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Training methods for elite youth climbers: A composite vignette of coaches' awareness, knowledge and practices

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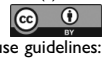
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Abstract

With the exponential growth of indoor climbing competitions, and recent Olympic status, there is an increased pressure on elite youth climbers, training methods, and balancing the dangers of epiphyseal fracture of the phalanges. However, little is known of coach awareness, knowledge, and practices of elite youth climbing training methods. The aim of the study was to explore coaches' current views on current awareness, knowledge, and practice within Elite Youth Climbers training methods. Ten elite climbing coaches with 15 ± 12 years climbing coaching experience participated in semi-structured interviews, lasting 67 ± 20 min, exploring their awareness, knowledge, and practices of youth training with elite climbers. Interviews were analysed using a reflexive thematic approach. Three composite vignettes were created from ten initial lower order themes to provide an insightful and rich account of coaching elite youth climbers. Coaches were aware of epiphyseal fracture risks in youth climbers and had different perspectives on appropriate training methods relative to training age. Coaches lacking in academic knowledge or less experienced working with elite youth climbers were unlikely to use training practices such as system boards, campus boards and finger boards compared to coaches with greater academic knowledge or more experience in the field. All coaches identified a need for updated training guidance in context of increased climbing standards for youth climbers and advances in coach education.

Keywords

Epiphyseal fracture, grip, injury risk, national governing body, phalanges

Reviewer: Nick Draper (University of Canterbury, New Zealand)
Julian Henz (German Sport University Cologne, Germany)

Introduction

The sport of rock climbing, once considered an eccentric activity conducted by a minority, has grown to a billion-euro industry and surpassed previous generations to now reach maturity.[1] Climbing's growth is evident in both the leisure and competitive stage, with its first successful appearance in the Tokyo 2020 Olympic Games.[2] Furthermore, the Paris 2024 Games doubled the allocation of climbing medals acknowledging its inaugural popularity. With its growth, climbing standards and grades have increased along with the popularity of social and elite competitions.[3,4] As climbing standards have increased, the average age of competitors has reduced with adolescent climbers engaging in structured training.[3,4] To provide context, the mean age of the Great Britain Climbing Team at time of enquiry was 17.6 years (±2.7 years) for male climbers (n = 25) and 19.3 years (± 4.1 years) for female climbers (n = 23), with the youngest competitors representing their country at 14 years of age.[5] With the inclusion of climbing within the Olympic Games, a further increase in youth training is expected.[6]

The limited research around youth training in climbing, with a need for increased awareness and progress in this field. The use of climbing specific training tools and practices such as campus boards and overuse of the crimp position have previously led to epiphyseal fractures of the phalanges during peak height velocity.[4,6,7] Therefore, precautionary advice has been given on training methods, volume, and intensity of climbing sessions during growth spurts.[8] Despite the potential for injury, research evidence could further support coaches with specific information on how to support the exponential growth in youth climbing standards and their training needs. There is a range of training tools evident in most public climbing walls but with

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Figure 1. Climbing specific training tools, from left to right: systems board, campus board and finger boards.

limited evidence-based guidance on use or modification for youth climbers to structure effective and safe practices. Figure 1 identifies three common training tools. Systems boards are often used for training steeper, more powerful routes. Campus boards can be used with feet on but traditionally used for explosive moves between rungs with feet off. Finger boards have a variety of hanging protocols intensities from reduced body weight through to weight added. Throughout this study they will be referred to individually or collectively as training boards.

In contrast to what seems a healthy dialogue and growth in climbing specific training methods for adults,[9–11] there is limited supporting guidance for children. A search of literature and organised training courses, looking for specific information to guide youth training methods in climbing resulted in minimal contributions. Therefore, further research is required to understand climbing coaches' views on awareness, knowledge and current practices within youth climbing. This would help to understand current practice within youth climbing, such as tools and techniques which coaches are currently aware of. Furthermore, topics such as training board methods, low and high-risk intensity levels, and overall training volume could be explored to ensure safe practices. Utilising experiential knowledge of experienced coaches can inform empirical research, as well as guide effective practice design.

