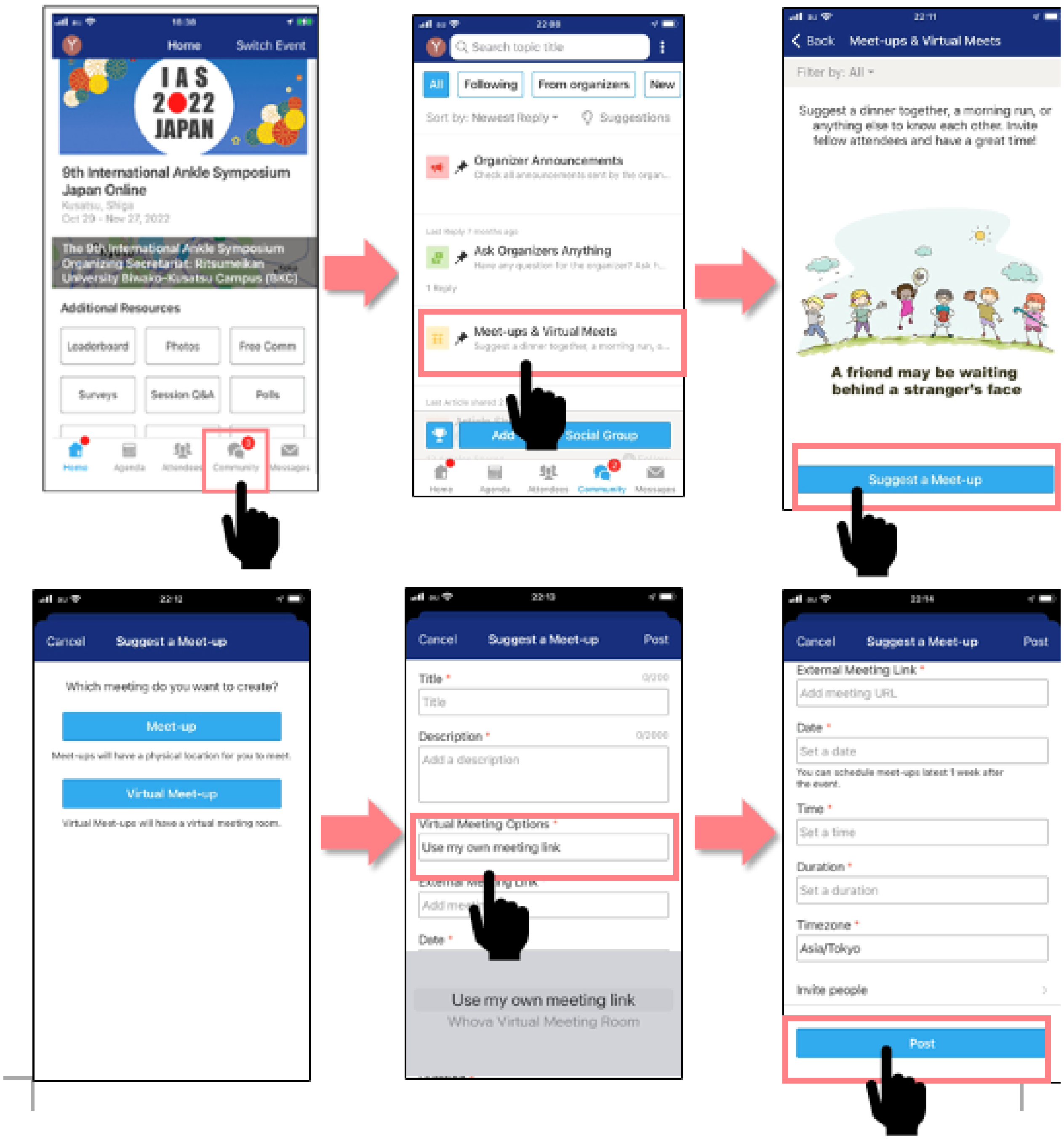
1. Click the **Community** tab on the side menu to the left of the screen
2. Create a new conversation topic, or use existing topics like "**Meet-ups**."
3. Click Follow directly next to the topics on the Community Board that you want to stay up to date with. To find the topics you're following, choose between three tabs near the top of the topics list section: All Topics, Followed, and New Topics.



Start or join a virtual meetup

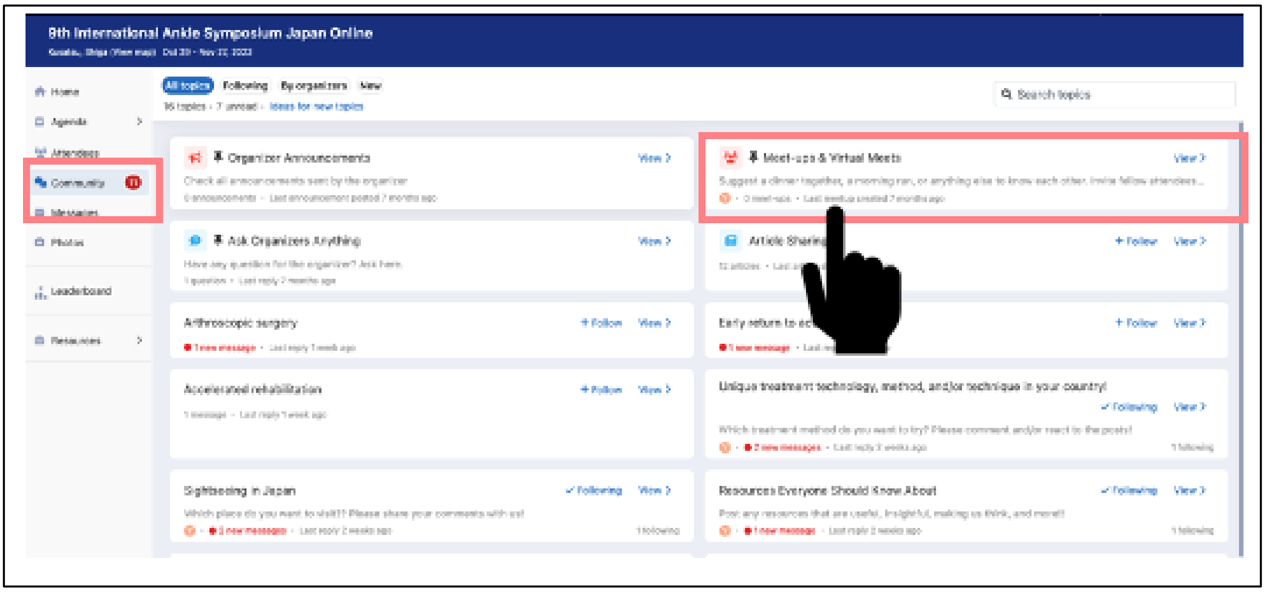
On mobile app

1. Go to the Community Board, and find the board for Meet-ups and Virtual Meets.
2. Find the meet-up you are interested in, join directly, or tap into it to see more details, and then tap "Join"
3. You can also suggest a new meetup by tapping "Suggest a Meet", and inputting the details. If you know someone will be interested, **don't forget to invite** them as well. If you have a meeting link, you can copy-paste there. *Please select "Use my own meeting link."

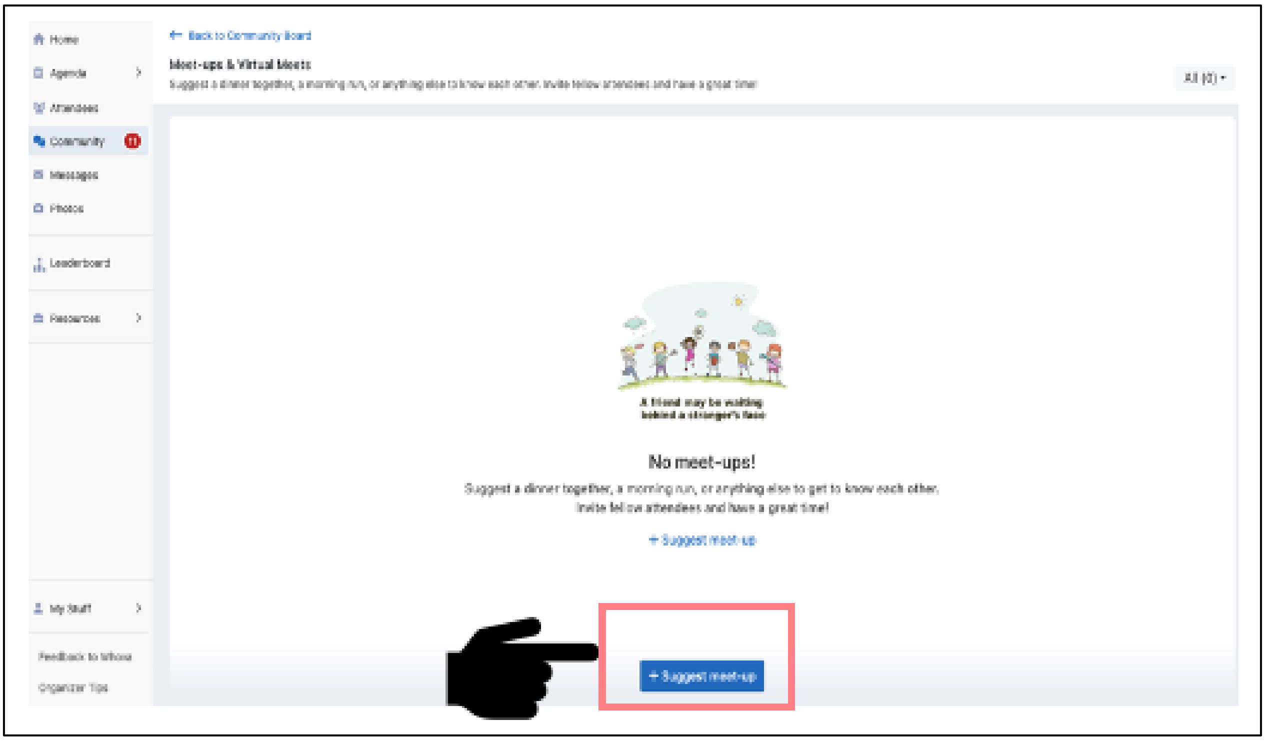


On web portal

1. Go to the Community Board, and find the board for Meet-ups and Virtual Meets.

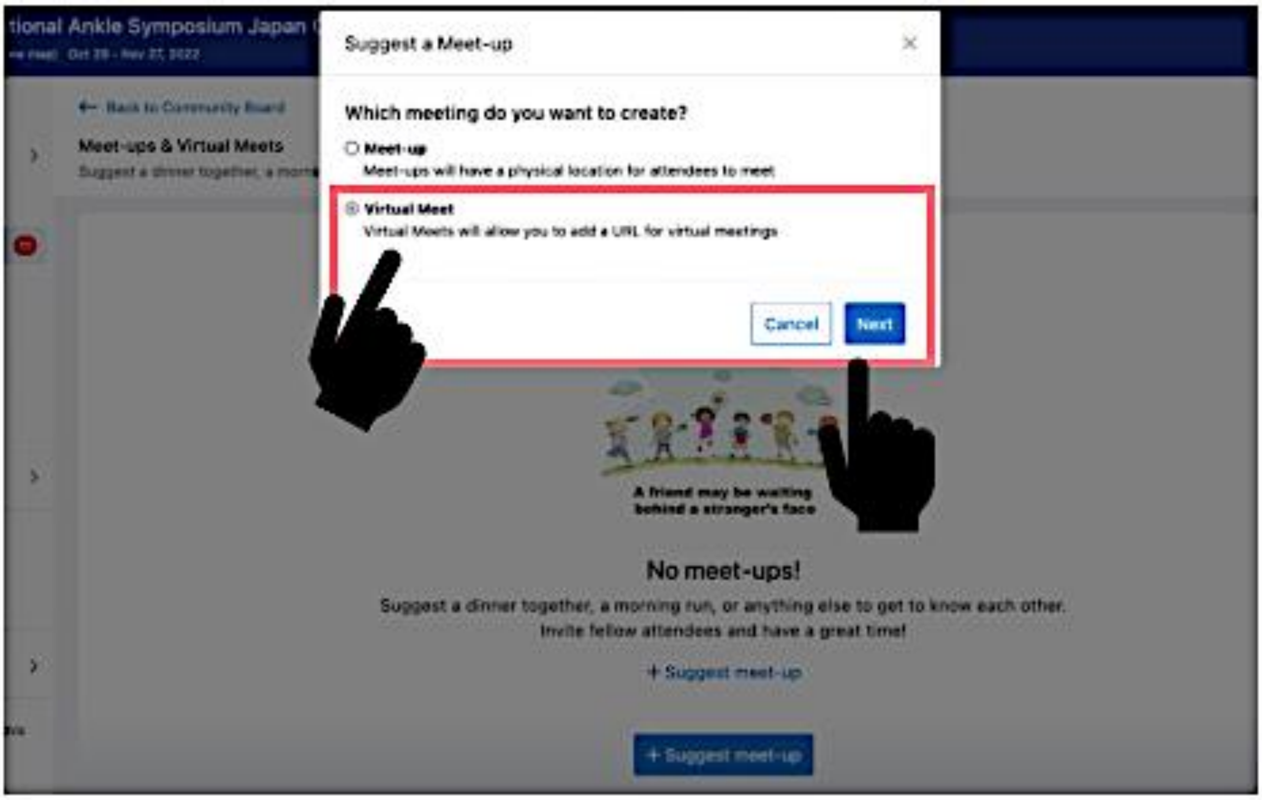


2. You are welcome to make any Virtual Meet-ups and please enjoy interacting with other attendees by tapping "Suggest a Meet."



*Please select your personal link. You can copy-paste your link.

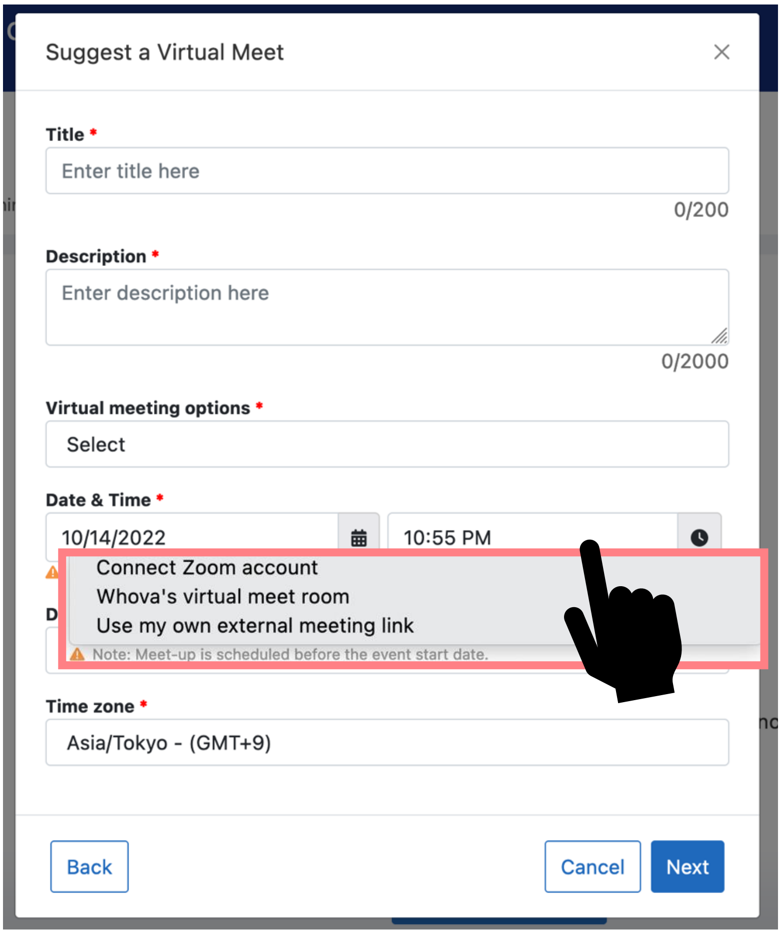
After clicking "Suggest Meet up," please select "Virtual Meet" and click "Next."



Please enter the details!
You can select virtual meeting options, but please select either "connect Zoom account" or "Use my own external meeting link."

When you use the live online sessions, we suggest that you use **Chrome browser** for the web portal.
Some streaming software may have compatibility issues with other browsers.

Find the meetup you are interested in, join directly, or click into it to see more details, and then click "RSVP"

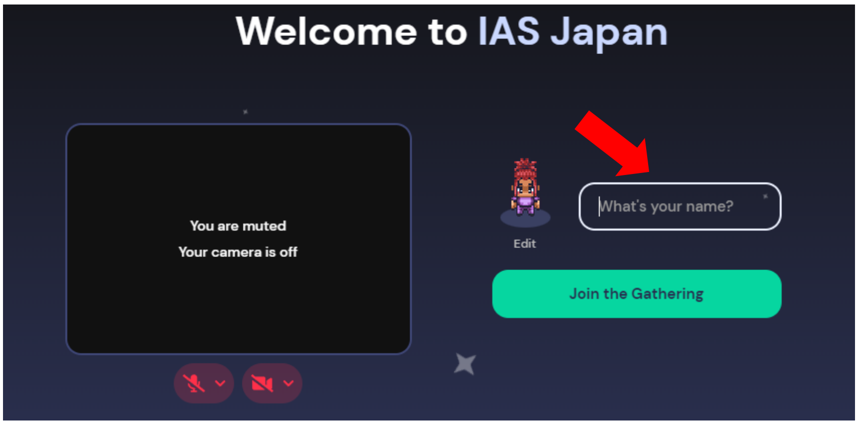


How to access Gather.Town

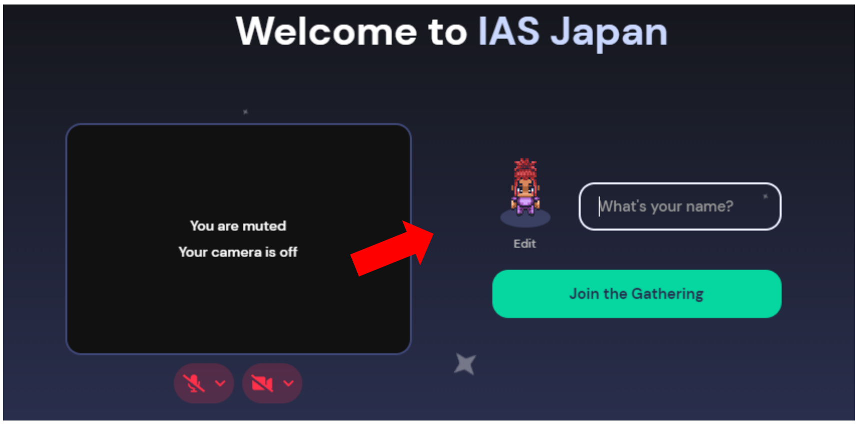
1. Please enter Gather.Town via the symposium platform (Whova) or a link below.

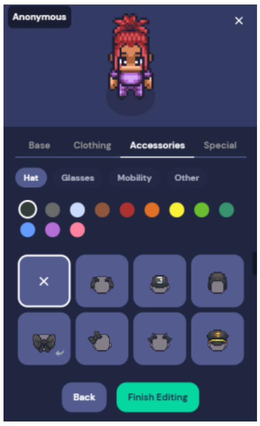
https://app.gather.town/app/v6zYLrzWPh4HR5Fj/IAS%2

2. Click on Request Permissions and type in your name or nickname.

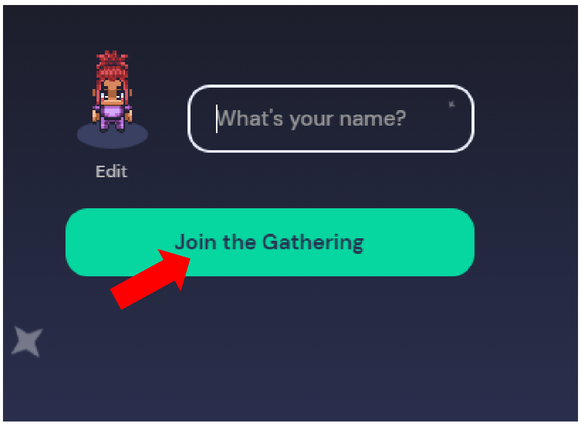


3. You can change your character by clicking on Edit just below your avatar.



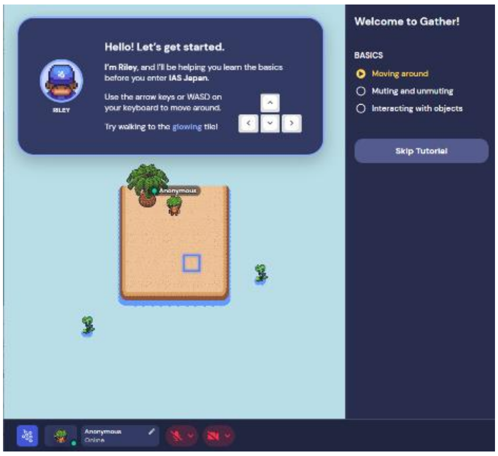


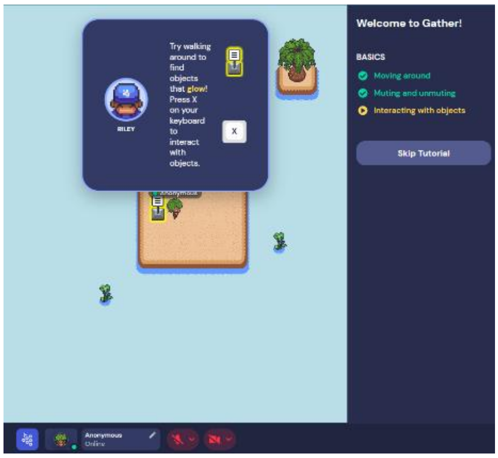
4. Click on "Join the Gathering" to enter the world of Gather town.