The supporting material from the National Governing Body for youth training is cautionary due to historic learning of injury risk. The British Mountaineering Council (BMC) advise youth athletes to avoid foot-off or dynamic campusing for under 18's.[12] This is reiterated by Mountain Training's supporting text for coaches and further excludes finger strength training in a child's final growth spurt.[8] The guidance provides appropriate warning and represents the majority of youth climbers, however there is limited literature and research evidence to support elite youth climbers and coaches. The general message is commonplace at most major climbing walls in the UK, with typical exclusion of under 18's in the training areas. This absence of detail can results in ambiguity for coaches and stifles to acknowledge or contribute to the wider discussion of appropriate training for Elite Youth Climbers (EYC), combined with a change in climbing standards with increased popularity of the sport. Furthermore, coach education courses are structured around grass roots and fundamental principles taken from the Long-Term Athlete Development approach,[13] but typically focus on fundamentals and rather than the later stages of training. This does not support coaches with the possibility that EYC will engage in more climbing specific training[7] with further research required.

Guidance for youth climbers to avoid exercises such as foot off campus boarding and reduce overuse of crimping small edges is not unfounded. The explosive movement to small edges was identified as problematic and a leading facture to epiphyseal fracture of the phalanges in young high-level climbers.[14] This injury was first described in the literature in 1997,[15] with a growing body of research in the field to date.[4,6,7,16] In exploring the radiographic changes in the hands of young high-level climbers, research has identified epiphyseal fractures in the fingers of two climbers using campus board training and one climber not using this training method.[14] Further research on adolescent epiphyseal fractures identified several additional trends. For example, boys between 13–16 years were more likely to suffer with epiphyseal fractures associated with greater body weight gains over girls.[6] Furthermore, the boys were performing maximum power training on small edges in the closed crimp position (Figure 2) and combined with campus boarding would lead to a high risk of injury. There were no reports of acute trauma and associated with repetition of

Figure 2. A closed (full) crimp grip which is often stronger than other grips but carries a higher risk of finger injuries.

climbing on small edges which can be found in many forms of climbing and not just campus boards.

Research identifies that epiphyseal fractures are more complex than just campus board training, with increased climbing hours, grade and training to be significant.[3] The closed crimp grip also causes high pressure to the middle phalanx base growth plate as an additional cause.[17] As a reaction to these injuries governing bodies started to provide cautionary guidance.[3,18] The Medical Commission of the International Climbing and Mountaineering Federation (UIAA) recommended a ban on highly intensive boulder competitions,[19] and the BMC published campus board guidance which remains unchanged to date.[12] As a result of this guidance, early intervention has caught injuries sooner and at a more treatable stage.[18] Epiphyseal fractures in the longitudinal work,[7] remarkably healed without consequence, with further supporting evidence that treatment was excellent in 34 cases and good in 3.[17] Early identification is key to treatment, but with increased youth training a possibility in the future, discretion around causation would be advised.

Accessible climbing coach literature has seen a slow shift from historic warnings against physical training and finger boarding with youth climbers.[20,21] Contemporary literature provides more nuances detail of epiphyseal fractures warnings during peak height velocity for youth climbers, and therefore training volume and intensity of sessions including intense bouldering must be monitored during this growth spurt.[8] However, methods to measure peak height velocity and how to monitor training volume lacks supporting evidence. Further literature acknowledges the risk of intense climbing and bouldering during this stage and argue well-controlled deadhangs on a finger board with negative weight would have a lower load and an alternative to some types of climbing.[22] Furthermore, controlled finger strength training with a sensible training program can help reduce the risk of finger injury.[22,23] Importantly this requires a proactive coach to support a range of adapted and progressive training methods to help EYC into a self-directed adult climber.[23]

Despite an increasing growth in the popularity of climbing, there is a relatively slow development of knowledge sharing around youth training. There is an abundance of literature available for adult training with growing trends towards maximal loading of the fingers. For example, heavy weight and low repetitions benefit neurologically, and avoid detrimental weight gain of muscle hypertrophy in a power to weight-based sport.[11] Although these trends support fully grown adult climbers, such methods would be considered high risk for growing teenagers and limited supporting literature is available. With the current volume of discussion around the variety of training methods in general, and the growth of EYC competing at an ever-decreasing age,[3,4] further supportive literature around specialist youth training is needed.

Coaches are integral to provide appropriate and safe practices in guiding youth athletes in their climbing, training, and education, and therefore essential to the research question. Future research aims to support coaches in EYC training methods and open a healthy dialogue to discuss safe methods. This may come through literature, education or policy change, but to support that, research must first explore coaches' awareness, knowledge, and current practices regarding EYC training. Therefore, the aim of the study was to explore coaches' current views on awareness, knowledge, and practice within Elite Youth Climbers training methods. To address this aim, the specific research questions are: i) understand the current awareness of climbing coaches on how youth climbers train; ii) explore how climbing coach knowledge can inform effective and safe training for youth climbers; and iii) explore coach perceptions of current practice activities.

Method

Participants

Ten elite youth climbing coaches were selected for the study (9 male, one female; mean ± SD age: 43 ± 13 years; and climbing coaching experience: 15 ± 12 years). Participants were purposefully selected based on experience working with EYC who have met at least one of three criteria: qualified for the Youth Climbing Series finals,

selection for Great Britain (GB) Climbing, or achieved a minimum elite status on the comparative grading scale.[24] Coaches required a minimum of 12 months experience working with EYC to allow a fair reflection and insight of the coaching experience of those working with elite climbers. Participants were selected nationally to avoid regional bias and via email through either the GB Climbing database, the Mountain Training Performance Coach database, or the researcher's professional contacts. Coaches' backgrounds varied from no formal qualifications through to holding climbing coaching qualification and some with bachelor's degrees in Sport Science, Coaching, or other non-related vocations. Ethical approval was obtained from the lead author's University and participants provided written informed consent.

Procedure

This study was underpinned by a constructionist ontology and relativist epistemology.[25] Semi-structured interviews were used to collect data.[26] To provide some structure to the interviews, an interview guide was created which was divided into five key areas aimed at elite climbing coaches: climbing and coaching history, awareness, knowledge, and practices of youth training methods, and comfort discussing the topic (see supplementary information). The interview guide provided an overall structure, but participants were provided with the freedom to express and expand their comments without interruption. Probing questions were then used to encourage further depth if required. The lead author conducted all interviews and considers themselves a practitioner and a cultural insider to the world of climbing. Within this domain, the lead author has over 20 years of personal climbing and coaching experience and is a provider for Governing Body climbing qualifications and workshops. This provided the interviewer with an historic insight to the growth of youth climbing and coaching pathway. Furthermore, these insights allowed the support of data generation through familiarity of the subject area with probing questions to elicit richer answers from participants.

Data analysis

Interviews lasted for an average of 67 ± 20 min. Interviews were conducted, recorded and transcribed verbatim over Microsoft Teams, and any transcript errors were checked and corrected. All coaches were given the option to partake in a follow up interview and to provide any comments or amendments to their interview within two weeks post interview. One coach requested a second interview to add additional concerns with remote training plans, as a past athlete had just sustained an epiphyseal fracture. A reflexive thematic analysis was used to analyse the data.[27] The first author engaged in familiarisation and immersive analysis, which involved listening to participant interviews whilst walking in 'Green Space' where freedom of thought was provided, and away from office pressures. Transcripts and audio recordings were then coded line-by-line. This involved identifying each salient point in the transcript and considering 'what is the meaning of this statement?' and 'how does it add to our understanding?'. Brief notes or codes were written in the margin next to salient points. These codes were then considered by the research team who worked to make connections between codes (e.g., how do these ideas fit together? How do they extend our understanding? Why do these experiences differ between participants?) in the development of themes. Grouping codes together resulted in the development of ten broad themes, which represent what Braun and Clarke described as topic summaries.[28] Each topic summary provided some insight into the coach experiences, but had yet to include sufficient depth and interpretation. At this point, to enhance the rigour of the analysis, the second and third author acted as critical friends, one from a qualitative background and the other as cultural insider, climbing coach, and academic. This supported researcher accountability and methodological decision making through the analysis process.[28] Their role provided a theoretical sounding board to encourage researcher reflections on subjectivity and provide alternative explanations and interpretations of the analysis as well as adding layers of meaning.[29] Our work debating topic summaries and adding layers of meaning allowed us to develop three final themes which move beyond surface level to consider latent meaning. On completion, the research findings were video recorded in a lay person summary and shared with the participants who were encouraged to provide feedback. In line with contemporary perspectives on rigour in qualitative research, our thematic analysis enhanced rigour in a number of ways. First, we worked as critical friends to debate and consider alternative perspectives at each stage. Second, we engaged with participants through the use of member reflections to gather feedback on the analysis. Third we maintained an audit trail of decisions throughout, to help us consider subjectivity and decision-making processes throughout the analysis.[25]