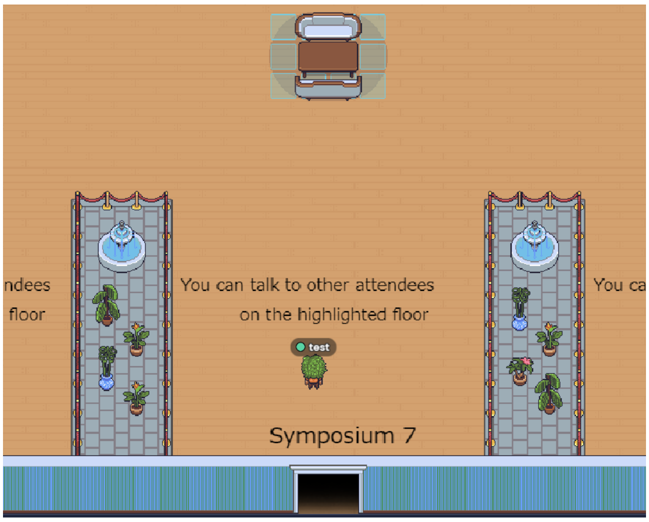
How to operate

1. Enter Gather.Town and the tutorial will begin. Follow the on-screen instructions.
   Click on Skip Tutorial after you have completed the tutorial.

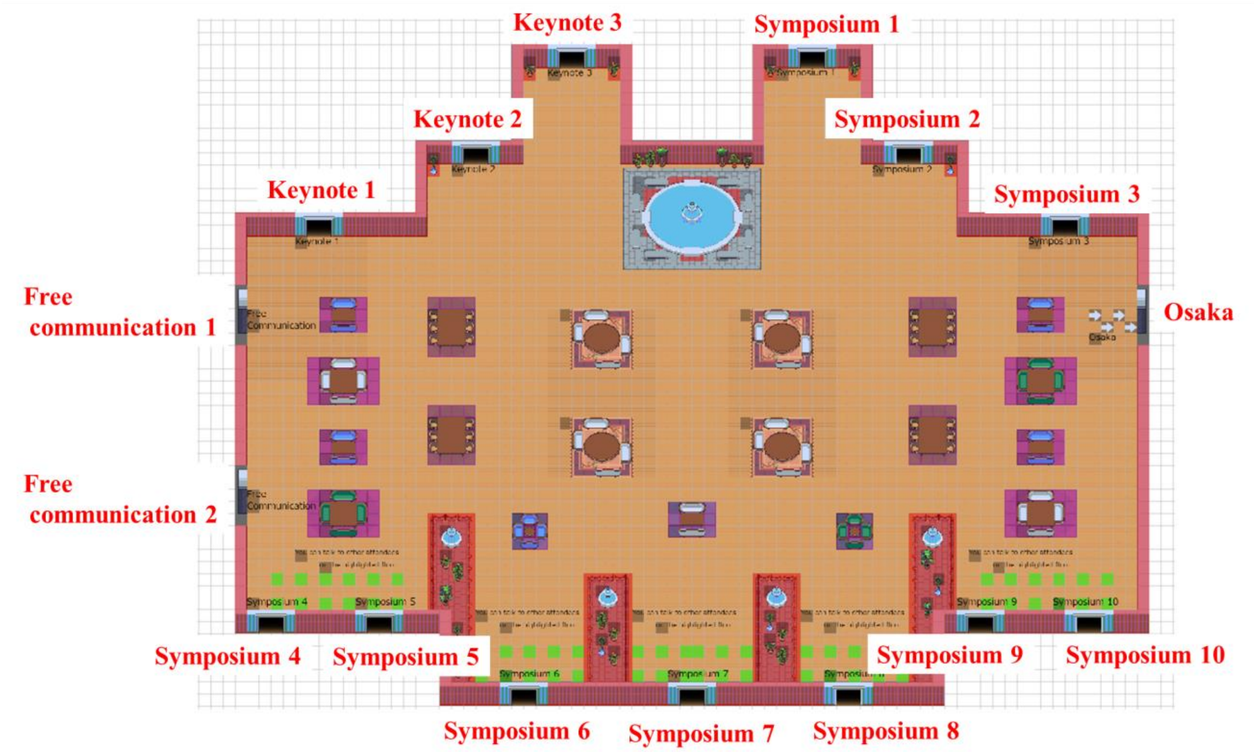




2. **Location:** When you first enter Gather.Town you will be in the hall where the IAS will be held. You can follow the paths to the different rooms (keynote, symposium, and free communication sessions) and enter each room to watch a video of a presentation.



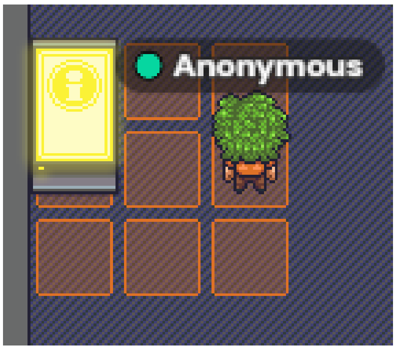
3. **Map Overview:** Here is a map overview of the main hall for in Gather.Town and where the 3 keynote, 10 symposium, and 2 free communication session rooms are located within the space.



4. **Video Chat:** As you get closer to other attendees, the "Ring OOO(name)" screen will appear, click on "Ring OOO(name)" to do video chat with that person.

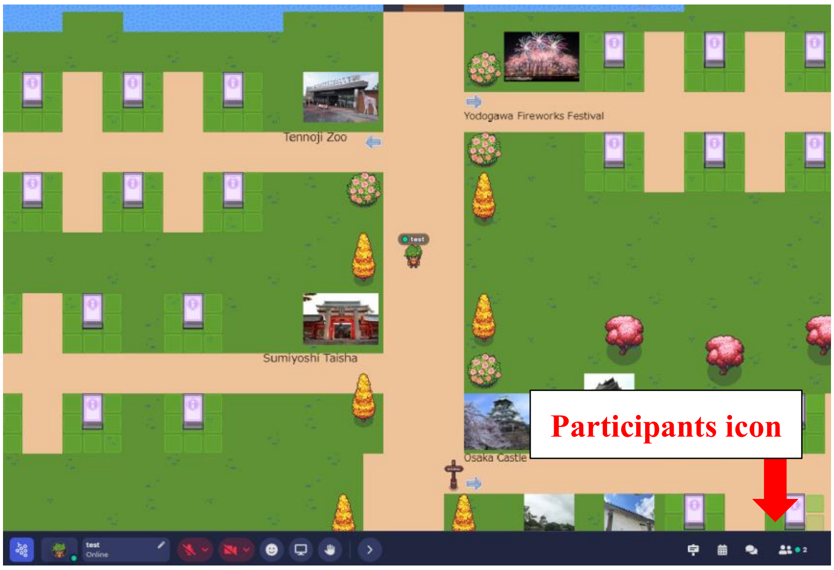
5. **Highlighted Space:** You can talk to other attendees on the highlighted floor. When you step in the highlighted area, you can only chat with other attendees who are in the same space.

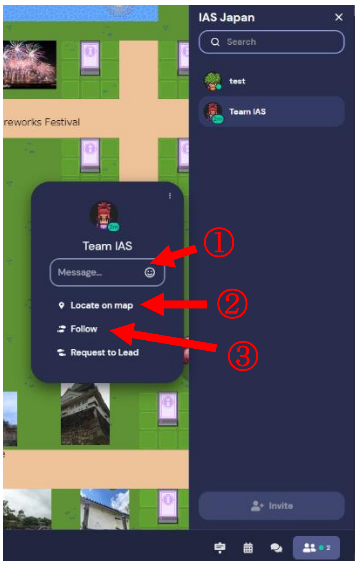
6. **Scientific Program Session Rooms:** When you enter a session room, you can find a computer terminal. **Stand on the highlighted floor and press the "X" key** on your keyboard to watch a video of a presentation.



7. There is also an exit on the right wall, and you can use the exit to go sightseeing in Osaka. We have a variety of pictures and videos of popular tourist attractions and historical landmarks in Osaka, please enjoy!

8. Search for an Attendee: You can search for a specific person with his/her name in the "Participants" icon on the right. There are three ways to contact them:
   ① Select "Message" to chat directly.
   ② Use "Locate on map" to see a path to reach the person.
   ③ Use "Follow" and the system will automatically take you to the person





SCIENTIFIC PROGRAMME INFORMATION

Proceedings

- All symposium sessions will be held only online (on-demand playback on our virtual symposium platforms).
- A textual Q&A box, tied to the presentation, will be used for each session. This Q&A box will be accessible throughout the symposium period.
- All free communications will be presented as an oral presentation format (no poster presentation).
    - Thirty-eight abstracts of original research were accepted at the 9th IAS.
    - The abstracts that follow from the oral presentations of the symposium represent current advances in foot and ankle research evidence, which include the following:
        - ① Treatment, intervention, and prevention
        - ② Screening, diagnosing, and testing
        - ③ Imaging and mechanism
        - ④ Sensory-perceptual and motor-behavioral (impairments)
        - ⑤ Return-to-play decision making
        - ⑥ Epidemiology, health economics, and socioeconomics
- There will be no formal proceedings published for this symposium. Abstracts of papers presented at the IAS 2022 are published in this booklet only.
- On the following pages, you will find the abstracts of the keynote lectures, invited symposium lectures, and the original research, oral presentations, from the 9th IAS.

Certificate of Attendance

- Electronic certificates will be sent to each delegate via email.

List of Invited Lectures

The scientific program consisted of 28 invited presentations (3 keynote sessions and 10 symposium sessions) from internationally recognized experts and early career scientists (next generation of experts), as well as was designed to appeal to clinicians, scientists, students who are seeking a professional degree and/or are interested in foot and ankle research. The topics of these presentations included the following: Keynote Speaker Sessions: 1) Arthroscopic Surgery and Rehabilitation, 2) Neuroscience Application to Ankle Injury Intervention, 3) Neuromuscular Training for Ankle Injury Prevention. Symposium Sessions: 1) Foot Core System, 2) Injury Prevention, 3) Return to Play, 4) Viscomotor and Neurocognitive Assessment & Rehabilitation, 5) Innovative Ideas for Ankle Injury Prevention, 6) Gait-Training Interventions, 7) Neuromechanical Strategies, 8) Psychological and Pain Management Issues, 9) New Topics of CAI from Japanese Researcher, 10) Athletic Trainers' Osteoarthritis Consortium (ATOAC) Session.

【Keynote Speaker Sessions】

Keynote #1: Arthroscopic Surgery and Rehabilitation

- **Title:** Up-to-Date for Chronic Ankle Instability ~Arthroscopic Surgery and Subsequent Accelerated Rehabilitation for Early Return to Sports Activities~

  Speaker: Masato Takao (Jujo Hospital, Japan)

Keynote #2: Neuroscience Application to Ankle Injury Intervention

- **Title:** Ankle Sprains Are Getting On My Nerves: Treating Instability as a Central Nervous System Disorder

  Speaker: Alan R Needle (Appalachian State University, USA)

Keynote #3: Neuromuscular Training for Ankle Injury Prevention

- **Title:** NEUROMUSCULAR TRAINING. Can it work? Will it work? Make it work!

  Speaker: Evert Verhagen (Amsterdam University Medical Center, Netherlands)

【Symposium Sessions】

Symposium #1: Foot Core System/Subtalar

- **Title:** Foot Core strengthening strategies 1.0 and 2.0

  Speaker: François Fourchet (Hôpital de La Tour, Switzerland)
- **Title:** The Relationship between Strength and Volume of Toe Flexor Muscles: its Potential Applications to Evaluation and Improvement in the Plantar Intrinsic Foot Muscle Function

  Speaker: Yuki Kusagawa (Ritsumeikan University, Japan)

Symposium #2: Injury Prevention (primary & secondary)

Prevention of ankle sprain injuries: an essential update and guide for clinicians

- **Title:** Understanding the results of epidemiological research is integral to the planning of effective ankle sprain prevention strategies

  Speaker: Eamonn Delahunt (University College Dublin, Ireland)
- **Title:** Braces and tape: integrating clinical expertise and best evidence to make informed decisions for the prevention of ankle sprains

  Speaker: Claire Hiller (University of Sydney, Australia)
- **Title:** A guide to implementing effective therapeutic interventions to prevent first-time ankle sprains and chronic ankle instability

  Speaker: Phillip Gribble (University of Kentucky, USA)

Symposium #3: Return to Play

- **Title:** Athletic Trainers' Methods for Deciding Return-to-Activity Readiness in Ankle Sprain Patients
  Speaker: Ryan McCann (Old Dominion University, USA)
- **Title:** Return to sport decision-making following lateral ankle sprain: Where are we now? What can we do?
  Speaker: Bruno Tassignon (Vrije Universiteit Brusse, Belgium)
- **Title:** The Ankle-GO, a new score to assess return to sport after lateral ankle sprain and chronic ankle instability
  Speaker: Brice Picot (Fédération Française de Handball, France)

Symposium #4: Viscomotor and Neurocognitive Assessment & Rehabilitation

- **Title:** Theoretical Framework for Examining Perceptual-Cognitive Control Following Lateral Ankle Sprain
  Speaker: Matthew Hoch (University of Kentucky, USA)
- **Title:** Central Neural Sensorimotor Integration Assessments in Individuals with Chronic Ankle Instability
  Speaker: Kyeongtak Song (University of Kentucky, USA)
- **Title:** Interventions to Address Perceptual and Neurocognitive Impairments in Chronic Ankle Instability
  Speaker: Christopher J. Burcal (University of Nebraska at Omaha, USA)

Symposium #5: Innovative Ideas for Ankle Injury Prevention

- **Title:** Mechanism and Prevention of Ankle Sprain: An Overview
  Speaker: Daniel Fong (Loughborough University, United Kingdom)
- **Title:** Spraino: A new strategy for lateral ankle sprain injury prevention
  Speaker: Filip Gertz Lysdal (Technical University of Denmark, Denmark)
- **Title:** Smart Technologies for Ankle Sprain Prevetion, Assessment and Rehabilitation
  Speaker: Aliaa Rehan Youssef (Cairo University, Egypt)

Symposium #6: Gait-Training Interventions

- **Title:** Delivery, dosage, and desires: Considerations for maximizing gait-training benefits for foot and ankle injury patients
  Speaker 1: Alexandra F DeJong Lempke (University of Michigan, USA)
  Speaker 2: Luke Donovan (University of North Carolina at Charlotte, USA)

Symposium #7: Neuromechanical Strategies

- **Title:** Movement Strategies as a Clinical Key in Chronic Ankle Instability
  Speaker: Ty Hopkins (Brigham Young University, USA)
- **Title:** Biomechanical and Clinical Risk Factors for Recurrent Ankle Sprains in Chronic Ankle Instability: A 2-yearfollow-up
  Speaker: Hyunsoo Kim (West Chester University, USA)
- **Title:** Kinetic Movement Strategies of Recurrent Ankle Sprains in Chronic Ankle Instability: A 2-year Follow-up Study
  Speaker: S. Jun Son (CHA University, South Korea)
- **Title:** Movement Strategies of Recurrent Ankle Sprains in Chronic Ankle Instability: A 2-year follow-up
  Speaker: Seunguk Han (Brigham Young University, USA)

Symposium #8: Psychological and Pain Management Issues

- **Title:** Psychological aspects of the pain experience in lateral ankle sprain populations
  Speaker: Ashley Suttmiller (Atlantic Orthopaedic Specialists, USA)
- **Title:** The consequences of improper pain management after an acute lateral ankle sprain
  Speaker: Kyle Kosik (University of Kentucky, USA)

Symposium #9: New Topics of CAI from Japanese Researchers

- **Title:** Anatomical topics for CAI
  Speaker: Mutsuaki Edama (Niigata University of Health and Welfare, Japan)
- **Title:** Rehabilitative Ultrasound Imaging for CAI
  Speaker: Shintarou Kudo (Morinomiya University of Medical Sciences, Japan)
- **Title:** Biomechanical topics for CAI
  Speaker: Tomoya Takabayashi (Niigata University of Health and Welfare, Japan)

Symposium #10: ATOAC Session

- **Title:** The past, present, and the future for innovative approaches to assess and slow the progression of osteoarthritis after an ankle sprain.
  Speaker 1: Kyle Kosik (University of Kentucky, USA)
  Speaker 2: Kyeongtak Song (University of Kentucky, USA)
  Speaker 3: Danielle Torp (University of Kentucky, USA)

Key Note #1

Up-to-date for chronic ankle instability
Arthroscopic surgery and subsequent accelerated rehabilitation for early return to sports activities

Speaker: Masato Takao
Clinical and Research Institute for Foot and Ankle Surgery, Jujo Hospital, Chiba, Japan

About this lecture

Ankle sprains are the most common injuries among athletes, and lateral ankle sprains account for 90% of all ankle sprains. Most authors have recommended non-surgical treatment for acute rupture of the lateral ligaments of the ankle. However, non-surgical treatment sometimes fails, and symptomatic chronic ankle instability (CLAI) develops in approximately 20% of patients after an inversion sprain of the lateral ankle ligaments. Persistent CLAI may cause osteochondral lesions of the talar dome, and may subsequently result in osteoarthritis of the ankle. Furthermore, CLAI negatively affects not only the plantar flexion of the ankle but also the extensor strength of the hip and knee by affecting sensorimotor control at both spinal and supraspinal levels. As a result, it has been suggested that the performance of athletes is reduced. Therefore, if non-surgical treatment fails and lateral instability of the ankle remains persistent, then surgical repair or reconstruction should be performed in order to maintain the lateral stability of the ankle and in order to prevent subsequent disorders such as osteochondral lesions of the talar dome and osteoarthritis of the ankle.

The choice of surgery for CLAI may involve ligament repair to suture the remaining ligaments or reconstruction using a graft. The choice of a surgical procedure is often based on the quality of the residual ligament. If the quality of the residual ligament is satisfactory a repair technique is chosen where the remnant ligaments are imbricated or reattached to the origin site on fibula. If the quality of the remnant is insufficient, then a reconstruction technique is indicated using graft.

The direct anatomic repair of lateral ligaments of the ankle, originally described by Broström in 1966 is popular and this technique has been used as a gold standard still now. Although patients have tended to report subjective satisfaction with these procedures, there remain several problems including requiring at least a 4cm long incision with significant dissection and soft tissue debridement which sometimes causing superficial nerve disorders. Furthermore, by evolving to a less invasive technique, it is thought that the return to sports activities will be faster. While arthroscopic surgery of other joints evolved quickly after the development of the suture anchors, the procedure for suturing the residual ankle lateral ligament arthroscopically have been developed by top runners in this field.

Regarding the reconstructive surgery for CLAI, various surgical reconstructive techniques have been described. However, some of these procedures are non-anatomical that may lead to restrictions in the range of motion of the ankle, or may result in persistent lateral instability after surgical intervension. Further, these procedures are described using open techniques that are more likely to result in delayed recoveries with wound healing problems and residual scarring. Recently, anatomic reconstruction procedures using arthroscopic and percutaneous minimally invasive technique has been described with the goal of improving clinical outcomes of open non-MIS techniques.

I would like to talk about the history of the arthroscopic lateral ankle ligament repair and reconstruction and show my recommended procedure with subsequent accelerated rehabilitation.

Brief Biography of Speaker

Dr. Takao is an orthopedic surgeon and the president of Clinical and Research Institute for Foot and Ankle Surgery in Jujo Hospital. Dr. Takao is bord member of Japanese Orthopaedic Association (JOS) and The Japanese Society for Surgery of Foot (JSSF). Dr. Takao is also facility member of International Congress on Cartilage Repair of the Ankle and Ankle Instability Group. Dr. Takao has (co-) authored over 140 peer-reviewed English papers and 10 English book chapter. He also had more than 190 Japanese papers and publications.

Key Note #2

Ankle Sprains Are Getting On My Nerves: Treating Instability as a Central Nervous System Disorder

Speaker: Alan Needle

Department of Public Health & Exercise Science and Department of Rehabilitation Science, Appalachian State University

About this lecture

Etiological models behind chronic ankle instability have established a myriad of factors contributing to dysfunction that provide clinicians with potential targets for intervention. While impairment-based rehabilitation has become the standard of care for clinicians treating joint instability, a growing body of evidence suggests that function may be restored through atypical neurological activation. This maladaptive neuroplasticity is often described in terms of changes to motor activation that increases the difficulty of recruiting stabilizing muscles, and increased cortical resources required for motor planning. As such, high rates of reinjury, even in the presence of rehabilitation efforts, may reflect the correction of impairments through activation strategies that are not sustainable in real-world settings where a patient must negotiate distractions and unanticipated events. Therefore, clinicians should consider interventions specifically aimed at restoring typical neural functioning in order to minimize re-injury risk.

Given an improved understanding of the neurological phenomena that occur following an ankle sprain that has emerged over the past decade, clinicians can begin to consider interventions aimed at addressing these neural impairments. Techniques may include appropriate management of the initial ankle sprain, such that inhibitory changes secondary to pain & swelling are minimized. Alternatively, reversing this maladaptive neuroplasticity could also be achieved in patients with instability by using disinhibitory interventions to improve stabilizing muscle activation, and thereby decreasing the reliance on extraneous cortical areas.

At the conclusion of this session, attendees can expect to understand why maladaptive neuroplasticity may be a barrier for treating their patients’ symptoms related to joint instability, and develop intervention strategies that can improve neural functioning and subsequently decrease sensations of instability in patients following ankle injury.

Brief Biography of Speaker

Dr. Needle is a professor in the Department of Public Health & Exercise Science and Department of Rehabilitation Science at Appalachian State University in which he lectures in the Master of Science in Exercise Science and the Master of Science in Athletic Training programs. At Appalachian State, Dr. Needle directs the Injury Laboratory that aims to understand the neuromechanical changes underlying joint injury and develop and assess treatment & screening tools aimed at reducing joint instability and its negative sequelae. His previous work has established theories related to injury-induced maladaptive neuroplasticity that exists in patients with ACL injury & chronic ankle instability, and the clinical implications of these changes. His current work has focused on developing screening tools that allow clinicians to identify these changes in patients with chronic ankle instability, and the development of neuromodulatory interventions to improve function among these patients.

Key Note #3

NEUROMUSCULAR TRAINING.
Can it work? Will it work? Make it work!

Speaker: Evert Verhagen

Department of Public and Occupational Health of the Amsterdam University Medical Center and the Amsterdam Movement Science Research Institute, Amsterdam, Netherlands

About this lecture

Neuromuscular training (NMT) is one of the preventive options we have available against the still very common lateral ankle sprains. Arguably – given the available evidence – it is the most effective preventive option we have available for athletes. The literature reports up to 50% injury rate reductions amongst various programmes across multiple sports. Unfortunately, such impressive research outcomes do not translate easily to sports practice. Hence, the rate of ankle injuries remains high. Efforts have focused on the implementation of research outcomes in athletics contexts. With mixed success. The limitation of implementing research evidence is that the available exercises and programs are built upon efficacious solutions that do not always fit the athletic context. To improve our programs, we must develop preventive solutions for the athletes and their specific context. This demands, however, not only co-creation but we also need understanding of NMT working pathways to be able to adapt programs to the individual and communicate to understand the users' context.

In this lecture I will provide an overview of the effectiveness of NMT in preventing ankle injury, I will describe why we do not achieve the effects as expected from the literature, and I will – from my point of view – come with potential solutions and approaches to improve the effectiveness of NMT against ankle injury.

Brief Biography of Speaker

Professional：Evert Verhagen (1976) is a human movement scientist and epidemiologist. He holds a University Research Chair as a full professor at the Department of Public and Occupational Health of the Amsterdam UMC and the Amsterdam Movement Science Research Institute. He is the Editor in Chief of BMJ Open Sports & Exercise Medicine, the director of the Amsterdam Collaboration on Health and Safety in Sports (one of the 11 IOC research centers), and director of the Amsterdam Institute of Sports Sciences (AISS). His research revolves around the prevention of sports and physical activity related injuries; including monitoring, cost-effectiveness and implementation issues. He supervises several (inter-)national PhDs and post-docs and has (co-) authored over 310 peer-reviewed publications around these topics.

Personal：My dad took me to local running events when I was little and ever since I have been an avid runner. I competed at a national level when I was a junior, finishing top 5 in cross country and top 10 in middle distance events. An injury prevented me from continuing at that level and made me decide to study Sports Science to understand better what happened to me. Now, many years later I still run, but I moved my interest to ultra-distance events; preferably multi-day trail runs.

アナトミー・トレイン
──徒手運動療法のための筋膜経線

第4版 Web動画付

原著 Thomas W. Myers

訳 板場英行
のぞみ整形外科クリニック西条セラピスト部・学術顧問

石井慎一郎
国際医療福祉大学大学院
保健医療学専攻福祉支援工学分野・教授

人体を走る筋膜経線によって、姿勢制御や運動連鎖のしくみを、列車の路線(lines)や駅(stations)にたとえて解説したテキストの改訂第4版。筋膜のつながりとその驚くべき機能が明らかになる。2019年より、アナトミートレイン・ストラクチュラルインテグレーション（ATSI）認定プログラムが日本でも開始され、国内での資格取得が可能となった。リハビリテーションやボディワークに携わるすべての人々へ。

● A4 頁404 2022年
定価：7,480円（本体6,800円＋税10%）
[ISBN978-4-260-04924-5]

身体の筋膜経線をたどる旅へ、解剖列車(アナトミー・トレイン)に乗って出発進行！

Contents

医学書院
〒113-8719 東京都文京区本郷1-28-23 [WEBサイト]https://www.igaku-shoin.co.jp
[販売・PR部]TEL:03-3817-5650 FAX:03-3815-7804 E-mail:sd@igaku-shoin.co.jp

Symposium #1

Foot Core System/Subtalar

Speaker 1: François Fourchet Responsable

Département Physiothérapie & Ergothérapie, Hôpital de La Tour

Presentation title: Foot Core strengthening strategies 1.0 and 2.0

Foot core strengthening is a topic that have become increasingly present in the scientific literature and in clinical concerns in recent years.

The work of the last 15 years has focused on individualized recruitment of the intrinsic foot muscles. This can be achieved with some success as mentioned in many studies reporting, after intervention, increase in force production and cross sectional area of the intrinsic foot muscles or decrease in midfoot deformity in weight bearing situations. Exercises such as Short Foot Exercise or Doming are the most frequently used in this regard. This may be named the Foot Core Strengthening 1.0.

With this experience, we believe that it is now necessary to consolidate the Foot Core Strengthening 1.0 by the Foot Core Strengthening 2.0 to go further. If it seems important to keep the above mentioned exercises, especially at the beginning of rehabilitation, other parameters now seem morev than mandatory such as:

- The use of surimposed electrostimulation at the level of the abductor hallucis and flexor halluces brevis muscles
- Integration of heavy load exercises involving both the intrinsic muscles and the extrinsic foot muscles
- Toes positioning in dorsal flexion
- Individualized load progression in accordance with muscular physiology and strength and conditioning principles

We hardly think that modern rehabilitation programs must include as well this "high-load" stimulation of the foot. This is what the Foot Core Strengthening 2.0 approach aims at promoting.

Speaker 2: Yuki Kusagawa

Graduate School of Sport and Health Science, Ristumeikan University, Shiga, Japan

Presentation title: The Relationship between Strength and Volume of Toe Flexor Muscles: its Potential Applications to Evaluation and Improvement in the Plantar Intrinsic Foot Muscle Function

The active subsystem of the foot core system, which consists of intrinsic and extrinsic foot muscles, provides functional stability and flexibility to the ankle and foot by contributing to sensorimotor control. The clinical assessment of toe flexor strength (TFS) and structural assessment of the plantar intrinsic muscles are important for determining impairments assocatied a musculoskeletal iniury and detecting improvements in funcational captivity of the active subsystem following rehabilitation in pathological populations. Recently, deficits in TFS and atrophy of several plantar intrinsic foot muscles have been reported as one of the physical profiles following lower extremity joint injuries. Thus, developing an understanding of function of toe flexor muscles, in particular, plantar intrinsic foot muscles may be beneficial to determine the consequence of developing chronic issues following a lower extremity joint injury and design effective rehabilitation strategies for this condition. However, the anatomical complexity of the plantar intrinsic foot muscles restricts our knowledge of impact of lower extremity injury on foot core function. The focus of this presentation will be to discuss the relationship between the strength and volume of intrinsic toe flexor muscles as a perspective in understanding of plantar intrinsic foot muscle function. Specifically, morphological characteristics of individual plantar intrinsic foot muscles obtained from MRI will be presented. The presentor will present how toe flexor muscles contribute to producing the TFS from the viewpoint of the muscle volume. Based on the relationship between TFS and the volume of toe flexor muscles, potential applications for evaluation of and improvement in plantar intrinsic foot muscle functions will be discussed.

Symposium #2

Injury Prevention (primary & secondary)

"Prevention of Ankle Sprain Injuries: An Essential Update and Guide For Clinicians"

Background & Relevance

Ankle sprains are the most commonly incurred lower limb musculoskeletal injury by athletes across all levels of competition. The prevalence of ankle sprains amongst the general population is also substantial – up to 70% of the general population report having incurred an ankle injury during their lifetime.

Colloquial terms such as a "rolled" or "twisted" ankle are often used to describe an acute ankle sprain injury. In reality, acute ankle sprains are rarely ever a "simple" injury. Ankle sprains have the highest reinjury/recurrence rate of all lower limb musculoskeletal injuries. This is compounded by the high propensity for the development of long-term injury-associated impairments. People who have incurred an ankle sprain often experience ankle joint instability, regular occurrences of "giving way" of their ankle joint, as well as recurrent sprains during the months and years after their initial injury; these constitute the characteristic features of chronic ankle instability.

Ankle sprains and chronic ankle instability can negatively affect a person's ability to participate in physical activity at their desired level and can initiate the development of long-term sequelae such as early onset post-traumatic osteoarthritis. This is particularly concerning as ankle sprains are especially prevalent in adolescent and young adult populations.

Considering the high prevalence, injury incidence rates and associated economic costs of ankle sprains, efforts to prevent this common injury should be a priority.

This symposium will provide a comprehensive evidence-informed overview of prevention strategies for ankle sprains. Three internationally recognized researchers with significant expertise on ankle sprains and chronic ankle instability will share their research and clinical perspectives on the prevention of this common injury.

Speaker 1: Eamonn Delahunt

School of Public Health, Physiotherapy and Sports Science, University College Dublin, Ireland

Presentation title: Understanding the Results of Epidemiological Research is Integral to the Planning of Effective Ankle Sprain Prevention Strategies

Speaker 2: Claire Hiller

Faculty of Medicine and Health, University of Sydney, NSW, Australia

Presentation title: Braces and Tape: Integrating Clinical Expertise and Best Evidence to Make Informed Decisions for the Prevention of Ankle Sprains

Speaker 3: Phillip Gribble

Department of Athletic Training and Clinical Nutrition, University of Kentucky, KY, USA

Presentation title: A guide to Implementing Effective Therapeutic Interventions to Prevent First-Time Ankle Sprains and Chronic Ankle Instability

Symposium #3

Return to Play

Speaker 1: Ryan McCann

School of Rehabilitation Sciences, Old Dominion University

Presentation title: Athletic Trainers' Methods for Deciding Return-to-activity Readiness in Ankle Sprain Patients

Abstract: Athletic trainers (ATs) commonly care for ankle sprain patients, but often provide return-to-activity clearance before all injury-associated impairments have resolved. The persistence of injury-associated impairments have previously been connected to recurrent ankle sprains and development of chronic ankle instability. Thus, ATs must conduct comprehensive clinical assessments to ensure the resolution of injury-associated impairments before providing return-to-activity clearance. The 2019 International Ankle Consortium consensus statement on Rehabilitation-Oriented ASsessmenTs (ROASTs) provides clinicians with guidance on how to use an impairment-based clinical assessment for planning and progressing therapeutic interventions for patients with an acute lateral ankle sprain. However, recent data indicate the recommendations within this consensus statement are not consistently used by ATs to make return-to-activity decisions. Of note, arthrokinematics (29.0%), physical activity level (35.1%), and patient reported outcomes (25.3%) are the outcome domains least frequently assessed by ATs. Additionally, specific assessments within the ROAST guidelines are often excluded in favor of alternative assessment methods. Evidence indicates that numerous personal and environmental factors facilitate ATs' use of ROASTs, including higher level of education, employment in non-traditional settings, and familiarity with the ROAST guildelines. Various barriers, including a lack of previous education, lack of availability of certain ROASTs, and low personal comfort often prevent ATs from incorporating ROASTs in clinical practice. Examining ATs' current practice habits and related influences will help to identify potential strategies for optimizing assessment and return-to-activity decisions for ankle sprain patients.

Speaker 2: Bruno Tassignon

Human Physiology & Sports Physiotherapy Research Group, Vrije Universiteit Brussel, Belgium

Presentation title: Return to Sport Decision-making following Lateral Ankle Sprain: Where Are We Now? What Can We Do?

Abstract: Lateral ankle sprain (LAS) is one of the most frequently incurred musculoskeletal injuries and shows high recurrence rates in individuals participating in sports. Up to 40% of individuals who sustain a first lateral ankle sprain develop chronic ankle instability. This high recurrence rate and high prevalence of chronic ankle instability are hypothesised to be mainly caused by an increased re-injury risk due to previous LAS, the persistence of sensorimotor impairments and a premature return to sport (RTS) clearance.

Over the last couple of years, the scientific community undertook several initiatives and published numerous papers to improve the quality of RTS decision-making following LAS. During this talk, we will discuss the current scientific state-of-the-art and practical guidelines in RTS decision-making following LAS. We will also shed light on current clinical practice and how we can keep making progress to guide athletes to a safer and more successful RTS. Together, we will subsequently explore some fundamental and practical considerations to keep in mind when being involved in the shared RTS decision-making process, such as but not limited to local tissue healing timelines, the potential role of the brain and neurocognition, fatigue, the athlete-centred-approach, and

rehabilitation progress monitoring. Future directions for research and clinical practice will be addressed as well.

Speaker 3: Brice Picot

Scientific Comitee Of French Society Of Physical Therapist, France

Presentation title: The Ankle-GO, a new score to assess return to sport after lateral ankle sprain and chronic ankle instability

Abstract: Lateral ankle sprain is the most common injury in sport and up to 40% of patients will develop chronic ankle instability (CAI). One possible cause of this high recurrence rate is a premature return to sport (RTS). There are currently no specific criteria for RTS in patients with CAI, so decisions are primarily time-based. A recent international consensus has emphasized the relevance and importance of including patient-reported ankle function questionnaires combined with functional testing targeting ankle impairments. In this topic, we will present a new score designed to help clinicians decide on return to sport in athletes with a lateral ankle sprain or chronic instability. This score is a combination of 4 functional tests and 2 self-reported questionnaires designed to assess patient impairments following LAS. The proposed composite score, the Ankle-GO, could help identify athletes who will successfully return to the same preinjury level of sport.

Symposium #4

Visuomotor and Neurocognitive Assessment and Rehabilitation

Speaker 1: Matthew Hoch

Department of Athletic Training and Clinical Nutrition, University of Kentucky, KY, USA

Presentation title: Theoretical Framework for Examining Perceptual-Cognitive Control Following Lateral Ankle Sprain

Abstract: The purpose of this session is to introduce theoretical frameworks and concepts to integrate perceptual-cognitive control into the assessment and rehabilitation of individuals with a history of lateral ankle sprain. The focus of this presentation will be on the ability to plan, select, and execute an action based on the perception of a situation which is otherwise known as perceptual-cognitive control. Challenging perceptual-cognitive control may expose residual impairments following ankle sprain, gaps in current strategies for rehabilitation, and a new approach for evaluating return to participation readiness. Additional theoretical frameworks including the information processing model, sensory re-weighting, situational awareness theory, and the functional task environment will be included to provide context into the application of perceptual-cognitive control following lateral ankle sprain. Additionally, this presentation will distinguish the differences between strategic, tactical, and reactive task execution as a paradigm for challenging perceptual-cognitive control during assessment and rehabilitation. Following this presentation, attendees will understand perceptual-cognitive control and the supporting theoretical frameworks and concepts for application to contemporary assessment and rehabilitation strategies for patients with a history of lateral ankle sprain.

Speaker 2: Kyeongtak Song

Sports Medicine Research Institute, Department of Athletic Training & Clinical Nutrition, University of Kentucky, KY, USA

Presentation title: Central Neural Sensorimotor Integration Assessments in Individuals with Chronic Ankle Instability

Abstract: Lateral ankle sprains are highly prevalent and costly musculoskeletal injuries that often result in chronic ankle instability (CAI). Individuals with CAI have known sensorimotor deficits, especially postural control impairments. The underlying mechanism of those postural control impairments remains unclear but current emerging theory suggests that altered central sensorimotor control after ankle sprains contributes to CAI-associated impairments. For example, those with CAI have a reduced ability to appropriately reweigh sensory and/or somatosensory information during static and dynamic postural control. Specifically, those with CAI rely more on visual information to maintain both static and dynamic postural control compared to those without CAI. Also, recent evidence suggests that altered neurocognitive processing may be related to decreased postural control in those with CAI. For instance, individuals with a history of ankle sprain showed slower visuomotor reaction time compared to those with no previous ankle sprains. These studies may indicate alterations in the central processing of information in individuals with ankle sprains. Identifying the underlying mechanisms that contribute to postural control deficits is critical to developing more effective prevention and treatment strategies that can reduce recurrent ankle sprains. Therefore, my presentation at this symposium session will include 1) current studies on sensory/somatosensory reweighting assessments during static and dynamic postural control and 2) introduce novel neurocognitive assessments including visuomotor reaction

time tests during static and dynamic postural control in those with CAI.

Speaker 3: Christopher J. Burcal

School of Health and Kinesiology, University of Nebraska at Omaha, NE, USA

Presentation title: Interventions to Address Perceptual and Neurocognitive Impairments in Chronic Ankle Instability

Abstract: Chronic ankle instability (CAI) is a musculoskeletal condition linked to many clinically measurable deficits such as decreased range of motion, strength, and worsened balance. Patients with CAI suffer from repetitive injuries which may disrupt their ability to remain physically active. Due to the recurrent nature of ankle sprains and episodes of the ankle giving way, repeated microtrauma damages musculoskeletal soft tissue which may lead to changes in the peripheral nervous system. Damage to afferent proprioceptors leads to altered or flawed sensory inputs being used by the central nervous system (i.e. cerebral cortex, cerebellum) to plan for and execute movements. This theory is supported by consistent findings of altered biomechanics which may further contribute to future injury risk, thus perpetuating the cycle of reinjury and neuroplastic changes in patients with CAI. The past few years have seen efforts to improve our ability to both understand and measure these neuroplastic changes, however they remain difficult to measure. Given these difficult-to-measure impairments in CAI patients, it is easy to understand why common treatment approaches may not directly address these underlying factors which may contribute to continued reinjury. To date there have been several investigations that have focused on understanding how rehabilitation impacts this central nervous system dysfunction. There have also been new interventions developed specifically to target central nervous system alterations. These interventions include incorporating cognitive loading/increasing neurocognitive demand, challenging the sensory system to adapt to changing conditions, and directly targeting the cerebral cortex through stimulation. In this session we will cover what is known about, as well as the future directions for, treating neuroplastic changes in patients with CAI.

Symposium #5

Innovative Ideas for Ankle Injury Prevention

Speaker 1: Daniel Fong

School of Sport, Exercise and Health Sciences, Loughborough University, Loughborough,UK

Presentation title: Mechanism and Prevention of Ankle Sprain: An Overview

Abstract: Ankle sprain is very common in sports. Repeated sprains may lead to long term instability. Therefore, it is important to research in its prevention as well as rehabilitation, and the research in this area has been called 'prehabilitation'. In order to be successful in injury prevention, we first need to understand the risk factors, the aetiology, and most importantly, the mechanism, so we can design interventions to modify these risk factors, to avoid the aetiology, or to stop the injury mechanism once it has been happening. In this sessions, together with the other two presenters, we will first talk about the current knowledge we obtained from the case reports in the literature. This will help us understand the mechanism of lateral ankle sprain injury. We will also discuss on a few further computational studies to understand the joint torque and ligament strains during these injuries.

Then, we will presented two prophylactic devices for the purpose, including a wearable device that stimulates the peroneal muscle to initiate quick contraction to stop an inversion spraining motion when it started to happen. We will elaborate its development from the understanding of the problem, to the engineering consideration in fabrication. We will also present Spraino, a tripo-tape applied to the outside of the shoe to reduce friction, and its effect in reducing ankle sprain incidence in a clinical trial. Finally, we will add a few examples on the use of virtual reality in rehabilitation of ankle sprain injury.

Speaker 2: Filip Gertz Lysdal

St Mary's University, London, UK

Presentation title: Spraino: A New Strategy for Lateral Ankle Sprain Injury Prevention

Abstract: The lateral ankle sprain is among the most common musculoskeltal injuries and prevention is pertinent. Until recently, effective strategies have mainly sought to prevent injury through functional joint support (i.e., brace or tape) and exercise therapy (i.e., coordination, strength, and balance training). The lateral ankle sprain is the typical result following an excessive inversion moment, which is directly affected by the position, magnitude and orientation of the ground reaction force vector – in relation to the ankle joint center. A viable strategy would therefore be to simply reduce this moment of force. 'Spraino' ("no" + "sprain") is the new preventive strategy designed with this specific purpose. Spraino works by minimizing friction between the surface and the lateral shoe outsole, effectively changing the orientation of the ground reaction force, and thereby the external joint moment, when facing a potential injury situation. In a recent 510-athlete randomized controlled trial, allocation to Spraino resulted in a 53% reduction of severe ankle sprain injuries. This talk will seek to establish a link between excessive shoe-surface friction and the mechanism with which lateral ankle sprain injuries occur, and ultimately present how minimizing lateral edge shoe-surface friction can be a viable and effective injury preventive strategy with potential future implications.

Speaker 3: Aliaa Rehan Youssef

Cairo University, Egypt

Presentation title: Innovative Technology in Ankle Injury Prevention: "Smart Technologies for Ankle Sprain Prevention, Assessment and Rehabilitation"

Abstract: Ankle sprain is a common injury that may persist causing chronic ankle instability. Different methods were proposed to prevent and treat such injury. In this presentation, the role of technology in the assessment, prevention, and rehabilitation of ankle sprain will be discussed; considering injury mechanisms and other preventive methods proposed by the other two speakers. Specifically, two technologies will be addressed: Inertial motion sensors (IMUs) and virtual reality (VR)

One of the most accepted etiologies of ankle sprain is deficient neuromuscular control, particularly delayed peroneal muscles response. We are going to describe a smart wearable device that can predict and prevent the occurrence of ankle sprain. Prediction of potentially harmful motion is based on measuring ankle kinematics using IMUs. Once the hazardous movement is detected, the peroneal muscles are stimulated electrically to correct foot position, and hence prevent the potential injury.

On the other hand, as balance reflects adequate neuromuscular control, we are also going to describe the validity and reliability of assessing balance using IMUs embedded in smartphone. Further, we will discuss evidence regarding the use of VR in assessing and improving balance. Using VR has the advantage of including other cognitive, visual, and auditory dimensions in assessing and addressing ankle sprain injury. Although most of scientific evidence arouse mainly from clinical efficacy studies conducted on participants with actual ankle sprain, it could be transferred to prevention of such injury in at-risk population.

Symposium #6

Gait-Training Interventions

"Delivery, Dosage, and Desires: Considerations for Maximizing Gait-training Benefits for Foot and Ankle Injury Patients"

Background & Relevance:

Walking and running gait evaluations are frequently incorporated into foot and ankle injury patient assessments to elucidate contributing biomechanical factors to injury development and persistent dysfunction. Such evaluations often lead to interventions with the goal of favorably adjusting movement patterns to avoid future injury and return to regular physical activity and sport. Researchers have begun to leverage clinic-friendly equipment to prescribe injury-specific gait-training, such as using a laser level to reduce ankle inversion and initial contact for chronic ankle instability patients. While these advancements are promising, clinical varriers to implementation include but are not limited to: a) delivery of the intervention, including indetifying which patients would be most likely to benefit from such efforts; b) dosage and frequency of gait-training programs to most successfully elicit change; c) desires of the clinicians and the patients to maximize benefit and guide gait-training strategies. Furthermore, with advancements in wearable technology, there is the potential to administer gait-training interventions in natural training environments for athletes. It is important to consider there factors to advance gait-training research and clinical approaches to improve long-term outcomes for patients with foot and ankle injuries. During this symposium, we aim to present up-to-date evidence on gait-training interventions for patients with foot and ankle pathologies, and apply frameworks from gait-training programs among patients with other lower extremity injuries, with a specific emphasis on gait-training delivery, dosage, and patient and clinician desires. Through this approach, we hope to provide recommendations and frameworks for future interventions.