Rather than present the results as a traditional thematic analysis, composite vignettes were chosen as coaches presented similar viewpoints and data supported an amalgamation of coach experience and voices into a single synthesised narrative rather than individual stories.[30] Composite vignettes are a type of creative analytical practice that illustrate to the reader that stories are based on 'real' events and people. This approach to representing data uses techniques such as characters and monologue to enhance the vibrancy and relatability of results. The vignette should not be read as a series of quotes from multiple people but a single rich narrative[30] provided from 3 decades of insightful coaching and climbing history. This contributes to an accessible and compelling narrative aimed to engage the climbing community, youth athletes, parents and coaches. Creative non-fiction narratives preserve the

words of all participants in a compelling story and have been well used in qualitative research.[30–32] To write the vignettes we decided that each of the three themes should be represented by one vignette to ensure clarity and not over-complicate each vignette with multiple themes. For each vignette, the research team returned to the data and the audit trail of analytical decisions to consider *how* each participant discussed the theme (e.g., language used) and *what* was discussed (e.g., content). Direct quotes from interview transcripts were gathered alongside contextual examples.[30–32] The first author drafted each vignette which was then discussed and edited by the research team. Where possible vignettes were constructed entirely from verbatim quotations with syntax and grammatical errors adjusted. Once edited we also re-visited each vignette to ensure that participants were equally represented (e.g., similar amount of quotations) and that quotations used spanned all participants. We also considered similarities, differences, and insightful features of each participant on the three developed themes. In doing this we held two aims: first, that the vignette should be representative of the data collected and second, that atypical or extreme cases should also be included. We considered it important to acknowledge that atypical or extreme cases may reveal more or richer information, often helping to clarify deeper causes behind a problem.[33] Consequently, our aim in developing the vignette was not to develop one single, finalised interpretation, but to tell a metastory rich in information and depth. In developing the vignettes our aim was to create both resonance and coherence.[34] To do this, each vignette was framed as a conversation from one coach to the reader. We hope that by doing this, the vignettes encourage the reader to 'think with' the coach as they narrate the story.

Findings

The following results present the three vignettes in turn:

1. Bending tradition with the evolution of climbing
2. Playing catch up: coach knowledge and supporting guidance
3. Rewriting the rule book on youth training methods

Bending tradition with the evolution of climbing

Compared to the early days when I first started coaching, climbing culture has changed so much. I remember the anarchy of characters like John Redhead and Johnny Dawes from the 90's when climbing was a pastime activity conducted by a group of outsiders. Then Wolfgang Gullich's ascent of the world's first route given the grade of 9a, 'Action Direct' in 1991 was pivotal. It changed everything and evolved what was considered possible with structural training and campus boarding. Climbers soon became aware and latched on to this strength training method, and with limited guidance so did children. To the surprise of coaches, finger injuries appeared in German youth athletes who started to have epiphyseal fractures. This then influenced caution back in the UK with Governing Body guidance bringing awareness and warning against under 18's campus boarding.