Speaker 1: Luke Donovan

University of North Carolina at Charlotte, NC, USA

Speaker 2: Alexandra DeJong Lempke

University of Michigan, MI, USA

Symposium #7

Neuromechanical Strategies

Speaker 1: Ty Hopkins

Department of Exercise Sciences, Brigham Young University, UT, USA

Presentation title: Movement Strategies as a Clinical Key in Chronic Ankle Instability

Abstract: Complex movement requires successful integration of multiple sensory inputs, motor programs, and appropriate internal moments that match the demands of the task. When any of these factors are deficient, huge demands are placed on the systems to compensate for the deficiency. The result is likely acute and/or chronic failure of tissues, which then negatively affects the integration balance. The movement strategies used by CAI patients tell a story that can help guide clinical intervention. Identifying the problematic movements and positions during movement in CAI patients may provide a specific target for clinicians. The big question now is how to identify problematic movements. We will present data on ideas to identify various movements strategies in CAI patients, what keys we find from CAI patients who reinjure within a 2-year window, and future directions of movement strategy work with CAI patients.

Speaker 2: Hyunsoo Kim

Department of Kinesiology, West Chester University, PA, USA

Presentation title: Biomechanical and Clinical Risk Factors for Recurrent Ankle Sprains in Chronic Ankle Instability: A 2-year follow-up

Abstract: Purpose: To identify biomechanical and clinical risk factors for recurrent lateral ankle sprain (LAS) in patients with CAI at a 2-year follow-up.

Design: A prospective study.

Setting: Laboratory setting. Methods: 96 of 100 CAI patients completed a 2-year follow-up survey after initial data collection. Forty-one CAI patients (43%) reported recurrent LASs within 2 years while 55 CAI patients (57%) did not have recurrent LASs. Biomechanical variables were collected during the stance phase of a maximal forward jump-landing/cutting maneuver with the involved leg. Odds ratios (OR) were calculated to identify risk factors for the recurrence of LASs.

Results: For clinical risk factors, (i) higher arch height index (OR=25.13, p=.04), (ii) reduced dorsiflexion (OR=.85, p=.003), (iii) poor Biodex balance index (OR=1.42, p=.03) (iv) faster figure-8 drill speed (OR=.63, p=.006), and (v) previous LASs (OR=1.34, p=.01) were significant predictors for recurrent LASs in CAI patients. For biomechanical risk factors, (i) less plantarflexion angle at initial contact (OR=1.56, p=.03) and (ii) less hip abduction angle at initial contract (OR=8.0, p=.02), (iii) greater peak knee extension angle (OR=8.45, p=.008), (iv) less peak knee flexion angle (OR=1.12, p=.03), (v) less peak hip adduction angle (OR=1.16, p=.04), and (vi) less knee joint power at initial contact (OR=5.23, p=.02) are significant predictors for recurrent LASs in CAI patients.

Conclusions: Measurable and modifiable clinical and biomechanical risk factors predicted recurrent LASs in CAI patients. These predictors of recurrent LASs may enable clinicians to develop prevention and rehabilitation programs for CAI patients.

Speaker 3: Jun Son

CHA University, Seongnam, South Korea

Presentation title: Kinetic Movement Strategies of Recurrent Ankle Sprains in Chronic Ankle Instability: A 2-year Follow-up Study

Abstract: Recurrent ankle sprains frequently occur in chronic ankle instability (CAI) patients. However, it remains unknown what biomechanical characteristics are

associated with recurrent sprains in CAI patients.

Objective: To examine kinetic movement strategies during landing/cutting in CAI patients with and without recurrent sprains during a 2-year follow-up.

Design: A 2-year follow-up study.

Setting: Laboratory controlled trial. Patients: 96 of 100 CAI patients completed a 2-year follow-up survey after initial biomechanical data collection. To reduce a drop-out rate during the 2-year follow-up period, the survey was completed at 6-months, 1-year, and 2-years. Forty-one CAI patients (43%) had recurrent sprains while 55 CAI patients (57%) experienced no recurrent sprain. Interventions: Participants performed 10 trials of maximal vertical, forward jump-landing/cutting with the involved leg.

Main Outcome Measures: 3D biomechanical (kinetic and kinematic) data were collected. Functional linear models were used to detect between-group differences in 3D ground reaction force (GRF) and ankle, knee and joint powers ($p<0.05$).

Results: CAI patients with recurrent sprains show 5-10% higher vertical, posterior, and medial GRF including (i) 0.35 body weight (BW) more vertical GRF during initial landing (ii) 0.2 BW more medial GRF during initial landing, and (iii) 0.03 BW more posterior GRF during cutting. CAI patients with recurrent sprains also show 10-25% increased ankle, knee, and hip eccentric and/or concentric joint power including (i) 0.8-1.5 W/kg more concentric and eccentric ankle joint power during landing/cutting, (ii) 1.6 W/kg more eccentric knee joint power during landing, and (iii) 2.8 W/kg more eccentric and concentric hip joint power during landing/cutting.

Conclusions: CAI patients with recurrent sprains show increased kinetic movement strategies during landing/cutting. They control landing with more kinetic impact loading. Risk of recurrent sprains may increase when CAI patients don't properly absorb and dissipate high impact loading during functional movement.

Speaker 4: Seunguk Han

Brigham Young University, UT, USA

Presentation title: Movement Strategies of Recurrent Ankle Sprains in Chronic Ankle Instability: A 2-year Follow-up

Abstract: To identify neuromechanics during landing/cutting between chronic ankle instability (CAI) patients with and without lateral ankle sprain (LAS) recurrence at a 2-year follow-up.

Design: A prospective study.

Setting: A laboratory setting Methods: 96 of 100 CAI patients completed a 2-year follow-up survey after initial data collection. Forty-one CAI individuals (43%) reported recurrent LASs within 2 years while 55 CAI individuals (57%) did not have recurrent LASs. Participants performed a maximal forward jump-landing/cutting maneuver with the involved leg. Lower-extremity joint angles, moments, and EMG activation were collected during the stance phase of the task.

Results: CAI patients with recurrent LASs displayed deleterious neuromechanical alterations including (i) increased inversion angle and (ii) plantar flexion moments during early landing phase (0%-20% of stance) compared with CAI patients with no recurrent LASs. However, they showed protective neuromechanical strategies including (i) increased eversion moment, (ii) increased peroneal activation, (iii) increased knee flexion, and decreased knee valgus angles, (iv) increased knee and hip extension moments, and (v) increased gluteal activation after the early landing phase.

Conclusions: CAI patients with recurrent LASs displayed movement strategies in the ankle joint consistent with more vulnerable positions and movements during early landing, followed by more "protective" movement strategies in the remaining portions of stance. Altered neuromechanical strategies in early landing may be associated with recurrent LASs. Protective movement strategies in the later stance phase may be too late to protect against subsequent LASs.

Symposium #8

Psychological and Pain Management Issues

Speaker 1: Kyle Kosik

Department of Athletic Training and Clinical Nutrition,

University of Kentucky, Lexington, KY, USA

Presentation title: The Consequences of Improper Pain Management After an Acute Lateral Ankle Sprain.

Ankle sprain causes immediate swelling, elevated levels of acute musculoskeletal pain, and loss of ankle function. Yet, the majority of individuals who sustain an ankle sprain never seek medical care. Unfortuatnely, a small faction of those who do seek medical treatement receive appropriate care as 1 in 4 are prescribed opioids and only 15% are referred to physical rehabilitation. Deviating from the standard of care for an ankle sprain can have detrimental physical and psychological effects.For example, ankle sprain patients discharged from the ED with an opioid prescription are 6x more likely to fill another prescription within 30 days. Without physical therapy, ankle sprain patients can develop chronic pain, be less physically active, report having worse physical, mental and social health-related quality of life, suffer a recurrent injury and show early symptoms of post-traumatic osteoarthritis. Therefore, it's important to understand the current pain management strategies currently utilized for patients with ankle sprain and recognizing common barriers that need to be addressed through future research. This presentation will aim to provide an overview of the current pain management strategies for an acute ankle sprain, how deviating from the standard of care can increase the risk for future injury recurrent or chronic pain, and identify possible alternatives to increase timely access to specialized cared.

Speaker 2: Ashley Suttmiller

Atlantic Orthopaedic Specialists, Virginia Beach, VA, USA

Presentation title: Psychological Aspects of The Pain Experience in Lateral Ankle Sprain Populations

Pain is a typical consequence after ankle sprain injury, and managing pain is often the focus of early intervention strategies. Unfortunately, not all individuals seek care after an ankle sprain and some that do, still report pain and other deficits upon returning to activity. Early return to activity may be contributing to residual issues associated with chronic ankle instability, including the persistence of pain which is estimated to affect up to 60% of those with CAI. This supports the need for better pain management strategies at both the acute phases of ankle injury, but also in those who present with CAI. Advances in pain research identify the pain experience to be multi-dimensional and inherently linked to psychological factors which makes managing pain, specifically persisting pain, more complex. Therefore, an understanding of the pain experience and associated psychological factors is necessary to begin to determine the best strategies for clinicians to address these issues in ankle sprain populations.

This presentation will aim to provide an overview of the multi-dimensional experiences of pain with a focus on how persisting pain can affect the pain experience, as well as the relationship pain has with psychological factors. This will be explored through theoretical frameworks including the neuromatrix theory of pain and the fear-avoidance model, and then applied to ankle sprain populations using evidence from the literature. We will also discuss the potential role that psychologically-informed practice could play in reducing the burden of pain and psychological distress associated with ankle sprain injuries

Symposium #9

New Topics of Chronic Ankle Instability from Japanese Researcher

Speaker 1: Mutsuaki Edama

Institute for Human Movement and Medical Sciences, Niigata University of Health and Welfare, Niigata, Japan

Presentation title: Anatomical Topics for CAI

Abstract: This presentation provides anatomical knowledge for CAI that our laboratory has been investigating. The aim was to clarify the relationships between differences in the number of fiber bundles of the ATFL and differences in the angle of the CFL with respect to the long axis of the fibula and their effects on ankle braking function. The study sample included 110 Japanese cadavers. ATFLs were categorized as: Type I with one fiber bundle; Type II with two fiber bundles with incomplete separation and complete separation; and Type III with three fiber bundles. The CFLs were categorized according to the angles of the CFLs with respect to the long axis of the fibula and the number of fiber bundles. Six categories were established: CFL10° (angle of the CFL with respect to the long axis of the fibula from 10° to 19°); CFL20° (range 20–29°); CFL30° (range 30–39°); CFL40° (range 40–49°); CFL50° (range 50–59°); and CFL2 (CFLs with two crossing fiber bundles). ATFL was Type I in 31%, Type II in 60%, and Type III in 9%. Five CFL categories were identified: CFL10° in 3.7%; CFL20° in 20.9%; CFL30° in 30.9%; CFL40° in 30%; CFL50° in 13.6%; and CFL2 in 0.9%. Type III contained mainly CFL40° and CFL50° (7 of 10 feet). And in simulation study, the ATFL and CFL appeared to cooperate in ankle joint braking function. It is suggested that the damage of ATFL and CFL coordination may be involved in the mechanism of CAI.

Speaker 2: Shintaro Kudo

Inclusive medical sciences institute, Morinomiya University of Medical Sciences, Osaka, Japan

Presentation title: Rehabilitative Ultrasound Imaging for CAI

Abstract: The chronic ankle instability (CAI) involves mechanical and functional instability of the ankle consisted of both talocrural and subtalar joint. Therefore, ultrasound imaging for the CAI need to assess stability of both joint. The ultrasound imaging of the anterior talofibular ligaments is widely spread, however, the subtalar joint instability reminds unclear. We develop the assessment of the subtalar joint instability using ultrasound imaging. Moreover, physical therapy for CAI needs to improve the proprioception of the foot and ankle. The short foot exercise (SFE) is one of the frequently exercises performed in physical therapy for the CAI, however, shorten the foot length with the intrinsic foot muscles is hard to acquire without any feedback. The biofeedback using ultrasound imaging has strong evidence for both abdominal wall muscles and pelvic floor muscles which are the deeper muscles of the trunk. The intrinsic foot muscles are consisted of lots of small muscles with four layers. Therefore, we hypothesized that SFE with ultrasound biofeedback which focused on the alignment of the talonavicular joint had a possibility to aquire in short time. In our study, SFE using ultrasound biofeedback can be increased the navicular height after 2 minutes, although the SFE with only verbal feedback cannot be increased it even after 5minutes. In conclusion, the rehabilitative ultrasound imaging for CAI is effective to assess the joint instability, and to help to learn the movement pattern such as SFE.

Speaker 3: Tomoya Takabayashi

Institute for Human Movement and Medical Sciences, Niigata University of Health and Welfare, Niigata, Japan

Presentation title: Biomechanical Topics for CAI

Abstract: Lateral ankle sprain (LAS) is an ankle injury that occurs in both athletes and non-athletes, with very high incidence and recurrence rates. LAS is an injury that is often neglected because it is mostly mild, but many of the injured are prone to developing chronic ankle instability (CAI). However, not all patients develop CAI; some may transition to coper without developing CAI. Coper is defined as someone who has not sprained the ankle again for more than 12 months after the first sprain and does not feel unstable in the ankle joint. After the first sprain, the injured person should aim to return to coper instead of CAI. However, the underlying mechanism by which LAS patients transition to CAI or coper remains unclear. It is necessary to clarify the kinematic characteristics of coper to provide rehabilitation that transitions to coper for the injured after the first sprain. Many previous studies have compared the lower extremity biomechanics of coper and CAI groups to clarify the characteristics of transition to coper after the first sprain. In our laboratory, we have evaluated difference in movements of the trunk, lower extremities and foot between the CAI and coper groups. This presentation provides biomechanical knowledge of the CAI and coper groups that we have been investigating. Finally, what kind of movement strategy the coper group adopts to prevent re-spraining will introduce.

Symposium #10

Athletic Trainers' Osteoarthritis Consortium Session

"The Past, Present, and the Future for Innovative Approaches to Assess and Slow the Progression of Osteoarthritis After an Ankle Sprain"

Background & Relevance

Contemporary models suggest the leading modifiable factor responsible for accelerating the transition from ankle instability to osteoarthritis is abnormal joint loading caused by aberrant movement patterns. Identifying the underlying mechanisms that contribute to this transition is critical to developing innovative therapies that can improve patient outcomes and slowing the early development of joint degeneration. Emerging data from members of our research team and others have started to implement novel cartilage assessment techniques to evaluate the compositional structure of the talar cartilage and how it responds to mechanical load early in this transition phase. These round breaking data has allowed our research team to develop innovative gait re-training methods that can be easily implemented into clinical practice for targeting the aberrant movement patterns and abnormal joint loading associated with ankle instability.

Therefore, this symposium will 1) contextualize the transition from ankle instability to post-traumatic osteoarthritis using currently published evidence and preliminary data assessing talar cartilage health; 2) present emerging data on the effects of rehabilitation to intervene within this transition; 3) discuss areas for future research to advance the understanding of cartilage health after an ankle joint injury and appropriate interventions that target joint structure and patient outcomes.

Speaker 1: Kyle Kosik

Department of Athletic Training and Clinical Nutrition, University of Kentucky, KY, USA

Speaker 2: Kyeongtak Song

Department of Athletic Training and Clinical Nutrition, University of Kentucky, KY, USA

Speaker 3: Danielle Torp

Department of Athletic Training and Clinical Nutrition, University of Kentucky, KY, USA

This proposal will align with the ATOAC mission that aims to advance the best practices in primary osteoarthritis prevention through understanding and evaluating the latest assessment and intervention strategies for joint health after lateral ankle sprain

Free Communication Content

Category #1: Treatment, Intervention, and Prevention

Category #2: Screening, Diagnosing, and Testing

Category #3: Imaging and Mechanism

Category #4: Sensory-Perceptual and Motor-Behavioral (impairments)

Category #5: Return-to-Play Decision Making

Category #6: Epidemiology, Health Economics, and Socioeconomics

Free Communication Abstracts

Category #1: Treatment, Intervention, and Prevention

#03_Implications of biofeedback sensor location during gait retraining in CAI: Evidence for a forefoot sensor location

Presenting Author: Kimmery Migel

Authors & Affiliations: Kimmery Migel[1,2], Erik Wikstrom[3,2]

(1) University of North Carolina at Chapel Hill, Human Movement Science Curriculum, NC, USA

(2) University of North Carolina at Chapel Hill, Motion Science Institute, NC, USA.

(3)University of North Carolina at Chapel Hill, Department of Exercise and Sport Science, NC, USA

Background: Sensory biofeedback with pressure sensors under the 5th metatarsal head (5MH) and heel change the medial-lateral center of pressure (COP) location during walking in various populations. The impact of sensor location on anterior-posterior (AP) COP has not been established. An anterior COP is thought to lead to non-traumatic acquired foot and ankle pathologies.

Objective(s): Determine AP COP changes at initial contact during vibration biofeedback gait retraining with different sensor locations in people with CAI. We hypothesized a heel sensor would produce an anterior COP shift.

Design: Crossover study

Setting: Research Laboratory

Patients (or Participants): Ten CAI volunteers (Age: 22.9 ±4.25yrs, Height: 170.65 ±13.02cm, Mass: 70.66±14.52kg, Number of ankle sprains: 5±2.94, IdFAI: 22.7±6.95, FAAM-ADL: 82±9%, FAAM-S: 56±20%)

Interventions (or Assessment of Risk Factors):
Gait biomechanics were collected during two separate sessions at least 72 hours apart. Participants walked on a split belt treadmill for 2 minutes with and without vibration feedback. Data were collected during the second minute. Feedback was delivered from pressure sensors under the 5MH in one session and under the lateral heel in the other. Session order was randomized.

Main Outcome Measurements: The AP COP location at initial contact was defined as the shortest distance between posterior calcaneal marker and the AP COP location. A two-way repeated measures ANOVA was conducted with alpha ≤ 0.05 set a priori.

Results: There was a significant location x time interaction ($F(1,9)=5.402$, $p=0.045$). The COP shifted significantly more anteriorly at initial contact during the heel sensor condition (Post to pre mean difference (MD)= 14 mm (1, 27mm), $p=0.033$) relative to no feedback condition. No change occurred during the 5MH condition (MD= -1 mm (-14, 12mm), $p=0.860$).

Conclusions: The sensor under the heel caused the initial contact to be shifted towards the midfoot creating a more equinous initial contact position. This could lead to altered gait biomechanics throughout the kinetic chain.

#06_Association between the lower limb, trunk kinematics and time to stabilization in the individuals with chronic ankle instability and coper during reactive single-leg landing

Presenting Author: Takaya Watabe

Authors & Affiliations: Takaya Watabe[1,2], Tomoya Takabayashi[3], Yuta Tokunaga[4], Takahiro Watanabe[3], Masayoshi Kubo[3]

(1) Section of Rehabilitation, Kanazawa University Hospital, Kanazawa, Japan.

(2) Institute of Science & Engineering, Kanazawa University, Kanazawa, Japan.

(3) Institute for Human Movement and Medical Sciences, Niigata University of Health and Welfare, Niigata, Japan.

(4) Biomechanics, Terrabyte Corporation, Tokyo, Japan

Background: Dynamic postural stability deficits are risk factors for lateral ankle sprain in sports activities. However, the time to stabilization (TTS), which is an assessment of postural dynamic stability that can be predicted from the lower limb and trunk kinematics, is unclear.

Objective(s): This study aimed to identify the factors with the potential to predict the TTS in individuals with chronic ankle instability (CAI) and the coper and control groups during reactive single-leg landing.

Design: Cross-sectional study

Setting: Biomechanics laboratory

Patients (or Participants): Physically active adults with CAI（N = 14) and coper（N = 14）and control（N = 14）groups.

Interventions (or Assessment of Risk Factors): The participants performed reactive landings, including side-step cutting, side-step cutting at 60°, single-leg landing, and forward stepping. The maximum ankle dorsiflexion, knee flexion, hip flexion, and trunk flexion angles were calculated; the correlations between the TTS in the mediolateral (ML) and other factors were assessed. We performed multiple regression analysis to determine whether TTS ML could be predicted by these parameters.

Main Outcome Measurements: The lower limb, trunk kinematics, and TTS ML conditions were recorded during reactive single-leg landing.

Results: The multiple-regression model, including the lower limb and trunk kinematics, showed 70% variance in the TTS ML of the CAI group (R2 = 0.70, P<.001). In addition, the coper and control groups showed 44% and 52% variance. The maximum ankle dorsiflexion and hip flexion angles of the CAI group were the only significant variables, with hip flexion angle being the strongest predictor of TTS ML (β = 1.03).

Conclusions: The maximum hip flexion angle increased in the CAI group during reactive single leg-landing; hence, it is associated with a longer TTS ML. The CAI group has a higher coefficient of determination, which may limit its landing strategy.

#08_Title: Health-seeking behaviours, management practices, and return to play decisions after an ankle sprain in netball: An international cross-sectional survey of 1,592 non-elite netballers

Presenting Author: Patrick Rowe

Authors & Affiliations: *Patrick Rowe, Adam Bryant, Rana Hinman, Kade Paterson*

The University of Melbourne, a. Department of Physiotherapy, Melbourne, Victoria, Australia

Background: Ankle sprains are common in netball and rates of recurrent sprains and instability are high. Evidence indicates netballers do not appropriately manage ankle sprains. However, it is unknown whether netballers receive care from a health professional, if they are psychologically ready or experience symptoms when returning to play. Differences between countries are also unknown.

Objective(s): To evaluate health-seeking behaviours, treatment strategies, and return to play decisions by netballers after an ankle sprain, and explore between-country differences.

Design: Retrospective cross-sectional study.

Setting: Online.