Since then, the growth of indoor climbing and competitions has evolved into a unique discipline and the youth climbing scene has just exploded, adding even greater pressure on high performance. It's funny, indoor climbing used to be seen as a training tool for outdoor climbing, but not anymore. I appreciate it, but I almost see it as a different sport now with the unique coordination and dynamic movement these kids are pulling off. The climbing wall industry and competitions have become so huge in the last 10 years. There are climbing walls in every major city, and you can even live stream all the World Cups!

The indoor climbing population has accelerated quickly into a commercial industry, and other aspects like coaching have struggled to maintain pace. There are some good coaches, but many more climbing walls than there are good coaches. It was awe-inspiring to see indoor climbing in the Olympics for the first time, and Toby Roberts bringing home Team GB's first gold medal. But coaching is infant and now needs to play catch up for what is becoming an early specialisation sport. I see many walls often hiring the strongest 25-year-old as a part-time coach with limited background in physical education or coaching. There is no ill intent here and reminds me of my early days coaching with limited awareness of youth training and coaching knowledge. Climbing walls are just trying to service the talented youth demand.

Frustratingly climbing walls often don't make it easy, as many routes are designed around adult customers and eliminate younger children where they struggle to reach the holds. They cannot access the volume of climbs and movement required and makes me question why we train more in the UK. We end up doing more board and strength work as the kids exhaust the number of attainable routes. It's not just the routes though, you also have athletes and parent motivation to train especially if they do well in a competition. For example, they will compete amongst themselves to be top dog. Most parents are brilliant and supportive, but the occasional pushy parent can be the driving force behind the training aspirations. Frustratingly one parent was constantly asking for a fingerboard program for their 12-year-old son against my advice as his footwork was shocking and at the time more important. They didn't like my restraint against a fingerboard program and ended up going to a different coach. But my most shocking experience was receiving a parental email asking if their daughter needed to go on a diet after a bad result in competition. I asked the parent to take stock and questioned who the climbing is for.

The time reward ratio of coaching is at a tipping point and many youth coaches have aged out or will do soon. The role is totally all-consuming, and it takes over your

entire life. Full-time coaching can be literally working 24 h a day, seven days a week and spending every single weekend at climbing competitions or be at the other end of the phone. All my youth athletes are adults now and I don't feel the desire to sacrifice my work life balance or not being able to give it my all by going back into youth coaching. It's a sad reality and I'm fully aware this will add further pressure for younger less experienced coaches to take the reins of an ever-growing and competitive youth scene.

Playing catch up: coach knowledge and supporting guidance

When I first started coaching children there was nothing, no books or anything really, until Michelle Hurni brought out a children's climbing coaching book in 2003. That's partly where my knowledge built up from and I literally have 3 bookshelves full of climbing literature now. Having the opportunity to shadow or talk with other United Kingdom and international coaches is a pleasure. I chat with many knowledge hungry coaches sharing current practices or discussing the latest podcasts. You have the occasional secretive coach who believes they have the latest training hack, but most are happy to share. Looking back, I was a little defensive in my early years thinking coaches were challenging my knowledge but as I have got older I have realised many coaches are inquisitive and just want to learn. I now see this as an opportunity to go and question what I'm doing and whether I have got ideas or training loads wrong at times.

Nowadays we have this rapid information exchange on the Internet with social media, and I applaud this, but I still wonder if it's the trap of modern times. Having books or academic papers to reference gave me confidence as a coach. I think that's lacking for newer coaches who rely on interpretations of literature and position themselves the second rung down from the gospel of truth. I think it's what a lot of people are missing. They hear information externally and believe it verbatim. Realistically, if they're making a podcast or a good post, they're probably saying stuff in a more extreme manner to make people listen or push a product. Coaches need to be wary and filter out these polarising topics which are trying to create interest and marketing around social media posts.

If possible, I now start from the academic side of things and explore research from inside and outside of climbing. Often, I would find other coaches or podcasts misquoting research, so I now have a small team of informed coaches around me with academic backgrounds, where we can debate research on new training protocols before we implement it with a group of adult athletes. This backs up my coaching and provides confidence. This reminds me of earlier days when I was lacking in knowledge, and the risk outweighed the reward so I would refrain from implementing new training protocols.

The Governing Bodies policy of no under 18's on a campus boarding is basically ******** because it's has to be applicable to the climber. It's effectively a comfort zone avoiding challenging decisions and I'm totally against there being these hard rules. I would have a little more respect for the statement if it included no training or bouldering. I appreciate the concerns around epiphyseal fractures and where the research comes from, but we need to consider the young athletes on their own merits and their training history. I understand the Governing Body is just doing their job, which probably doesn't specifically include youth training. Campus boards along with other training tools can be used in so many ways, it's like saying cars are dangerous, but it's the driver that's dangerous. Although unlikely, I would use a campus board if that's an appropriate activity for that person. Other coaches are cautious and follow the guidance but along with coach education it needs updating. The question is, who would lead that change and has experience using climbing specific training exercises?

Pretending it's not a problem is not the way forward, because this is where athletes are going, and coaching is falling behind. We need to get the A-Team in a room and tell it how it is. Youth training is a topic that demands a lot of caveats and nuance, but the worst thing you could do is draw a red line and bury our heads in the sand. We need expert coaches who are doing this work already, to help produce a manual, educational courses, training camps, and disseminate this down to grassroots. My vision would start with online modules to help eliminate travel and have BMC poster using a traffic light system to educate on safe and straightforward training exercises through to high risk that have knackered really good climbers. I know younger coaches who are screaming out for extra training to support youth athletes. Currently it's at a basic level and there needs to be progression from basic to advanced and finally progress along the Longer-Term Athlete Development model.

Rewriting the rule book on youth training methods

It's got to be context over content, and we need to focus on low hanging fruit first. Many training exercises have been demonised, but it shouldn't be, it just needs to be well directed. We need to accept every child is different and taken on their own merit with consideration to their age, gender, experience, and training history. At the same time, I see why coaches feel vulnerable and cautious by avoiding formal training. This is the right decision if their knowledge is superficial. From my perspective nothing is off the cards and it's just about context. Campus boarding has gone out of vogue as it's a basic movement pattern and not representative of climbing moves. I'm not bothered about the intensity, a strong climber going 1,2,3,4,5 is lower intensity than going on a woody or hard bouldering. However, finger boarding for youth athletes is extremely useful and

important, I see coaches using it to warm up or a rehabilitation exercise prescribed by a physiotherapist. It's about progression and learning, for example, 'No Hangs' with feet on or 'Density' and 'Repeated Hangs'. People think maximal loading, but it doesn't have to be. It provides a static loaded learning tool on how to use different holds rather than being in a dynamic uncalculated situation on the wall, or even aid recruitment issues. Woody's are also an effective training tool and no different to a steep competition boulder. After a robust warm up and with a foot on focus, the kids love it, especially the new Kilter Board.

In contrast remote coaching youth athletes presents its own challenges. Again, context is important, remotely coaching youth athletes is very different between 12 and 17 and maturity considerations are vital. I have seen the consequences of remote training through unattainable programs that are absolutely nails from the start, or even worse, an epiphyseal fracture with an athlete so determined to increase training load against my warnings. Motivated children don't know when to stop and it's impossible to monitor form. You cannot put responsibility on them to absorb information and it's about consistency, time and constant messaging. You cannot trust them to do certain exercises with good form, so therefore you need to see youth athletes in person or every time something changes.

Discussion

The aim of the study was to explore coaches' current views on awareness, knowledge, and practice within Elite Youth Climbers training methods. Interviews with 10 climbing coaches showed that coach awareness and knowledge of EYC training methods varies dependent on experience, education, and formal training. Coaches with either formal education in sport science or strength and conditioning at a bachelor's level, or academically well-read were more confident in using a range of training methods with EYC. This supports the educational profile and development of strength and conditioning coaches in other sports.[35,36] Coaches without relevant academic education in this field and fewer years' experience may be less inclined to use training methods outside of climbing movement. This is potentially influenced by coach education and resources provided by the Governing Body.[12] All coaches were aware of the growth velocity curve which determines the onset of maximal growth spurt,[13] and the need to monitor training levels during this period.[8,36] They identified the high risk of epiphyseal fractures during growth spurts.