Patients (or Participants): Female and male netballers aged >14 years with an ankle sprain history were recruited from non-elite competitions in Australia, United Kingdom (UK), and New Zealand (NZ).

Interventions (or Assessment of Risk Factors): Participants completed an online survey describing their last ankle sprain during netball.

Main Outcome Measurements: The primary variable of interest was the proportion who received health professional care and treatment. Other variables measured included medical clearance, psychological readiness, and residual symptoms reported when returning to play. Data was described using number (proportion), and between-country differences were compared using chi-square tests.

Results: A total of 1,592 netballers, mostly female (N=1,574) from Australia (N=846), UK (N=454), and NZ

(N=292) completed the survey. Fewer UK netballers sought medical care (Australia=60%, NZ=68% vs. UK=53%, $p<0.001$) received strengthening (84%, 84% vs. 73%, $p=0.001$) or balance exercises (71%, 80% vs. 60%, $p<0.001$) and were prescribed taping (74%, 82% vs. 39%, $p<0.001$) or bracing (33%, 34% vs. 23%, $p<0.001$). When returning to play, fewer UK netballers received medical clearance (28%, 28% vs. 10%, $p<0.001$), fewer Australian netballers reported fear of re-injury (72%, 70% vs. 62%, $p<0.001$) and more NZ netballers reported pain (58%, 69% vs. 61%, $p=0.01$).

Conclusion: Fewer UK netballers sought medical care, received exercises, were prescribed external ankle support, and received return to play clearance after an ankle sprain than Australian and NZ netballers.

Association between the lower limb, trunk kinematics and time to stabilization in the individuals with chronic ankle instability and coper during reactive single-leg landing

#09_Decellularised Porcine Tendon as a Potential Graft for Ankle Ligament Reconstruction: A Biomechanical Characterisation Under Tension and Compression Assessing the Contribution of Glycosaminoglycans to Tendon Mechanics

Presenting Author: Jacqueline Solis

Authors & Affiliations: Jacqueline Solis[1], Jennifer H Edwards[1], Hazel L Fermor[1], Philip Riches[2], Claire L Brockett[1], Anthony Herbert[1]

(1) University of Leeds, Institute of Medical and Biological Engineering, Leeds, UK

(2) University of Strathclyde, Department of Biomedical Engineering, Glasgow, UK

Background: Approximately 2 million acute ankle sprains occur annually in United States alone, often leading to ruptures of anterior talofibular and calcaneofibular ligaments, which synergistically provide ankle stability. Decellularised porcine superflexor tendons (pSFT) provide a promising graft option for ankle ligament reconstruction (ALR). Decellularisation can reduce pSFT glycosaminoglycan (GAG) content, thereby impacting graft biomechanics.

Objective(s): Determine the effects of decellularisation on pSFT GAG content and function by investigating GAG contribution to tendon biomechanics.

Design: Controlled laboratory study

Setting: Research laboratory

Patients (or Participants): pSFT dimensions were matched for native, decellularised and GAG-depleted groups (n=6).

Interventions (or Assessment of Risk Factors): Decellularisation followed previous techniques. Native pSFTs were treated with chondroitinase-ABC to deplete GAGs and validated. Groups were biomechanically characterised through tensile (stress relaxation, strength testing) and confined compression loading.

Main Outcome Measurements: Stress relaxation data was fitted to modified Maxwell-Weichert model obtaining time-dependent (E1,E2), time-independent moduli (E0). Toe, linear region moduli (Etoe,Elinear), tensile strength (UTS), failure strain (εfail) were determined from strength testing. Biphasic theory parameters aggregate modulus (HA) and zero-strain permeability (k0) were determined from compression testing. Data was analysed by one-way ANOVA with Tukey post-hoc test. A $p<0.05$ denoted statistical significance.

Results: Quantitative assays showed no significant differences in GAG content of native (3.75±0.58μg/mg) and decellularized(3.4±0.37μg/mg) groups, but 86% reduction in GAG-depleted pSFT($p<0.0001$). E0 was significantly reduced($p<0.001$) in decellularised group(84.04±26.02MPa) compared to native(207.90±59.81MPa) and GAG-depleted (209.03±49.37MPa). HA was reduced 74% in GAG-depleted group($p=0.018$) compared to native(1.69±0.97MPa). k0 was significantly higher for GAG-depleted group (0.86±0.65mm4/Ns) compared to decellularized (0.03±0.04mm4/Ns).

Conclusion: Decellularisation does not affect GAG content or impair mechanical function in pSFT. GAG depletion adversely affects pSFT compressive properties, revealing major mechanical contribution under compression, but no significant role under tension. The biomechanical properties of decellularised pSFT remained within a similar range to native, providing a mechanically competent graft for ALR.

#11_Does ankle research translate to clinical practice: an online survey of 426 French-speaking physiotherapists

Presenting Author: Romain Tourillon

Authors & Affiliations: Romain Tourillon[1,2], Eamonn Delahunt[3,4], François Fourchet[1,5], Brice Picot[5,6,7], Massamba M'baye[8]

(1) Swiss Olympic Medical Center, La Tour Hospital,, Physiotherapy Department and Motion Analysis Lab, Meyrin, Switzerland.

(2) Univ Lyon, UJM-Saint-Etienne, Inter-university Laboratory of Human Movement Biology, EA 7424, F-42023, Saint-Etienne, France.

(3) University College Dublin, School of Public Health, Physiotherapy and Sports Science, Dublin, Ireland.

(4) University College Dublin, Institute for Sport and Health, Dublin, Ireland.

(5) French Society of Sports Physical Therapist SFMKS Lab, Pierrefitte-sur-Seine, France.

(6) French Handball Federation, Physiotherapy Department, Creteil, France.

(7) Savoie Mont-Blanc University, Inter-University Laboratory of Human Movement Biology (LIBM), Chambéry, France.

(8) Kin'Aixpert, Physiotherapy, Viviers du Lac, France

Background: Despite growing research, lateral ankle sprain (LAS) and chronic ankle instability (CAI) financial and societal burden remains very high. A critical factor is the transfer of research findings into clinical practice.

Objective(s): To investigate [1] how French speaking physiotherapists evaluate LAS in clinical practice in comparison to Rehabilitation-Oriented-ASsessmenT (ROAST) international guidelines and [2] their understanding of the mechanical and sensorimotor impairments associated with CAI according to Hertel's developed model.

Design: Qualitative cross-sectional study.

Setting: One-time online survey.

Patients (or Participants): Physiotherapists working in France, Switzerland, Quebec-Canada, Belgium or Luxembourg.

Interventions (or Assessment of Risk Factors): An online survey developed by the authors and disseminated by national or regional professional associations and scientific/continuing education organizations.

Main Outcome Measurements: The online survey was composed of closed and open-ended questions divided in five sections : (1) demographics, (2) self-assessment, (3) clinical diagnosis assessment (bony and ligamentous integrity), (4) clinical evaluation after LAS (ROAST items) and (5) CAI. The qualitative data from the open-ended questions was analyzed following thematic analysis guidelines.

Results: A total of 426 physiotherapists fully completed the survey. Considering section 3 only 6% of the respondents could name all the Ottawa Ankle Rules criteria. Regarding ankle lateral ligaments diagnostic assessment, 25% cited or described "gold standard" tests from the literature to assess their integrity. In section 4 less than 25% of the physiotherapists used some validated ROAST tools after LAS. Finally, we discovered in section 5 that mechanical insufficiencies associated with CAI were less known than functional insufficiencies as 13% of the physiotherapists were not able to list any impairment.

Conclusion: Our results have substantial implications as they clearly illustrate the actual gap between international research guidelines and field practice. This underscores the responsibility of the scientific community to endeavor the dissemination of their research for clinicians.

#13_The influence of toe flexor muscle fatigue on dynamic postural control and subjective foot and ankle stability in young healthy individuals

Presenting Author: Junji Shinohara

Authors & Affiliations: Junji Shinohara, Kazushi Yoshida, Kazuma Hayashi, Shogo Takano, Mikuto Katsuya

Chukyo University, School of Health and Sport Sciences, Aichi, Japan

Background: The toe flexor muscles play an important role in providing appropriate dynamic postural control and foot and ankle stability during physical activity. However, research evidence on the influence of toe flexor muscle fatigue (TFMF) on dynamic postural control and foot and ankle stability is limited.

Objective(s): To examine the influence of TFMF on dynamic postural control and subjective foot and ankle stability (SFAS) in healthy young individuals.

Design: Cross-sectional study.

Setting: Research laboratory setting.

Patients (or Participants): Twelve healthy subjects (ten males and two females; age: 20.25±1.06years, height: 168.54±9.07cm, mass: 60.54±6.64kg) volunteered for this study.

Interventions (or Assessment of Risk Factors): Subjects reported to the laboratory for two testing sessions, separated by one week apart, during which dynamic postural control was assessed with SEBT performed immediately after two fatigue-induced conditions: TFMF and Sham. Subjects performed the anterior (ANT), posterior-medial (PM), and posterior-lateral (PL) directions of SEBT while standing on the dominant limb. Three trials of each SEBT direction were averaged and normalized as a percentage of stance leg length (normalized reach distance, NRD). Each subject was asked to fill out a subjective measurement form with scores ranging from 0 to 5, asking about SFAS during reaching performance in each SEBT direction.

Main Outcome Measurements: The dependent variables were NRD (TFMF and Sham) and SFAS (TFMF and Sham). The independent variable was SEBT reaching direction (ANT, PM, and PL). A repeated paired t-test was performed for NRD, and a Wilcoxon signed-rank test was performed for SFAS. Alpha level was set a priori at 0.05.

Results: In ANT and PM, TFMF had a significantly lower NRD than Sham (ANT: TFMF, 0.84±0.09; Sham, 0.87±0.07, p=0.01, PM: TFMF, 0.99±0.08; Sham, 1.02±0.07, p=0.03). No other significant difference was observed.

Conclusion: These results indicated that TFMF negatively influences dynamic postural control but not SFAS.

#14_Objective and subjective effects of individualized therapy after ankle inversion trauma

Presenting Author: Rosemary Dubbeldam

Authors & Affiliations: Rosemary Dubbeldam[1], Semjon Janauschek[1], Lena Fennen[1], Alexander Milstrey[2], Sabine Ochmann[2], Heiko Wagner[1]

(1) University Münster, Institute of Sport and Exercise Science, Münster, Germany.

(2) University Hospital Münster, Department of Trauma Surgery, Münster, Germany

Background: Ankle inversion trauma may have severe consequences as 40-70% develop chronic impairments. While training has shown to reduce the recurrence rate after ankle trauma, therapy in general does not seem to influence the development of chronic ankle instability. Also, there is no consensus of training content and duration.

Objective: Since patients show a broad variety of impairments in function and activity after ankle inversion trauma, our aim is to offer patients therapy based on their individual impairments and evaluate their rehabilitation process.

Design: Observational study.

Setting: Patients were recruited and tested by the University Hospital and Sports Institute and treated at the local sports-medicine praxis.

Patients (or Participants): So far, 13 patients (26 ± 6 years) with chronic or acute ankle instability after ankle inversion trauma were evaluated during a 3-months period.

Interventions (or Assessment of Risk Factors): The patients received individual physiotherapy focusing on e.g., muscle strengthening, coordination, and or joint mobility.

Main Outcome Measurements: One-limb stance eyes-open performance was recorded for 60 seconds using Qualisys motion analysis system and assessed objectively by means of Centre of Pressure (CoP) parameters. CoP cumulative distance and standard deviation were assessed. The FAAM and CAIT were used to monitor daily life performance subjectively. Objective and subjective performance assessments were made in week 0, 3, 6 and 12. Mixed models allowing for subject differences were used to test for effects.

Results: The CoP cumulative distance significantly reduced over time in anterior-posterior (β -3.5, CI [-4.9,-2.0], $p < .001$) and medial-lateral (β -1.9, CI [-3.2,-0.6], $p < .01$) direction, but the CoP standard deviation did not. The patients reported a significant improvement in daily (FAAM-ADL, β 1.0 CI [0.5,1.5], $p < .001$) and sports (FAAM-S, β 1.8, CI [0.8,2.8], $p < .01$) function, but not in instability score (CAIT, β 0.8, CI [-0.1,1.6]).

Conclusion: After 3 weeks, effects of individualized therapy were present in objective and subjective measures and impairments significantly reduced in the following weeks.

#18_Influence of intrinsic foot muscle fatigue on muscle stiffness measured using ultrasound shear wave elastography

Presenting Author: Kazushi Yoshida

Authors & Affiliations: Kazushi Yoshida, Junji Shinohara, Katsuya Mikuto, Takano Shogo, Hayashi Kazuma, Taisei Hakozaki

Chukyo university, School of Health and Sport Sciences, Aichi, Japan

Background: The intrinsic foot muscles play an important role in foot and ankle function. However, their physiological response to fatigue is largely unknown.

Objective(S): To examine the influence of intrinsic foot muscle fatigue on muscle stiffness using ultrasound shear wave elastography

Design(s): Cross-sectional study

Setting: Research laboratory setting

Patients (or Participants): Twelve healthy participants (nine men, three women; age=20.50±1.17years; height=166.79±6.04cm; mass=59.25±5.48kg) volunteered for this study.

Interventions (or Assessment of Risk Factors): The participants reported to the laboratory for two testing sessions performed 1 week apart during which stiffnesses of the abductor hallucis (AbH), flexor hallucis brevis (FHB), flexor digitorum brevis (FDB), and quadratus plantae (QP) muscles were assessed using ultrasound shear wave elastography. These intrinsic foot muscles were assessed with the participants in two positions: seated on a chair and standing on both feet (SBF). Measurements were obtained in two fatigue conditions: induced intrinsic foot muscle fatigue (IndF); and sham. The IndF protocol consisted of a series of toe flexions with controlled pace and amplitude for 5 min. Young's modulus (in kilopascals: kPa) was calculated to analyze the quantitative changes in muscle stiffnesses between the fatigue conditions.

Main Outcome Measurements: The dependent variable was muscle stiffness (AbH, FHB, FDB, QP). The independent variable was fatigue condition (IndF and sham). A repeated paired t-test was performed for each dependent variable. The alpha level was set a priori at 0.05.

Results: In the SBF position, the FDB and QP stiffnesses had significantly higher IFMS in the IndF than in the sham condition (FDB: IndF, 65.51±7.73 kPa, and sham, 37.81±7.44 kPa, p=0.01; QP: IndF, 55.58±6.69 kPa, and sham, 31.74±7.72 kPa, p=0.04). No other significant differences were observed.

Conclusion: These results indicated that intrinsic foot muscle fatigue greatly influenced muscle stiffness in the standing but not in the seated position.

#24_What are the clinical recommendations for the use of ankle braces? a scoping review

Presenting Author: Tomas Megalaa

Authors & Affiliations: Tomas Megalaa, Paula R Backenkamp, Alycia Fong Yan, Calire E Hiller

The University of Sydney, Faculty of Medicine and Health, NSW, Australia

Background: Ankle braces are widely used to treat and prevent ankle sprains. However, the clinical recommendations for ankle braces for the treatment and/or prevention of ankle sprains and CAI have not been reviewed.

Objective(s): To revise the recommendations for the use of ankle braces in the treatment and/or prevention of ankle sprains and CAI.

Design: Scoping review

Setting: Any form of healthcare practice setting

Patients (or Participants): Recommendations made for people with a history of acute ankle sprains or chronic ankle instability

Interventions (or Assessment of Risk Factors): Ankle brace

Main Outcome Measurements: Recommendations/ indications for the use of ankle braces

Results: Eleven guidelines and two position statements were included. All guidelines and position statements recommended ankle braces for the treatment of grade I and II lateral ankle sprains and CAI, but there were inconsistencies on the recommendations made for grade III sprains. All three guidelines and one position statement recommended immobilisation over ankle brace; however, stirrup ankle braces were considered a form of immobilisation. Seven guidelines recommended ankle brace use over immobilisation for all sprain grades. There were also inconsistencies on the terms used to describe the different types and the level of restriction ankle braces provide. Five guidelines recommended ankle braces for the prevention of recurring ankle sprains. Three guidelines and one position statement indicated that ankle braces should stop being worn when a patient can sufficiently perform weight-bearing activities, or in the presence of pain.

Conclusion: There was consensus on the recommendation of ankle braces for prevention of recurring sprains and the treatment of grade I and II sprains. Consensus is needed on the definitions used for the type of brace and the level of restriction ankle braces provide.

#25_The effects of ultrasound imaging biofeedback of the talonavicular joint on the short foot exercise

Presenting Author: Mizuki Hatanaka

Authors & Affiliations: Mizuki Hatanaka[1], Seiya Kanazawa[1], Keisuke Hirakawa[2], Masahiro Tsutsumi[1,3], Shintarou Kudo[1,2,3]

(1) Department of physical therapy, Morinomiya university of medical sciences, Osaka, Japan

(2) Graduate school of health sciences, Morinomiya university of medical sciences, Osaka, Japan

(3) Inclusive medical sciences research institute, Morinomiya university of medical sciences, Osaka, Japan

Background: The short foot exercise (SFE) is one of the exercises for the intrinsic foot muscles strength and proprioception of the foot. Because the quick acquisition of the SFE movement pattern is difficult, something feedback must be used in combination with the SFE.

Objective(s): This study aimed to clarify the effects of ultrasound imaging biofeedback (USBF) of the talonavicular joint on the SFE in the normal volunteers.

Design: Double blinded RCT

Setting: Biomechanics laboratory

Patients (or Participants): Seventeen normal volunteers (20.2±0.4 y/o, 164.5±6.5 cm 54.9±5.6 kg) without any pain of the lower limbs were participated in this study.

Interventions (or Assessment of Risk Factors): All participants performed the SFE for 5 minutes after the 30-seconds video instruction. Nine and eight participants were randomly assigned to receiving the only verbal feedback (control) and USBF during the SFE, respectively.

Main Outcome Measurements: Navicular height were recorded using the photograph at the start, 2 minutes after the start, and at the end (5 minutes after the start), and its height was measured based on the photograph by ImageJ.

Results: The navicular heights of the USBF group were 47.4±5.2mm at the start, 53.9±4.6mm at 2 minutes, and 54.0±3.9mm at the end. In a while, those of the control group were 49.0±4.9mm at the start, 51.0±5.4mm at 2 minutes, and 51.6±5.9mm at the end. The two-way ANOVA showed the significant difference among timing ($p<0.05$) and post-hoc analysis, Turkey test, its navicular height in USBF group at both 2 minutes and the end were significantly higher than that at the start ($p<0.05$). In contrast, there is no significant difference among timing in the control group.

Conclusion: The USBF of the talonavicular joint was effective in the navicular height elevation and quick SFE acquisition.

#35_The effect of peripheral somatosensory stimulation on neural excitability in individuals with chronic ankle instability

Presenting Author: Jacob A Barton

Authors & Affiliations: Jacob A Barton[1], Jennifer S Howard[2], Jared W Skinner[1], Alan R Needle[1,2]

(1) Appalachian State University, Department of Public Health & Exercise Science, NC, USA.

(2) Appalachian State University, Department of Rehabilitation Sciences, NC, USA

Background: Chronic ankle instability (CAI) is associated with decreased cortical & reflexive excitability. Neural excitability can be increased using electrical stimulation over a peripheral nerve (peripheral somatosensory stimulation, PSS); however, effects among injured patients are unstudied.

Objective(s): To conduct a preliminary investigation of a single PSS intervention on neural excitability in patients with CAI.

Design: Crossover study.

Setting: Electrophysiology laboratory.

Patients (or Participants): Ten participants with CAI were recruited (6M/4F, 22.1±3.8yrs, 174.7±10.6cm, 83.2±15.6kg).

Interventions (or Assessment of Risk Factors): Participants reported for 3 total sessions: a control session where measurements were before & after 60-minutes of quiet sitting; an intervention session where measurements were before and after 60-minutes of PSS (100Hz, 1000μsec, suprasensory) over common peroneal nerve; and 24-hour follow-up.

Main Outcome Measurements: Reflexive excitability to tibialis anterior (TA), peroneus longus (PL) and soleus (SOL) were determined from the Hoffmann-reflex (Hmax:Mmax), while cortical excitability was determined through transcranial magnetic stimulation (resting motor threshold, RMT; maximum motor evoked potential, MEPmax). Data were compared with factorial ANOVA across groups, times, & muscles ($\alpha=0.05$), and effect sizes using Cohen's d (small=0.2, medium=0.5, large=0.8).

Results: Analyses of variance revealed no treatment effects for Hmax:Mmax ($F[8,56]=0.586$, $p=0.785$, $\eta2=0.077$); RMT ($F[4,36]=0.423$, $p=0.791$, $\eta2=0.045$), or MEPMax (TA ($F[4,16]=0.519$, $p=0.723$, $\eta2=0.115$), PL ($F[4,12]=2.940$, $p=0.066$, $\eta2=0.495$), SOL ($F[4,16]=0.434$, $p=0.782$, $\eta2=0.098$). Large observed effect sizes ($\eta2$), prompted investigation of paired effects. Medium-to-large effects were observed for TA H:M ratio pre-intervention (0.130±0.074) to post-intervention (0.195±0.126, d=0.631), the SOL RMT pre-intervention (46.217±14.724) to post-intervention (31.673±12.433, d=1.067) and 24-hour (30.234±16.237, d=1.031), and TA MEPMax pre-intervention (0.246±0.098) to post-intervention (0.369±0.331, d=0.505) and pre-intervention to 24-hour (0.347±0.170, d=0.733).

Conclusion: Although statistical significance was not achieved, medium-to-large increases in neural excitability were observed following PSS, suggesting some efficacy for addressing a common impairment in patients with CAI.

#38_Electroacupuncture for the treatment of chronic ankle instability

Presenting Author: Geofrey Gustavsen

Authors & Affiliations: Geofrey Gustavsen, Amanda Delaney, Thomas W Kaminski

University of Delaware, Department of Kinesiology & Applied Physiology, Newark, DE, USA

Background: Treatment paradigms for those with chronic ankle instability (CAI) vary widely. Electroacupuncture (EAP), often used for acute and chronic pain control, is an intervention that has not been used in those with CAI.