The Governing Body guidance evoked a range of responses. Coaches often misquoted the content of guidance to mean no youth training in a variety of contexts regarding campus board, finger board or weight training. This misinformation may come from peer discussion, as research suggests this being the most prominent method of acquiring new knowledge.[37,38] Although peer discussions aid knowledge sharing, it is not unrealistic for coaches to observe or share poor practices or knowledge inaccuracies.[30,39]

Nearly all coaches in the present study felt current governing body guidance was outdated with the exponential growth of climbing walls and advances in EYC. With the development of indoor facilities and modern style of coordination moves in competitions, coaches consider campus boards obsolete with its overly simplistic linear movement pattern, with more complex and appropriate moves found on the climbing wall itself. Coaches felt guidance lacked other high-risk areas of intense bouldering problems with small crimp holds or overall volume and duration of climbing. This can be linked to past epiphyseal fractures research associated with a relatively high level of competitive performance, training several times a week and holds using the crimp grip.[40] Although guidance appears outdated, constant, and consistent messaging about epiphyseal fractures is evident with all coaches aware of the risks. This compliments the request of coach cooperation and education in an attempt to reduce epiphyseal fracture.[14,18,40]

Coaches with appropriate background knowledge and education, facilitate a range of training methods for EYC, and emphasised the importance of context over content. Considerations of growth spurts, training age, training intensity, volume, and overall climbing volume for each athlete was prevalent. This supports the sensitivity of individual differences, abilities and past training experience important to training children.[41] Training boards were used in a diversity of ways by those willing to use them. For example, prescribed rehabilitations protocols from physiotherapists; progressive recruitment hangs in warmups; or skill development in grip positions where the coach can closely observe form from eye level compared to athletes being high up on the wall. There is some supporting literature using these methods with children,[21] however, only a minority of coaches from this study are confident in leading the way.

Research shows a less popular method of coaches acquiring new knowledge comes from academic journals (2%) and books (12%).[28] Some coaches in this study using these methods of acquiring knowledge were more confident in their coaching and happy to justify training methods used with EYC. In contrast, coaches using secondary knowledge sources such as podcasts and peers were often less certain in their approaches. The popularity of open access podcasts is evident,[42] however some climbing podcasts were considered over embellished with attempts to increase interest and listening figures.

It is generally recommended for sports coaches to participate in educational programs and learn more about conditioning.[41] However, coaches in the present study identified that current climbing specific courses were too basic and do not meet coaches or EYC training needs. Furthermore, with the growth of youth climbing standards and pressures of competition and Olympic games, coaches

felt more support is needed. Inadvertently the lack of coach education in youth training could be placing EYC at greater risk, when athletes outgrow their coaches training knowledge. Some coach's athletes in this study sought supplementary coaching which was often provided remotely and often unsupervised due to geographical difficulties. In the strength and conditioning profession, resistance exercises have been agreed safe for youth athletes, but with appropriate design and competent supervision.[41,43,44] It discourages remote training and multiple coaches identified EYC who had been provided remote training plans, where intensity or volume was unattainable and inappropriate. Unfortunately, during the data collection of the study one EYC sustained an epiphyseal fracture due to an intense finger board program which had been prescribed remotely and not supervised.

Currently coaching workshops focus on the LTAD model,[13] with particular attention to FUNdamental movement skills,[45] and Physical Training through Learn to Train stage.[46] Coaches noted the Learn to Train stage was adult focused and lacked proper practical guidance for youth athletes, and in essence ring fenced a comfort zone around the topic. This early intervention and guidance to coaches from governing bodies could be considered relatively successful in protecting youth athletes with clear and consistent messaging about the risk of epiphyseal fractures. However, coaches identified it lacked support for those working with EYC and the development in youth performance and aspirant medallists. It is an exciting time for indoor climbing with developing opportunities for coach education and guidance to support youth athletes, and an opportunity to play catch up.