Objective: To measure the effects of a single, 10-minute EAP treatment on ankle strength in those with CAI.

Design: Pre-test/post-test repeated measures design.

Setting: Climate-controlled research laboratory.

Patients (or Participants): Ten subjects [2M (28 ± 8.5 yr., 90 ± 17.7 kg), 8F (22 ± 3.0 yr., 68 ± 20.5 kg)]

Interventions (or Assessment of Risk Factors): Subjects received a10-minute EAP treatment

Main Outcome Measurements: Concentric (CON) and eccentric (ECC) ankle strength was measured using a

KinCom 125 AP isokinetic dynamometer. All four motions were tested @ 30/s and 120/s. Strength was measured pre-, post-, and 1-month post-EAP. Average torque (AT) measures normalized for body mass were compared pre- to post-treatment as well as from pre-treatment to 1-month post-treatment using dependent samples T-tests.

Results: Results showed no significant strength differences pre- to post-treatment. AT measures were significantly improved 1-month post-treatment when compared to pre-treatment for the PFCON30 (t = -2.57, df[10], p = 0.030), DFECC30 (t = -2.28 , df[10], p = 0.046), and DFECC120 (t = -2.97, df[10], p = 0.014) conditions.

Conclusion: The results of this preliminary study, suggest that electroacupuncture does not appear to have any acute effects on isokinetic ankle strength when subjects are tested immediately after treatment. However, in our clinical experience there is a noticeable strength difference in the DF appreciated with a single manual isometric break test done pre and post treatment. Subject fatigue could play a role as the second testing session on the isokinetic dynamometer (involving approximately 50 maximum strength repetitions) is less than a half hour after the first, resulting in lower immediate post treatment scores. The improvement in the PF and DF strength in subjects with CAI at the one month follow-up is promising.

Category 2: Screening, Diagnosing, and Testing

#04_Kinematic alterations during the side hop test with extended distance in healthy individuals

Presenting Author: Kyoya Ono

Authors & Affiliations: Kyoya Ono[1], Satoru Tanigawa[2]

(1) University of Tsukuba, Graduate School of Comprehensive Human Sciences, Ibaraki, Japan.

(2) University of Tsukuba, Faculty of Health and Sports Sciences, Ibaraki, Japan

Background: The Side Hop Test (SHT) is an assessment test with high validity in identifying CAI. The distance of the SHT is typically set at 30 cm, but no studies have investigated ankle kinematics at different distances. Investigating the influence of extending the distance of the SHT could provide useful findings in determining the appropriate distance for using the SHT.

Objective(s): To investigate the differences in ankle kinematics during the SHT between 30 cm and 45 cm in healthy individuals.

Design: Cross-sectional study.

Setting: Laboratory.

Patients (or Participants): Fifteen healthy men (age = 20.1 ± 1.5 years, height = 173.4 ± 5.1 cm, mass = 68.1 ± 5.6 kg).

Interventions (or Assessment of Risk Factors): The participants performed the 30 cm and 45 cm SHT three times with their dominant leg.

Main Outcome Measurements: The SHT time, ground contact time (GCT), and peak ankle joint angle were calculated separately for the medial hop contact phase (MC) and lateral hop contact phase (LC) in the SHT.

Results: Compared to the 30 cm SHT, the 45 cm SHT showed (1) longer time and GCT in the MC and LC (difference = 0.7 ± 0.3 sec, 24 ± 22.9 msec, and 11 ± 18.8 msec respectively; $p < .05$); (2) more peak dorsiflexion and external rotation angle in the MC (difference = 2.9 ± 2.6 ° and 0.7 ± 0.8 ° respectively; $p < .05$); and (3) more peak dorsiflexion, plantar flexion and internal rotation angle, and less peak external rotation angle in the LC (difference = 2.1 ± 1.6 °, 0.8 ± 2.4 °, 1.6 ± 0.8 °, and 0.5 ± 0.8 ° respectively; $p < .05$).

Conclusion: The extended distance of the SHT resulted in changes in peak joint angles in the sagittal and transverse planes but not in the frontal plane. These results suggested that using the 45 cm SHT could allow for the assessment of abilities different from those measured by the 30 cm SHT.

#15_Altered ankle joint contact force profiles in chronic ankle instability during walking

Presenting Author: Jaeho Jang

Authors & Affiliations: Jaeho Jang[1], Brian G.

Pietrosimone[1], Feng-Chang Lin[2], Jason R. Franz[3], Erik A. Wikstrom [1]

(1) University of North Carolina at Chapel Hill, Exercise and Sports Science, NC, USA

(2) University of North Carolina at Chapel Hill, Department of Biostatics, NC, USA

(3) University of North Carolina at Chapel Hill, Department of Biomedical Engineering, NC, USA

Background: Individuals with chronic ankle instability (CAI) exhibit aberrant gait biomechanics. Aberrant gait biomechanics may contribute to altered joint loading and subsequent early onset ankle joint degeneration. Critical gaps exist with ankle joint loading alterations in patients with CAI, which can be estimated via joint contact forces (JCF).

Objective(s): The purpose of this study was to compare tri-axial joint loading (i.e. compressive, anteroposterior shear, mediolateral shear) in those with and without CAI (CON) while walking. We hypothesized that those with CAI walk with different joint loading patterns in all directions compared to CON.

Design: Retrospective case-control

Setting: Laboratory

Patients (or Participants): Ten CAI (Age: 21.6±4.1 yrs, Mass: 69.0±13.9 kg, Height: 169.4±8.3 cm, Gait speed: 1.39±0.18 m/s), and 10 CON (Age: 20.5±1.6 yrs, Mass: 68.9±14.4 kg, Height: 173.9±11.4 cm, Gait speed: 1.37±0.11 m/s).

Interventions (or Assessment of Risk Factors): Participants completed a 2-min gait assessment at their self-selected speed on an instrumental treadmill. Measured kinematics and ground reaction forces drove a generic lower-extremity musculoskeletal modeling in OpenSim to estimate ankle JCF.

Main Outcome Measurements: Variables included the peak, impulse, and loading rates for compressive, anteroposterior shear, and mediolateral shear JCF.

Results: Those with CAI had significantly lower compressive peak (CAI: 5.29±0.52 BW vs CON: 5.73±0.39 BW, p=0.045) and impulse (CAI: 1.63±0.15 BW*s vs CON: 1.78±0.09 BW*s) values relative to controls. We also observed higher anteroposterior shear force (CAI: -0.68±0.14 BW vs CON -0.50±0.12 BW) and impulse (CAI: -0.08±0.04 BW*s vs CON: -0.05±0.01 BW*s) in those with CAI. Those with CAI also demonstrated higher mediolateral shear impulse (p = 0.021).

Conclusion: Those with CAI exhibit different ankle joint loading patterns than uninjured controls while walking at a self-selected speed. However, those differences found in each component of JCF vectors depend on the direction of movement.

#16_A Comparison of patient reported outcome measures and physical performance measures in adolescents with and without ankle sprain history

Presenting Author: Phillip A Gribble

Authors & Affiliations: Phillip A Gribble[1], Katherine Bain[2], Paige Clawson[3], Lauryn Lanzer[4], Kyle Kosik[1]

(1) University of Kentucky, College of Health Sciences, KY, USA

(2) Shenandoah University, School of Health Professions, VA, USA

(3) University of Kentucky, Department of Orthopedics, KY, USA

(4) Baldwin-Wallace University, Department of Athletics, OH, USA

Background: Adults with CAI have deficiencies in self-reported function, HRQOL, and physical measures such as the weight-beating lunge test (WBLT) and SEBT compared with Copers and Un-injured Controls. In spite of the fact the genesis of CAI initiates in adolescence, little effort has been made to explore these outcomes in adolescents with and without ankle sprain history.

Objective(s): Examine PROMs and physical measures in adolescents with and without CAI.

Design: Case-control

Setting: Research Laboratory

Patients (or Participants): A convenience sample of physically active adolescent volunteers between the ages of 13-17 years were screened according to the International Ankle Consortium guidelines, and allocated to either the CAI (n=12), Coper (n=12) or Un-injured Control (n=29) cohort.

Interventions (or Assessment of Risk Factors): N/A

Main Outcome Measurements: Participants completed PROMs (IdFAI, AII, FADI-ADL, FADI-S, CAIT-Youth, Pediatric Quality of Life Inventory, Disablement in the Physically Active scale, Fear Avoidance Belief Questionnaire, and Brief Resiliency Scale. The average of three trials were taken for the WBLT and each direction of the SEBT (anterior [SEBT_ANT], posteromedial [SEBT_PMED], posterolateral [SEBT_PLAT)] All outcomes were compared between cohorts using 1-way ANOVA models with post-hoc testing. When appropriate, minimal detectable change (MDC) scores were applied to group differences.

Results: Participants in the CAI group had worse PROM scores that the Copers and Un-injured Controls. No significant differences were observed between groups for the WBLT or SEBT.

Conclusion: Adolescents with CAI displayed self-reported differences on established PROMs compared with Copers and Un-injured controls. Physical performance test deficiencies were not statistically significant, but the CAI group had lower scores than the Coper and Un-injured Control groups on the SEBT_PMED and SEBT_PLAT that exceeded the MCD. However, the MCD scores are based on established performance levels in adults. More exploration is needed among adolescents to understand CAI development in hopes of identifying strategies to interrupt long-term disability in adulthood.

#23_Development of a core domain set for ankle osteoarthritis

Presenting Author: Sultan A Alanazi

Authors & Affiliations: Sultan A Alanazi[1,2], Bill Vicenzino[1], Christiaan J.A. van Bergen[3], David J Hunter[4,5], Erik Wikstrom[6], Hylton B Menz[7], Yvonne Golightly[8,9], Michelle D Smith[1]

(1) The University of Queensland, School of Health and Rehabilitation Sciences, Physiotherapy, Queensland, Australia.

(2) Department of Physical Therapy, College of Applied Medical Sciences, Majmaah University, Al-Majmaah, 11952, Saudi Arabia.

(3) Amphia Hospital, Department of Orthopedic Surgery, Breda 4818 CK, Netherlands.

(4) Sydney Musculoskeletal Health, Kolling Institute, The University of Sydney, NSW, Australia.

(5) Rheumatology Department, Royal North Shore Hospital, NSW, Australia.

(6) MOTION Science Institute Department of Exercise & Sport Science, University of North Carolina at Chapel Hill, NC, USA.

(7) Discipline of Podiatry, School of Allied Health, Human Services and Sport, La Trobe University, Victoria, Australia.

(8) College of Allied Health Professionals, University of Nebraska Medical Center, NE, USA.

(9) Thurston Arthritis Research Center, University of North Carolina, NC, USA

Background: There are lack of guidelines and variability in outcome measures used in ankle osteoarthritis (OA) research which limits ability to synthesise data and inform management. An agreed-upon set of health-related domains – a core domain set – will provide guidance for researchers and clinicians working with people with ankle OA.

Objective(s): To develop a core domain set for ankle OA.

Design: We undertook a scoping review to identify outcome measures in previous ankle OA research and associated domains. We then conducted semi-structured interviews with 23 individuals with ankle OA and 21 healthcare professionals (HCP) to capture their perspectives. The steering committee generated a list of 29 candidate domains that were presented to 25 people with ankle OA and 75 HCP in a Delphi survey.

Setting: International

Patients (or Participants): People with ankle OA and HCP Interventions (or Assessment of Risk Factors): Health-related domains

Main Outcome Measurements: Consensus in the Delphi study was defined as 70% agreement that the domain be included or excluded in the core domain set.

Results: Our scoping review identified 250 outcome measures that were mapped to 19 potential domains. Interviews with people with ankle OA indicated that pain is a central feature of ankle OA; stiffness and swelling are key symptoms; mobility impairments compromise enjoyment in life; falling is a concern; and ankle OA has financial implications. Interviews with HCP highlighted that ankle OA pain and stiffness have physical and psychosocial implications. Five candidate domains reached Delphi consensus to be included as core domains – pain severity, function, health-related quality of life, disability and range of motion - and six domains reached consensus to be excluded. The other 18 candidate domains are being evaluated for consensus for inclusion/exclusion in the core domain set.

Conclusion: This research has identified core domains that should be included in all ankle OA research. Future research will determine the best outcome measures that represent each of the core domains

#26_Exploring Sleep Hygiene in Participants with Chronic Ankle Instability

Presenting Author: Colleen Vogel

Authors & Affiliations: Colleen Vogel[1], Ji Yeon Choi[1], Adam B Rosen[1], Michaela Schenkelberg[1], Brian Knarr[2]

(1) University of Nebraska at Omaha, School of Health and Kinesiology, NE, USA

(2) University of Nebraska at Omaha, Department of Biomechanics, NE, USA

Background: Poor sleep hygiene increases the risk of musculoskeletal injury and sleep behavior has been shown to be an important biomarker of injury recovery. However, the relationship between chronic ankle instability (CAI) and sleep hygiene remains unknown.

Objective(s): To investigate the interaction between self-reported function and sleep hygiene in individuals with CAI.

Design: Prospective cohort study.

Setting: Field research.

Patients (or Participants): Fourteen subjects with CAI (Male=8, age=22.63±2.669years, mass=84.878±12.008kg, height=179.313±6.341cm; Female=6, age=22.67±2.733years, mass=58.132±7.128kg, height=167.517±7.410cm).

Interventions (or Assessment of Risk Factors): Participants completed baseline testing including the Pittsburgh Quality Sleep Index (PSQI) and the Cumberland Ankle Instability Tool (CAIT). Participants were given a physical activity tracker (Fitbit Versa 2) to track sleep stages over a 30-day period.

Main Outcome Measurements: The CAIT, PSQI, time spent awake, and time spent asleep were assessed. Questionnaire items were correlated to the sleep measures across all participants, and then separately between males and females. Correlational coefficients were interpreted as low ($r<0.3$), moderate ($r=0.3$-0.5), or large ($r>0.5$).

Results: Across all participants, there was a moderate correlation between PSQI and CAIT in the CAI sample ($r=-0.453$, $p=0.052$). However, there was a significant, large correlation between the PSQI and CAIT in men ($r=-0.676$, $p=0.033$) that was not present in women ($r=-0.235$, $p=0.327$). Among women, minutes in light sleep was associated with a higher CAIT score ($r=0.815$, $p=0.024$).

Conclusion: This preliminary data shows that sleep quality may be related to self-reported function, however, this relationship was only present among males. This suggests that males who self-report worse function may also have lower quality of sleep. Among women, it appears that more minutes in light sleep may be related to higher self-reported function. [MS1] Although preliminary, this evidence suggests that sleep hygiene may influence self-reported function and could be a biomarker to target for clinicians treating those with CAI.

#27_Self-report function and clinical balance measures contribute to kinesiophobia in participants with Chronic Ankle Instability.

Presenting Author: Adam B Rosen

Authors & Affiliations: Adam B Rosen, Ji Yeon Choi, Colleen M Vogel

University of Nebraska at Omaha, School of Health and Kinesiology, NE, USA

Background: Individuals with Chronic Ankle Instability (CAI) demonstrate decreased function and postural control. Kinesiophobia is theorized to influence physical function in a variety of populations however, its influence on those with CAI and how it affects their health and performance is not well established.

Objective(s): To understand the influence of self-reported function and postural control on kinesiophobia in those with CAI.

Design: Cross-sectional study

Setting: Biomechanics research laboratory

Patients (or Participants): A total of 16 participants with CAI (10 men, 6 women; age=22.2±2.7 years, height= 174.6±8.5 cm, mass=76.0±17.3 kg) participated in this study.

Interventions (or Assessment of Risk Factors): Participants completed the Cumberland Ankle Instability Tool (CAIT) and Tampa Scale of Kinesiophobia (TSK) questionnaires. Participants then had their postural control measured utilizing the modified balance error scoring system (mBESS) via a smartphone application (Sway Version 5.4.4, Sway Medical LLC., Tulsa, OK, USA).

Main Outcome Measurements: The CAIT, TSK, and the overall composite mBESS score were assessed via Pearson Correlation Coefficients. A backwards regression was also used to assess the combined contribution of the CAIT and mBESS score on the TSK. Correlational coefficients were interpreted as low (r<0.3), moderate (r=0.3-0.5), or large (r>0.5).

Results: The TSK was significantly correlated with both the CAIT (r = -0.601, p=0.007) and the mBESS composite score (r = -0.601, p=0.007). The backwards regression model revealed that when combined, the CAIT and mBESS explained 48% of the variability of the TSK in CAI participants (r= 0.692, R2= 0.48, p=0.015).

Conclusion: Self-report function and balance demonstrated a large, significant portion of the variability in the TSK. This suggests that patients with worse function and balance ability concurrently indicate greater levels of kinesiophobia. Clinicians may want to consider the role kinesiophobia plays in moderating physical function in patients with CAI.

#28_Instruments and methods for the assessment of ankle evertors strength: a systematic review of measurement properties

Presenting Author: Aude Aguilaniu

Authors & Affiliations: Aude Aguilaniu[1,2], Stéphanie Grosdent[1], Cédric Schwartz[2], Geraldine Martens[3], Jean-Louis Croisier[1,2], Nancy Durieux[4]

(1) Motricity science departement, University of Liège, Liège, Belgium

(2) LAM – Motion Lab, University of Liège, Liège, Belgium

(3) French-speaking Research Network for Athlete Health Protection & Performance (REFORM), Central University Hospital of Liège, Liège, Belgium

(4) Research Unit for a life-Course perspective on Health & Education - RUCHE, Faculty of Psychology, Speech and Language Therapy and Educational Sciences, University of Liège, Liège, Belgium

Background: After lateral ankle sprain (LAS), patient could still present chronic ankle instability (CAI). It has been established that evertors strength is weaker for CAI patient than healthy one. Additionally, the lesioning LAS movement could be counteracted by an eccentric contraction of the evertors. A potential weakness of the evertors should be quantified for rehabilitation.

Objective(s): This systematic review aims at evaluating the reliability and measurement error of instruments and their methods to measure evertors strength.

Design: A systematic review of measurement properties was conducted. The quality of the articles included was assessed with COSMIN risk of bias tool.

Setting: no setting restriction was applied.

Patients (or Participants): no population restriction was applied.

Interventions (or Assessment of Risk Factors): Instruments and their methods used to measure quantitatively evertors strength were the inclusion criteria of this review.

Main Outcome Measurements: Outcomes of test-retest and inter-rater, reliability and measurement error were extracted.

Results: The literature search identified 2829 articles. A total of 21 articles met the inclusion criteria. The population was mainly healthy and, the only pathologic population was patients with a history of LAS. The isokinetic dynamometer (57%) and hand-held dynamometer (38%) are the main methods used to assess evertors strength. The test-retest and inter-rater reliability are sufficient (ICC ≥

0.70) in the majority of the retrieved values (76%-78%). However, the test-retest and inter-rater measurement errors are sufficient (MDC or LoA ≤ 20%) in a low number of the retrieved values (35%-60%).

Conclusion: Although the existing methods are mainly reliable to assess evertors strength for healthy populations as well as for patients with a history of LAS, caution needs to be taken in regard to the protocol. Clinicians have to be aware of the parameters that could impact the measurement.

#29_The number of daily calories burned is related to self-reported ankle function in patients with Chronic Ankle Instability

Presenting Author: JI Yeon Choi

Authors & Affiliations: JI Yeon Choi, Colleen M Vogel, Adam B Rosen

University of Nebraska at Omaha, School of Health and Kinesiology, NE, USA

Background: Individuals with Chronic Ankle Instability (CAI) tend to have a higher body mass index (BMI) and decreased physical activity. However, the relationship between self-reported ankle function and daily physical activity behavior is unclear.

Objective(s): To investigate the relationship between self-reported ankle function and daily physical activity in patients with CAI.

Design: Cross-sectional study

Setting: Biomechanics research laboratory

Patients (or Participants): A total of 15 participants with CAI (8 men, 6 women; age=22.4±2.7years, height= 174.2±8.6cm, mass=74.7±17.0kg) participated in this study.

Interventions (or Assessment of Risk Factors): Participants completed baseline testing (range of motion, strength, and functional performance testing) and the Cumberland Ankle Instability Tool (CAIT) questionnaire then had their physical activity tracked (Fitbit Versa 2, Fitbit INC., San Francisco, CA, USA) for 4- weeks.

Main Outcome Measurements: The daily calories burned, steps, distance, floors, minutes sedentary, and minutes performing physical activity (sedentary, light, fairly, and very) were collected and averaged over 7 days. Spearman's rank correlations were used to evaluate the relationship between the CAIT score and the physical activity measures ($p<0.05$).

Results: There was a positive correlation between the calories burned and the CAIT ($\rho=0.576$, $p=0.012$). No other measures of physical activity were significantly correlated with the CAIT (all p-values >0.05).

Conclusion: Our study found that participants who scored less on the CAIT questionnaire, indicating increased symptom severity associated with chronic ankle instability, expended fewer calories compared to those with higher CAIT scores. Fewer daily calories burned in individuals with CAI may help in explaining the increased BMI often seen in individuals with CAI. This may escalate the secondary risk factor of developing cardiovascular diseases and chronic diseases such as diabetes, obesity, hypertension, and osteoarthritis. This suggests that clinicians should consider protocols that emphasize physical activity promotion for patients with CAI to optimize outcomes.

#34_Contemporary practices of clinicians assessing and managing acute ankle syndesmosis injuries

Presenting Author: Brendan Ware

Authors & Affiliations: Brendan Ware[1,2], Claire Hiller[1], Paula Beckenkamp[1], Kathryn Refshauge[1], Katherine Rae[1]

(1) The University of Sydney, Sydney School of Health Sciences - Faculty of Medicine and Health, NSW, Australia

(2) Charles Sturt University, School of Allied Health, Exercise and Sports Sciences - Faculty of Science, NSW, Australia

Background: Syndesmosis injuries without fracture or diastasis on x-ray are commonly misdiagnosed or not considered in primary care, contributing to poorer recovery compared to lateral ankle sprains.

Objective(s): Understand contemporary assessment and initial management practices of primary care clinicians dealing with suspected acute ankle syndesmotic injuries.

Design: An online survey aimed at Australian clinicians was designed and distributed using the Qualtrics platform.

Setting: Clinicians were invited to participate via advertisements distributed by their peak bodies, social media, university musculoskeletal group newsletters and the research groups professional networks. The survey was open from August 2021-July 2022.

Patients (or Participants): Currently practicing Doctors (including Registrars) in Emergency Medicine, General Practice, Orthopaedic Surgery and Sports Medicine, Nurse Practitioners, Physiotherapists and Podiatrists.

Interventions (or Assessment of Risk Factors): No intervention/exposures

Main Outcome Measurements: Participants responded to questions relating to their assessment practices of acute ankle sprains (including syndesmosis sprains) and their capacity to the differentiate types of sprains. Initial management preferences where also explored. Responses included 5-point Likert scales from 'Never' to 'Always', 'Yes/No' and open responses.

Results: 98 clinicians (59 physiotherapists) completed the survey. Where lateral ankle sprain was the preliminary diagnosis, 56% broadened their assessment to evaluate other potential injuries. 41% of respondents believed it was possible to differentiate between types of ankle sprains (lateral, medial, syndesmotic) 'always' or 'most of the time' in the acute stage of injury and 55% believed this was a priority. X-ray was most utilised for suspected syndesmosis injury, but MRI was preferred if cost and access weren't considerations.

Where acute syndesmosis injury was suspected, immobilising the ankle was preferred management by 71% (predominately controlled ankle motion boot). Weight bearing recommendations varied between non (23%), touch (17%), partial (26%) and weight bear as tolerated (44%).

Conclusion: Suspicion of injury and importance of diagnosing syndesmosis injury in acute ankle sprain presentations varies amongst clinicians. Similarly, initial immobilisation and weight bearing instructions also vary.

#37_Use of the lower extremity function scale in acute and non-acute ankle sprains

Presenting Author: Kathryn A Webster

Authors & Affiliations: Kathryn A Webster[1], Kimberly L Mace[2], James Camarinos[3]

(1) Endicott College, School of Sport Science, MA, USA

(2) Mass General Hospital Institute of Health Professions, Health Professions Education, MA, USA

(3) Boston University, Boston University Physical Therapy Center, MA, USA

Background: The prevalence of ankle sprains and potential lasting negative impacts warrant attention for the Patient-Rated Outcomes (PROs) most appropriate to track the impact of treatment and drive clinical decision making for patients with these injuries. The Lower Extremity Functional Scale (LEFS) is commonly used for patients with ankle sprains, but evidence is unclear about its utility for differing types of ankle sprains.

Objective(s): The purpose of this study was to examine the clinical utility of the LEFS in patients with acute ankle sprains (AAS) and non-acute ankle sprains (NAAS).

Design: This was a retrospective, blinded data review.

Setting: Data was analyzed from patient visits to an urban physical therapy clinic in the Northeastern United States.

Patients (or Participants): De-identified data between Jan 2016-Feb 2020 were searched, finding 115 with AAS and 79 with NAAS which were included in the analysis.

Interventions (or Assessment of Risk Factors): Participants completed LEFS questionnaires at the start of their visits to the physical therapy clinic.

Main Outcome Measurements: Independent t-tests were used to assess group differences for LEFS scores, days between clinic visits, total number of visits, and LEFS change over care. Higher LEFS scores indicate greater function, with 80 as the maximum score.

Results: Compared to AAS, NAAS patients had higher LEFS scores at visits 1, 2, 3, and discharge with significantly more patients scoring ≥72/80, precluding clinically meaningful improvements. At discharge, groups were similar in total number of visits and length of care.

Conclusion: From this data, clinicians treating patients with NAAS may have more difficulty detecting meaningful improvements using the LEFS compared to patients with AAS. NAAS and AAS had similar days of care, but the NAAS group was less likely to see meaningful change. Clinicians could face challenges in planning appropriate interventions and documenting meaningful improvements in function, indicating the LEFS may be more appropriate for patients with AAS, compared to NAAS.

Category 3: Imaging and Mechanism

#30_What characterises (video-recorded) lateral ankle joint injuries in indoor and court sports? A systematic video analysis of 445 non-consecutive case series

Presenting Author: Timo Bagehorn

Authors & Affiliations: Timo Bagehorn[1], Mark de Zee[1], Daniel T.P. Fong[2], Kristian Thorborg[3], Uwe G Kersting[4], Filip Gertz Lysdal[5,2]

(1) Aalborg University, Department of Health Science and Technology, Aalborg, Denmark

(2) Loughborough University, School of Sport, Exercise and Health Sciences, Loughborough, UK

(3) Copenhagen University Hospital, Sports Orthopaedic Research Center–Copenhagen (SORC-C), Hvidovre, Denmark

(4) German Sport University Cologne, Institute of Biomechanics and Orthopaedics, Cologne, Germany

(5) Technical University of Denmark, Department of Civil and Mechanical Engineering, Kgs. Lyngby, Denmark

Background: The lateral ankle sprain is the most common injury in indoor and court sports. Self-reports and case-studies have indicated that these injuries can occur via both contact and noncontact injury mechanisms, typically due to excessive inversion. The mechanism of occurrence, and evidence of joint excursion have thus far not been documented via video-analysis in large quantities.

Objective(s): To retrieve and systematically analyse a large number of video-recorded lateral ankle injuries in indoor and court sports.

Design: Descriptive, observational, non-consecutive case series design. Videos containing lateral ankle injuries were systematically retrieved from YouTube, screened, and analysed by two independent, blinded researchers.

Setting: Televised indoor and court sports events.

Patients (or Participants): 396 athletes, hereof 125 females (32%).

Interventions (or Assessment of Risk Factors): Video-recorded lateral ankle injuries.

Main Outcome Measurements: Classification of injury mechanism, location of rollover, and primary and secondary ankle joint distortion motion.

Results: We retrieved 585 video-recorded lateral ankle injuries. 79 duplicates, and 61 videos with no clear view or non-lateral joint excursion, were excluded. 445 injuries were included for analysis, most from basketball (184, 41.3%), volleyball (125, 28.1%) and handball (54, 12.1%). 292 (65.6%) occurred from direct contact, 113 (25.4%) were noncontact, and 31 (7%) indirect-contact injuries. Lateral forefoot (52.8%) and lateral midfoot (40.2%) were the main anchor points around which the distortion took place. Primary distortion motion was mainly inversion (64.7%) followed by internal rotation (32.8%). Secondary distortion motion was mainly internal rotation (47.9%) and inversion (30.3%). Plantar flexion was less often considered a driver for the joint excursion (1.8% and 4.3%).

Conclusion: Two out of three injuries were contact injuries. These were primarily characterised by inversion as the primary distortion motion (72%), followed by internal rotation (26%). The non-contact injuries were evenly distributed between inversion (49%) and internal rotation (48%) as the primary mode of joint excursion. Distortion motion seems related to injury mechanism and anchor point between foot and shoe.

#31_The noncontact lateral ankle sprain injury in indoor and court sports is not just the result of a "bad landing": A systematic video analysis of 145 non-consecutive case series

Presenting Author: Timo Bagehorn

Authors & Affiliations: Timo Bagehorn[1], Mark de Zee[1], Daniel T.P. Fong[2], Kristian Thorborg[3], Uwe G. Kersting[4], Filip Gertz Lysdal[5,2]

(1) Aalborg University, Department of Health Science and Technology, Aalborg, Denmark.

(2)Loughborough University, School of Sport, Exercise and Health Sciences, Loughborough, UK

(3) Copenhagen University Hospital, Sports Orthopaedic Research Center–Copenhagen (SORC-C), Hvidovre, Denmark.

(4) German Sport University Cologne, Institute of Biomechanics and Orthopaedics, Cologne, Germany.

(5) Technical University of Denmark, Department of Civil and Mechanical Engineering, Kgs. Lyngby, Denmark

Background: The noncontact lateral ankle sprain is the most common injury in indoor and court sports. Here, it is predominantly described as occurring via an injury mechanism that typically incites from an initial "bad landing" with the foot in an initially inverted position. Descriptions of the actual foot landing posture prior to an injury has, however, only been documented in few quantitative cases, or simply retrospectively reported by the incurring athletes during prospective trials.

Objective(s): To retrieve and systematically analyse video-recorded injuries to confirm whether the initial foot landing posture prior to an injury is indeed the cause of noncontact lateral ankle sprains.

Design: Observational, non-consecutive case series design. Videos containing noncontact and indirect-contact lateral ankle joint injuries were systematically retrieved from YouTube, screened, and analysed by two independent, blinded researchers.

Setting: Televised indoor and court sports events.

Patients (or Participants): 132 athletes, hereof 51 females (39%)

Interventions (or Assessment of Risk Factors): Video-recorded noncontact lateral ankle sprain injuries.

Main Outcome Measurements: Initial foot landing posture prior to injury occurrence.

Results: We retrieved 585 video-recorded lateral ankle sprain injuries. 79 duplicates, and 61 videos with no clear view or non-lateral joint excursion, were excluded. Of these, 113 (78%) were noncontact injuries and 32 (22%) were indirect-contact injuries. Among the 113 noncontact injuries, 18 (16%) were characterised by initial contact on the lateral side, while 95 (84%) had a medial- or flat landing posture prior to the injury. Among the 32 indirect-contact injuries, 9 (28%) injuries had initial contact on the lateral side, while 23 (72%) had a medial- or flat landing posture.

Conclusion: Contrary to our expectations, most noncontact injuries were not caused by an initial "bad landing" with the foot in an initially inverted position. It is important to concede that the noncontact lateral ankle sprain can indeed occur and progress irrespective of initial foot landing posture. Joint stiffness seems more important than joint position sense.

Category 4: Sensory-Perceptual and Motor-Behavioral (impairments)

#01_Running gait adaptations among adolescent athletes with soft tissue impairments following lateral ankle sprains

Presenting Author: Alexandra F DeJong Lempke

Authors & Affiliations: Alexandra F DeJong Lempke, Kristin E Whitney, William P Meehan III

Boston Children's Hospital, Department of Orthopedics, Division of Sports Medicine, MA, USA

Background: Lateral ankle sprains (LAS) frequently lead to secondary chronic soft tissue impairments, often attributed to biomechanical dysfunction. However, running assessments among adolescents with these impairments are limited.

Objective(s): To compare running biomechanics between adolescents with soft tissue pathologies following LAS (injured) and healthy athletes (controls). We hypothesized injured adolescents would have slower cadence, increased step width, internal rotation, and supinated landing.

Design: Retrospective analysis.

Setting: Hospital-affiliated sports injury prevention center.

Patients (or Participants): Twenty-five adolescents with a history of LAS and current ankle impingement or tendinopathy (23 Females; age: 15±2 years; BMI: 19.5±2.5kg/m2), and 23 controls without a history of LAS (19 Females; age: 15±1 years; BMI: 19.2±2.7kg/m2).

Interventions (or Assessment of Risk Factors): All athletes underwent a running assessment on an instrumented treadmill. Video cameras recorded 2-dimensional sagittal and coronal views to determine foot positioning at initial contact.

Main Outcome Measurements: Foot rotation, step width, contact time, and cadence were compared between groups and limbs (involved, uninvolved ["better" for bilateral cases]) using a multivariate analysis of variance. Foot landing at initial contact (supinated, neutral, pronated) was compared between groups and limbs using a Chi-square analysis.

Results: Injured adolescents had significantly increased step width (F=4.71, p=0.04; Mean Difference with Standard Error [MD]: 1.5[0.7]cm) compared to controls. Injured adolescents had longer contact time (F=4.62, p=0.03; MDgroup: 12[7]ms, MDlimb: 22[11]ms) with more internal foot rotation (F=14.60, p<0.001; MDgroup: 2.2[1.2]°, MDlimb: 4.2[1.3]°) on their involved limb compared to controls and their contralateral limb. There were no significant differences for cadence (F=2.43, p=0.13; MD: 4[3]), nor foot landing (X2=1.28, p=0.53).

Conclusion: We identified spatiotemporal and kinematic differences among adolescents with LAS history that may predispose to secondary soft tissue dysfunction due to loss of stability from ligamentous structures and an overreliance on surrounding myotendinous structures for control. These maladaptations might represent targets for injury prevention and rehabilitation.

#02_Differences in percent change in mean heart rate variability between females with history of lateral ankle sprain and uninjured-matched controls

Presenting Author: Katherine A Bain

Authors & Affiliations: Katherine A Bain[1], Shelby E Baez[2], Kyle B Kosik[3], Matthew C Hoch[3], Johanna M Hoch[3], Nathan F Johnson[4], Phillip A Gribble[3]

(1) Shenandoah University, Division of Physical Therapy, VA, USA

(2) Michigan State, Department of Kinesiology, EMI, USA

(3) University of Kentucky, Department of Athletic Training and Clinical Nutrition, KY, USA

(4) University of Kentucky, Department of Physical Therapy, KY, USA

Background: Heart rate variability (HRV) is a measure of variation in time between heartbeats and is strongly associated with psychological well-being. Self-reported psychological well-being outcomes in conjunction with HRV may serve as a proxy for central nervous system function which could help to better understand stress and general health in individuals with lateral ankle sprain (LAS).

Objective(s): To compare percent change in mean HRV between images of activities of daily living (ADL) and sports-specific activities during a picture imagination task (PIT) between individuals with history of LAS and matched controls. We hypothesized individuals with history of LAS would exhibit worse HRV and poorer scores of psychological well-being compared to controls.

Design: Case-control

Setting: Laboratory

Patients (or Participants): 22 female participants with LAS history (age=24±3years; height=165.1±12.7cm; mass=64.8±17.4kg) and 22 matched controls (age=23±6years; height=165.1±8.6cm; mass=62.5±6.6kg) were enrolled.

Interventions (or Assessment of Risk Factors): Participants completed the Fear Avoidance Beliefs Questionnaire (FABQ), modified Disablement in the Physically Active scale (mDPA), Penn State Worry Questionnaire (PSWQ), Foot and Ankle Disability Index (FADI), and the Tampa Scale of Kinesiophobia (TSK-11), then underwent the PIT. Psychophysiological responses to images were evaluated via a 3-lead ECG set-up to assess measures of HRV.

Main Outcome Measurements: Percent change in HRV and psychological well-being measures.

Results: The LAS group exhibited elevated fear avoidance beliefs and worse quality of life compared to the control group (FABQ-PA, FABQ-Work, mDPA-PSC, and mDPA-Total ($p<0.01$)). No differences were observed on the PSWQ ($p=0.11$) or TSK-11 ($p=0.13$) or in percent change in mean HRV between groups for ADL (g = 0.07 (-0.52, 0.66), $p=0.81$) and sport-specific (g = -0.10, (-0.69, 0.50), $p=0.89$) images.

Conclusion: While results do not support HRV varied between groups, individuals with history of LAS reported increased disablement. Assessment of HRV in this population is a novel approach, with the potential to elucidate connections between objective and subjective outcomes; but more research is needed.

#05_Foot and ankle biomechanical deficits in individuals with a posterior tibialis tendon dysfunction during walking: preliminary findings

Presenting Author: Ahmed Dami

Authors & Affiliations: Ahmed Dami[1], Dominic Chicoine[2,3], Marc Bouchard[4], Phillipe Corbeil[2,3], Vincent Cantin[1], Gabriel Moisan[1,3]

(1) Université du Québec à Trois-Rivières, department of human kinetics, Québec, Canada

(2) Université Laval, Department of Kinesiology, Québec, Canada

(3) Centre for Interdisciplinary Research in Rehabilitation and Social Integration, (CIRRIS), Québec, Canada.

(4) Université Laval, CHU de Québec, Québec, Canada

Background: Posterior tibialis tendon dysfunction (PTTD) is a chronic and degenerative musculoskeletal disorder causing a progressive ankle deformity and arch collapse which alters foot and ankle biomechanics. However, the biomechanical deficits associated with a PTTD need to be better characterized during the stance phase of gait to help guiding clinical recommendations and improving non-operative (conservative) treatment.

Objective(s): The main objective of this study is to determine the differences in foot and ankle kinematics and kinetics between individuals with a PTTD and healthy counterparts during walking.

Design: Multicentric case-control study.

Setting: Gait laboratories of the Groupe de Recherche sur les Affections Neuromusculosquelettiques (Université du Québec à Trois-Rivières, Canada) and Centre interdisciplinaire de recherche en réadaptation et intégration sociale (Laval University, Canada).

Patients (or Participants): Twenty individuals with stage I and II posterior tibialis tendon dysfunction and 20 healthy controls will be recruited based on the Johnson and Strom's classification. At this moment, 19 individuals with a PTTD and 12 controls have been recruited.

Interventions (or Assessment of Risk Factors): Kinematic and kinetic data were respectively recorded using a 3D motion capture system and a force plate embedded in a walkway during five walking trials at a self-selected speed. The Oxford foot model was used and joint moments were calculated using inverse dynamics.

Main Outcome Measurements: Three-dimensional foot and ankle angles and moments.

Results: Preliminary findings demonstrate that individuals with PTTD showed a trend towards greater forefoot dorsiflexion, ankle eversion and foot abduction angles and greater foot and ankle inversion moments during the stance phase.

Conclusion: Kinematic and kinetic alterations observed at the foot and ankle suggest a fallen medial arch and deterioration of foot and ankle dynamic function in individuals with a PTTD.

#07_Coordination among rearfoot, midfoot, and forefoot in individuals with chronic ankle instability and coper during running

Presenting Author: Takahiro Watanbe

Authors & Affiliations: Takahiro Watanbe[1,2], Tomoya Takabayashi[2], Takanori Kikumoto[2], Anthony Alexis santos Laigo[1,2], Takaya Watabe[3], Yudai Kikuchi[1,2], Masayoshi

Kubo[2]

(1) Graduate school, Niigata University of Health and Welfare, Niigata, Japan

(2) Institute for Human Movement and Medical Sciences, Niigata University of Health and Welfare, Niigata, Japan

(3) Section of Rehabilitation, Kanazawa University Hospital, Ishikawa, Japan

Background: Following an initial Lateral Ankle Sprain (LAS), to prevent chronic ankle instability (CAI), it is necessary to clarify the movement pattern of copers without recurrence of LAS. Copers have different rearfoot frontal and midfoot frontal plane coordination compared to the CAI group. However, intra-foot joints are coupled with various planes of motion (i.e., sagittal vs. frontal).

Objective(s): This study examined the intra-foot coordination in different plane couplings to clarify the movement patterns specific to copers.

Design: Cross-sectional study

Setting: Laboratory

Patients (or Participants): Twelve individuals with CAI, 12 copers, and 9 controls were selected following the International Ankle Consortium criteria.

Interventions (or Assessment of Risk Factors): All participants ran on the treadmill at a speed of 12.6km/h with rearfoot strike pattern. The running stance phase was divided into three sub-phases: 1) initial contact, 2) flatfoot and 3) push-off. The coupling angle, a measure of coordination, was calculated and classified into four coordination patterns. The coupling pair was defined as the sagittal plane of the proximal joint and the frontal plane of the distal joint.

Main Outcome Measurements: Proportion of the coordination patterns among three foot segments (rear/mid/frontal) in two planes (frontal/sagittal) during the stance phase of running.

Results: No significant differences were found between the coper group and either the CAI or control group. In the rearfoot sagittal and midfoot frontal plane couple during initial contact phase, the CAI group showed a significant decrease in the proportion of in-phase with proximal dominance compared with the control group (p=0.04). Furthermore, the CAI group showed a significantly increased proportion of anti-phase with proximal dominance compared to the control group (p=0.02).

Conclusion: Intra-foot joints are coupled with various planes of motion during running. The present study suggests that the multiplanar coordination among the rearfoot, midfoot and forefoot is important in clarifying the coper.

#10_Patient-reported ankle instability and cutaneous reflex modulation during gait

Presenting Author: Annalee MH Friedman

Authors & Affiliations: Annalee MH Friedman, Leif P Madsen

Indiana University, Department of Kinesiology, IN, USA

Background: Studies show that individuals with CAI exhibit altered reflexes in the gastrocnemius during the stance phase of the gait cycle following sural nerve stimulation. No studies to date have examined the relationship between these altered reflexes and subjective reports of instability.

Objective(s): To observe cutaneous reflex patterns of the gastrocnemius during gait in neurologically intact adults with varying levels of subjective ankle instability.

Design: Case-Control

Setting: Laboratory

Patients (or Participants): Forty physically active volunteers (12M/28F/age=20.2±1.9yrs/height=66.4±3.6in /weight=141.5±28.4lbs).

Interventions (or Assessment of Risk Factors): Subjects walked on a treadmill at 4km/hr and received random, non-noxious stimulations of the sural nerve at three different time points of the stance phase. Muscle activity of the ipsilateral gastrocnemius was captured using surface electrodes over the medial (MG) and lateral (LG) muscle bellies. Subjects reported perceived levels of instability after each stimulation on a scale of 0 (no instability) to 10 (maximum instability).

Main Outcome Measurements: Data from unstimulated gait cycles were used as control trials to calculate middlelatency reflexes (80-120ms post-stimulation) for the LG and MG. One-sample T-tests were used to identify significant average reflexes at each phase for "Unstable" subjects (average instability of >2/10) and "Stable" subjects (≤2/10).

Results: Different cutaneous reflex modulation patterns were observed between the Stable and Unstable groups despite exhibiting similar muscle activity during unstimulated gait cycles. Specifically, stable subjects reflexively inhibited the LG by -16.33% (95% CI, -27.83 to -4.82) at phase 3 (t(15)=-3.03, p=.009), while no significant reflex was observed at this phase for the unstable group (mean=-6.13%, 95% CI=-15.4 to 3.14, t(23)=-1.37, p=.184).

Conclusion: Individuals who report feelings of instability following sural nerve stimulation exhibit abnormal cutaneous reflex patterns previously observed in individuals with CAI. Failure to reflexively unload the LG throughout the stance phase may act as a biomarker during clinical treatment of ankle instability.