Drawing parallels, strength and conditioning practitioners may have considerations with youth resistant training. Specifically epiphyseal fractures,[47] and unfounded consequences of weightlifting on linear growth and maturation.[47,48] However, there are many youth benefits to resistant training, so clear guidance is provided in their field to reduce risk of overuse injury and guide best practice.[41] Climbing could also benefit from similar guidance and best practice that meets the advances in youth climbing standards. To stimulate debate and summarise salient points associated with this study, new and contemporary guidance taken from resistance training, climbing text, and epiphyseal research in youth climbers is suggested below,[8,14,18,40,41]

These guidelines suggest that early specialisation should be avoided and children should enjoy a variety of sports that focus on skill development, personal success and having fun.[23] If physical training is explored, both the child and parents should clearly understand the benefits and risks involved,[41] and the demand associated with elite competition. Climbing coaches should attend education training about conditioning, safe practice, recover, physiology of growth development and early injury identification.[41] Risk levels associated with training for EYC, sport specific education should be supported by the Governing Bodies, and not through peer learning between coaches with potential for poor practices and knowledge inaccuracies.[37,38] Higher epiphyseal fractures risk categories should be identified and commonly associated with: adolescent boys during growth spurts; maximum power training on small edges; increased climbing hours, grade, and training; overuse of closed crimps; high intensity bouldering; and chronic injuries are more common over an acute injury.[14,18,40] Coaches therefore need to be competent to supervise training sessions with focus on good technical form, and monitor tolerance to exercise stress.[41] Coaches should differentiate exercises specific to individual needs with light load that increase gradually as strength improves and monitor finger strength training closely,[8] whilst managing training during the final growth spurt.[8,23]

Experienced coaches from this study discussed all-consuming pressure and time commitments of EYC and the need to find a better work life balance. Many had already or were planning to step away from the role and acknowledging a greater pressure on less experienced coaches and a need for developments in coach education. There felt a need to nurture and support younger coaches who are often recruited because of their climbing ability over their coaching background. Coaches with an academic background showed confidence in their coaching, but a higher education pathway for youth coaches is unrealistic for many part-time position and alongside other working commitments. Youth coaching is relatively young in a fast-expanding industry and provides opportunities to develop coach awareness, knowledge, and guidance around youth training methods further. A limitation of the current study is retrospective discussion on current practice, and future studies could observe live practice sessions and interview coaches and climbers to further understand youth training methods. Future research could also develop collaboration with National Governing Bodies to ensure contemporary coaching practice aligns with evidence-based coach education and resources. Future knowledge sharing pathways should be forged through novel coach education situated around the needs to complement EYC and mentoring opportunities from those working at the upper end. With climbing now firmly poised in the Olympic Games increased athlete and coach pressure can be expected.

In conclusion, coaches in this study are aware of the risks associated with campus board training and other intense forms of training and bouldering for youth climbers during the peak height velocity curve. Those coaches with a higher level of academic knowledge were confident in facilitating a range of youth training practices, whereas those with less knowledge and experience would remain cautious and refrain from using some methods. Coaches identified the risk of unsupervised remote coaching, highlighting the need for clear guidance, coach educating and mentoring to support local coaches in facilitating and supervising training. With the high demand placed on youth coaching,

some were approached and unable to provide their time and a limitation of the study. Future work needs to build on this research, for example, focus groups and case studies exploring successful EYC and its coaching practices. This should include international coaches and how their Governing Bodies and coach education support EYC.

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Ethical considerations

Ethics Review Committee at University of Chichester approved our interviews (approval: 2324-0103119) on October 26th 2023. Respondents gave written consent for review and signature before starting interviews.

Consent to participate

Participants provided written informed consent to take part and be recorded in the study.

Consent for publication

Within the written informed consent participants agreed to the research output being publicly available using anonymised data.

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Data availability

The interview guide is provided as supplementary material.

Supplemental material

Supplemental material for this article is available online.

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