#12_Brain plasticity in patients with lateral ankle sprain and chronic ankle instability: a systematic review

Presenting Author: Alexandre Maricot

Authors & Affiliations: Alexandre Maricot[1], Emilie Dick[1], Annemiek Walravens[1], Bert Pluym[1], Lathouwers Elke[1], Kevin De Pauw[1,2], Jo Verschueren[1], Bart Roelands[1], Romain Meeusen[1], Bruno Tassignon[1]

(1) Human Physiology and Sports Physiotherapy Research Group, Faculty of Physical Education and Physiotherapy, Brussels, Belgium

(2) Brussels Human Robotics Research Center (Brubotics), Faculty of Physical Education and Physiotherapy, Brussels, Belgium

Background: Research investigating lateral ankle sprain (LAS) and CAI has essentially focused on local adaptations. Recently, growing evidence is supporting the hypothesis neural plasticity occurs at both the spinal and cortical levels following (repeated) ligamentous ankle injury. These alterations might explain persisting dysfunctions, an increased injury risk, and the increased probability of developing CAI.

Objective(s): This systematic review synthesizes the literature on brain plasticity following LAS and CAI.

Design: Systematic review

Setting: Not Applicable

Patients (or Participants): LAS and CAI

Interventions (or Assessment of Risk Factors): Not Applicable

Main Outcome Measurements: Functional and structural brain adaptations

Results: Studies eligible for this systematic review investigated the brain with direct outcomes measures in patients with LAS or CAI. The following electronic databases were used for the systematic search from their conception to 19/10/2021: Pubmed, Web of Science, Embase, Scopus, PEDro, The Cochrane Central Registry for Controlled Trials (CENTRAL) and SPORTDiscus. Three authors independently screened 1227 articles from 7 databases using a two-staged process to include 16 studies.

Conclusion: Patients with LAS showed lower superior cerebellar peduncles (white matter microstructure) compared with healthy controls. CAI populations displayed an increased sensitivity of intermediate inhibitory neurons and a decreased sensitivity of excitatory neurons in the corticospinal pathway. They also found more variability in cortical activation in the superior parietal lobe, pre-and postcentral gyrus and the supplementary motor area with lower corticomotor excitability in several lower limb muscles in patients with CAI. Whilst these findings may support the hypothesis of brain plasticity in patients with ligamentous ankle injuries, all studies were retrospective in nature and most used different measurement methods which makes direct comparisons difficult and limits the strength of evidence of this review. Future research should focus on the understanding of the underlying neurophysiological mechanisms.

#17_COP deviation during double leg stance to single leg stance in athletes with chronic ankle instability

Presenting Author: Takanori Kikumoto

Authors & Affiliations: Takanori Kikumoto[1,2], Tomoya Takabayashi[1,2], Masayoshi Kubo[1,2]

(1) Institute for Human Movement and Medical Sciences, Niigata University of Health and Welfare, Niigata, Japan

(2) Niigata University of Health and Welfare, Department of Physical Therapy, Niigata, Japan

Background: The amount of displacement of the center of foot pressure (COP) during postural control is a major clue to identifying ankles at high risk of ankle re-injury and preventing chronic ankle instability (CAI). In particular, the amount of COP displacement after postural translation is likely to be more useful in identifying high-risk individuals by better differentiating them from healthy individuals. Examination of the transitional COP behavior would give us an insight into implement appropriate rehabilitation.

Objective(s): This study aims to evaluate the amount of COP displacement during postural transition and characteristics of responses of those who have chronic ankle instability (CAI) with repeated ankle sprains.

Design: Cross-sectional study

Setting: Laboratory

Patients (or Participants): Nine players with unilateral CAI were selected following the International Ankle Consortium criteria.

Interventions (or Assessment of Risk Factors): All participants performed 10 seconds double-leg stance followed by 20 seconds single-leg stance to examine differences in COP trajectories in the CAI foot and the healthy foot. The participants were instructed to gaze at a point 3 meters away and to keep their hands on their pelvis. Nine trials were conducted in total with a one-minute break in between.

Main Outcome Measurements: The COP path length from the double-leg stance phase to the single-leg stance phase was verified, as well as the medial-lateral and anterior-posterior distances observed in the single-leg stance phase.

Results: The COP path length from the double-leg stance phase to the single-leg stance phase was significantly longer in the CAI foot ($p < 0.05$). The medial-lateral COP phase used in single-leg stance phase was significantly longer for the CAI foot ($P < 0.03$). And, the healthy foot shows significantly longer for the anterior-posterior path length ($P < 0.05$).

Conclusion: CAI shows a different transition behavior than the healthy individuals. Changes in transition behavior in the medial-lateral path length are associated with changes in the anterior-posterior path length.

#19_Drop vertical jump biomechanics in females with chronic ankle instability and ankle sprain copers

Presenting Author: Kaylee R Dixon

Authors & Affiliations: Kaylee R Dixon[1], Stirling C Tonniges[2], Rachel M Koldenhoven[2]

(1) University of New England, College of Osteopathic Medicine, ME, USA

(2) Texas State University, Department of Health and Human Performance, TX, USA

Background: The drop vertical jump (DVJ) simulates landing and propulsion movements in which a lateral ankle sprain (LAS) could occur. Determining motion patterns following LAS that may drive individuals to pre-injury health and activity status (copers) could aid in avoiding CAI.

Objective(s): To compare lower extremity kinematics, kinetics, and surface EMG during a DVJ between individuals with CAI and copers. We hypothesized that individuals with CAI would demonstrate greater ankle inversion and plantarflexion throughout the DVJ.

Design: Case-control

Setting: Laboratory

Patients (or Participants): Thirty (15 CAI, 15 Coper) physically active females volunteered (CAI: age=20.7±2.9 years, mass=66.9±14.1 kg, height=167.9±8.1 cm, # ankle sprains=3.3±1.2; Coper: age=20.5±2.0 years, mass=63.7±8.0 kg, height=166.7±4.4 cm, # ankle sprains=1.4±0.6).

Interventions (or Assessment of Risk Factors): The independent variable was group (Coper, CAI).

Main Outcome Measurements: Participants performed 5 DVJs from a 30-cm box wearing standardized shoes, reflective markers, and EMG sensors. Three-dimensional kinematics and kinetics at the ankle, knee, and hip and EMG for the fibularis longus, tibialis anterior, medial gastrocnemius, and gluteus medius were analyzed for 100-ms pre- and 200-ms post initial contact (IC). Statistical parametric mapping t-tests were used to compare differences between groups and Cohen's d effect sizes were used to determine the magnitude of difference between groups.

Results: No statistically significant differences were identified between groups for kinematics, kinetics, or EMG (P>0.05); however, the CAI group demonstrated greater plantarflexion (mean difference (MD)=7.7º, d=0.80) and decreased knee flexion (MD=8.2º, d=0.77) pre-IC and greater ankle internal rotation (MD=9.1º, d=0.80) for the entire activity. Post-IC, the CAI group demonstrated decreased internal joint moments for ankle dorsiflexion (MD=0.32 Nm/kg, d=1.04) and hip flexion (MD=0.27 Nm/kg, d=1.25).

Conclusion: While not significantly different, individuals with CAI demonstrated greater plantarflexion and ankle internal rotation prior to landing. This position may increase the risk for subsequent sprains and could be a modifiable movement pattern.

#36_A comparison of hip isometric strength in adolescents with and without chronic ankle instability

Presenting Author: Kyle B Kosik

Authors & Affiliations: Kyle B Kosik[1], Katherine Bain[2], Paige Clawson[3], Lauryn Lanzer[4], Phillip A Gribble[1]

(1) University of Kentucky, College of Health Sciences, KY, USA

(2) Shenandoah University, School of Health Professions, VA, USA

(3) University of Kentucky, Department of Orthopedics, KY, USA

(4) Baldwin-Wallace University, Department of Athletics, Department of Athletics, USA

Background: Adults with CAI have been shown to have deficiencies in hip strength compared with un-injured Controls. However, despite CAI often developing early in life, little effort has been made to determine if similar impairments exist in adolescents.

Objective(s): Compare isometric hip peak torque bilaterally between adolescents with and without CAI.

Design: Case-control.

Setting: Research laboratory.

Patients (or Participants): A convenience sample of physically active adolescent volunteers between the ages of 13-17 years were screened according the International Ankle Consortium guidelines, and allocated to either the CAI (n=10) or Un-injured Control (n=22) cohort.

Interventions (or Assessment of Risk Factors): N/A

Main Outcome Measurements: Participants reported for a single testing session. Bilateral hip abduction (ABD) and extension (EXT) isometric strength were assessed using a handheld dynamometer. Both assessments were performed with participants lying on a plinth using published methods for positioning. The CAI participants had a designated involved (INV) and uninvolved (UINV) side, while the limbs of the Un-injured Controls were randomly designated as INV or UINV. The order of testing for ABD and EXT was randomized. The average peak torque obtained from three, 5-second trials was normalized to each participants' body mass (Nm/kg) and compared using 2-way Group by Side repeated measures ANOVA models. In addition, Limb Symmetry Index (LSI) were calculated as (UINV/INV)*100 and compared between groups using independent samples t-tests. Significance was set a priori at $p<0.05$.

Results: The group main effect for isometric EXT peak torque approached statistical significance ($p=0.05$), suggesting CAI participants (1.32±0.42Nm/kg) had lower isometric hip EXT peak torque than un-injured controls (1.82±0.75Nm/kg). No other statistical differences were observed.

Conclusion: Adolescents with CAI had lower hip EXT isometric peak torque on than un-injured controls, but no side effects, LSI, or ABD strength differences. Continued research is needed to identify the deficiencies that develop early in life after an ankle sprain and persist into adulthood.

Category 5: Return-to-Play Decision Making

#33_Return to sport participation and activity limitation following a syndesmosis injury: a systematic review with meta-analysis

Presenting Author: Paula R Beckenkamp

Authors & Affiliations: Paula R Beckenkamp[1], Jane Grayson[1], Justin Sullivan[1], Fereshteh Pourkazemi[1], Kathryn Refshauge[1], Eamonn Delahunt2, Katherine Rae[1], Claire Hiller[1]

(1) The University of Sydney, Faculty of Medicine and Health, NSW, Australia

(2) University College Dublin, School of Public Health, Physiotherapy and Sports Science, Leinster, Ireland

Background: Ankle syndesmosis sprains account for 7% of all ankle ligament injuries and are associated with a lengthy recovery and prolonged disability, impacting participation in sporting activities. The clinical course of return to sport participation and activity limitation has not yet been systematically reviewed.

Objective(s): To identify the clinical course of return to sport participation and activity limitation in people following a syndesmosis injury.

Design: Systematic review with meta-analysis.

Setting: Any setting was included.

Patients (or Participants): People following a syndesmosis injury.

Interventions (or Assessment of Risk Factors): Any intervention was included.

Main Outcome Measurements: Six electronic databases were searched from inception to 14 July 2021. Studies reporting upon time to return to sport or activity limitation were included. Two independent reviewers screened title/abstracts and full-texts, extracted data and assessed the methodological quality of the included studies using the Quality in Prognostic Studies (QUIPS) tool. Where possible, a meta-analysis was conducted (Comprehensive meta-analysis software), otherwise, a qualitative description is presented.

Results: Forty studies were included in the review, and 23 (2,369 participants, mostly athletic populations) were included in the return to sport participation meta-analysis (random effects). On average, it took 47.6 days to return to sport participation (95% confidence interval 25.4-69.9). Five studies presented information on activity limitation using four different scales. The earliest time-point reported was at 18 months (FAOS: mean ± SD, 98.5 ± 1.2), and the latest was at a mean of 5 years post-injury (FADI: 100 ± 10.7, and American Orthopaedic Foot & Ankle Society score: 100 ± 3.3).

Conclusion: The expected time to return to sport participation following a syndesmosis injury is, on average, six weeks. The clinical course of activity limitation is less clear: although most people seem to present a near full recovery by 18 months post-injury, the clinical course prior to 18 months has not been investigated. Early recovery is critical information and should be appropriately investigated with some urgency.

Category 6: Epidemiology, Health Economics, and Socioeconomics

#20_Deltoid, syndesmotic, and multiple ligament ankle sprains in collegiate athletes

Presenting Author: SeokJae Choe

Authors & Affiliations: SeokJae Choe[1], Viktor E Bovbjerg[2], Michael Soucy[1], Michael Fredericson[3], Janet E Simon[4], Cathleen N Brown[1]

(1) Oregon State University, Kinesiology, OR, USA

(2) Oregon State University, Epidemiology, OR, USA

(3) Stanford University, School of Medicine, CA, USA

(4) Ohio University, College of Health Sciences and Professions, OH, USA

Background: While lateral ankle sprains are common, other types occur, with limited information on time-loss (TL) vs. non-time-loss (NTL) status and associated healthcare utilization.

Objective(s): To describe the occurrence of deltoid, syndesmotic, and 'multiple ligament' ankle sprains and associated athletic training services (ATS), physician encounters (PE), and other healthcare utilization stratified by TL and NTL in collegiate student-athletes.

Design: Descriptive epidemiology using de-identified electronic medical records obtained from August 2018-July 2021 within a Division I conference.

Setting: Sport-related injury data.

Patients (or Participants): A total of 732 team seasons (324 men's and 408 women's) among a conference's institutions in all sports from athletes providing authorization.

Interventions (or Assessment of Risk Factors): Acute ankle sprains were identified utilizing Orchard Sports Injury Classification System codes (deltoid, syndesmosis, multiple ligaments), then stratified by time-loss.

Main Outcome Measurements: Frequencies and rates per team season were reported for each type and their associated ATS and presence of PE, prescription medication, test, procedure, and surgical intervention.

Results: From 1540 total sprains, 292 cases were included, with TL-syndesmosis (n=113, 38.7%) being the most frequent, especially within men's sports (n=96/215, 44.7%), followed by TL-deltoid sprain (n=89, 30.5%) representing the most frequent type within women's sports (n=32/77, 41.6%). Football (4.35) and men's soccer (0.80) had the highest sprains per team season. Of 4847 ATS provided, football (65.9) and women's soccer (26.5) had the highest ATS per team season, with TL-syndesmosis in football (46.7) and TL-deltoid in women's gymnastics (18.3) as the greatest. TL-syndesmosis sprain required the greatest number of PE (n=65), medication (n=16), tests (n=63), procedures (n=12), and surgeries (n=7).

Conclusion: Approximately 19% of ankle sprains are to structures other than the lateral ligament complex, particularly in football and men's soccer. These cases take up considerable resources, and clinicians should be prepared to diagnose and manage these complex injuries.

#21_Subsequent lower extremity injury after index lateral ankle sprain in collegiate athletes

Presenting Author: Michael Soucy

Authors & Affiliations: Michael Soucy[1], Viktor E Bovbjerg[2], SeokJae Choe[1], Michael Fredericson[3], Janet E Simon[4], Cathleen N Brown[1]

(1) Oregon State University, Kinesiology, OR, USA

(2) Oregon State University, Epidemiology, OR, USA

(3) Stanford University, School of Medicine, CA, USA

(4) Ohio University, College of Health Sciences and Professions, OH, USA

Background: Previous injury is considered a risk factor for subsequent injury. Lateral ankle sprains (LAS) occur frequently in athletes and may contribute to subsequent lower extremity (LE) injuries, necessitating better rehabilitation interventions.

Objective(s): To report subsequent LE injury occurrence within 12 months in collegiate student athletes in a variety of sports after an index LAS.

Design: Descriptive epidemiology.

Setting: Electronic medical sports injury records from National Collegiate Athletic Association Division I athletes within one conference.

Patients (or Participants): Authorization was provided by 13,354 athletes to use their de-identified injury records.

Interventions (or Assessment of Risk Factors): Athletic trainers (ATs) documented sports-related injuries from August 2016 to July 2021. Across 1086 team-seasons (479 men's and 607 women's), an index LAS was identified based on Orchard Sports Injury Classification codes.

Main Outcome Measurements: The occurrence and frequency of subsequent LE injury, with injury location and type, were documented.

Results: An index LAS occurred in 1399 athletes (813 men, 586 women), with 717 subsequent LE injuries (n=435, 54% in men, and n=282, 48% in women). Most subsequent injuries occurred to the ankle (n=235, 32.8%), knee (n=173, 24.1%), or proximal segment (n=197, 27.5%). Ligament sprain represented 32.9% (n=236), with muscle strain (n=130, 18.1%), and tendinopathy (n=123, 17.2%) next most frequent. Thigh soft tissue injuries represented 32.5% (n=233), with ankle sprains representing 22.9% (n=164).

Conclusion: As a first step toward identifying subsequent

LE injury following an index LAS in collegiate athletes, this sample of diverse sports indicates the ankle is most frequently the subsequent injury, with the thigh and knee also commonly occurring. Ankle ligament sprains and thigh soft tissue injuries occur within 12 months following an index LAS in a substantial portion of collegiate athletes, and additional rehabilitation intervention may be needed. Future research should focus on gender and sport specific subsequent LE injury.

#22_Gender and sport differences in subsequent lateral ankle sprains in collegiate athletes

Presenting Author: Cathleen N Brown

Authors & Affiliations: Cathleen N Brown[1], Viktor E Bovbjerg[2], Michael Soucy[1], SeokJae Choe[1], Michael Fredericson[3], Janet E Simon[4]

(1) Oregon State University, Kinesiology, OR, USA

(2) Oregon State University, Epidemiology, OR, USA

(3) Stanford University, School of Medicine, CA, USA

(4) Ohio University, College of Health Sciences and Professions, OH, USA

Background: Lateral ankle sprain (LAS) frequently recurs in athletes, but the occurrence, timing, and treatment of a subsequent sprain is unclear.

Objective(s): To report index and subsequent LAS occurrence, comparing gender and selected sports. We hypothesized greater subsequent sprain in men.

Design: Descriptive epidemiology.

Setting: National Collegiate Athletic Association Division I athletes' de-identified electronic medical records from a single conference.

Patients (or Participants): Authorization was provided by 13,354 athletes.

Interventions (or Assessment of Risk Factors): Injury records were queried August 2016-July 2021 for LAS occurrence using Orchard Sports Injury Classification System codes, representing 1086 team-seasons (479 men's and 607 women's).

Main Outcome Measurements: An index sprain was the first LAS that occurred. Subsequent LAS to either limb was identified for 0-12 and 13+ month windows, with days to subsequent sprain and associated athletic training services (ATS). Chi-square and Mann-Whitney U tests assessed for group differences ($\alpha<0.05$).

Results: An index sprain occurred in 1399 athletes (813 men, 586 women), with no gender differences in subsequent sprain(s) for 0-12 months (n=144 17.7%; n=82 14.0% respectively; $\chi 2=7.2$, P=0.12) nor for 13+ months (n=73 9.0%; n=71 12.1%; $\chi 2=15.0$ P=0.06). Comparing genders in basketball, soccer, cross country, track and softball/baseball, men had more subsequent sprains for 0-12 (n=67/281 23.8% vs n=63/356 17.7%; $\chi 2=8.6$ P=0.04) but not for 13+ months (n=38/281 13.5% vs n=51/356 14.3% $\chi 2=5.9$ P=0.66). Men had shorter days to subsequent sprain across the entire time period (median, interquartile range [IQR] 173, 56-349 vs 241, 101-448, Z=2.5 P=0.01). Median ATS per sprain (IQR) for index, 0-12, and 13+ months respectively in men were 7.3 (3.5-10.6), 5.6 (1.8-8.2), 6.0 (2.3-9.2), and 9.0 (4.0-18.2), 10.3 (4.0-19.2), and 6.0 (2.0-11.3) in women.

Conclusion: Subsequent LAS occurrences were lower than previously reported, and men may be more affected in the first 12 months. Division I athletes receive substantial treatment, but still suffer subsequent LAS.

#32_Epidemiological patterns of pickleball ankle injuries in the United States, 2012 - 2021

Presenting Author: Jared Duggal

Authors & Affiliations: Jared Duggal, Max Greenky

Syracuse Orthopedic Specialists, Orthopaedic Surgery, New York, USA

Background: Pickleball is a recreational sport that has become the fastest growing sport in the United States. Participation rates by age showed that core participants tend to be older, with 42% of all players over 65. Analysis of pickleball ankle injuries in the The National Electronic Injury Surveillance System (NEISS), a statistically valid representative sample of hospital emergency departments, may help inform ankle injury prevention and fitness goals.

Objective(s): It is hypothesized that pickleball ankle injuries have become more frequent, given the increase in

pickleball participation in the United States. Utilizing the NEISS database were compared and stratified ankle injury incidences based on age and time. Weighted estimates were used to extrapolate the data to the US population.

Design: A cross-sectional descriptive study was performed using 2012 to 2021 data from the NEISS database. Analyses consisted of descriptive statistics, injury frequency, type, age and trends over time.

Setting: De-identified data was obtained from the publicly available U.S. National Electronic Injury Surveillance System.

Patients (or Participants): Variables examined included de-identified treatment date, age, gender, primary diagnosis, disposition and location.

Interventions (or Assessment of Risk Factors): A total of 51 ankle injuries were identified in the database, representing an estimated 5,098 injuries presented to United States Emergency Departments from 2012 to 2021.

Main Outcome Measurements: Pickleball ankle injuries have become more frequent, given the increase in pickleball participation in the United States. An estimated 499 ankle injuries were noted from the period 2012 to 2016, 4599 injuries were estimated from 2017 to 2021.

Results: The average age of pickleball ankle injuries presented to United States Emergency Departments from 2012 to 2021 in the NEISS database was 58.8 years. 64.7% of all ankle injuries recorded from 2012 to 2021 were in patients ≥60 years [22-84]. The leading pickleball-related ankle diagnoses were sprains followed by fractures.

Conclusion: Pickleball-related ankle injuries grew rapidly over the study period and increasingly among active seniors.

Free Communication Abstracts Index

#36_A Comparison of Hip Isometric Strength in Adolescents With and Without Chronic Ankle Instability	4	87
#37_Use of the Lower Extremity Function Scale in acute and non-acute ankle sprains	2	79
#38_Electroacupuncture for the treatment of chronic ankle instability	1	72

SPECIAL THANKS TO OUR SPONSORS!

Silver Member

Medical View Co., Ltd.

Archive Tips Inc.

Miyuki Giken Co., Ltd.

IGAKU-SHOIN Ltd.

Nippon Sigmax Co., Ltd.

We sincerely thank our sponsors for supporting our mission and the organization of the symposium.

9th International Ankle Symposium
Organizing Committee