

Institution: Cardiff Metropolitan University		
Unit of Assessment: UOA24: Sport and Exercise Sciences, Leisure and Tourism		
Title of case study: Youth Physical Development: Improving health and fitness and reducing injury risk in youth sport.		
Period when the underpinning research was undertaken: 2011-2020		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
Prof Rhodri Lloyd	Professor of Paediatric Strength and Conditioning	August 2012 - present
Prof Jon Oliver	Professor of Applied Paediatric Exercise Science	August 2006 - present
Period when the claimed impact occurred: 2014 - 2020		
Is this case study continued from a case study submitted in 2014? No		
1. Summary of the impact (indicative maximum 100 words)		
<p>Lloyd and Oliver's research into the long-term athletic development of children and adolescents has informed policy and practice nationally and internationally. Nationally it has underpinned the development and delivery of industry-leading coach education and athlete development programmes spanning National Governing Bodies and professional sports. Internationally it has informed guidelines on youth resistance training and long-term athletic development for organisations such as the American Academy of Pediatrics and the National Strength and Conditioning Association. It has also been integral to the development of a textbook to underpin the American College of Sports Medicine's Youth Fitness specialist certification, the largest certification programme of its kind in the world.</p>		
2. Underpinning research (indicative maximum 500 words)		
<p>Over the last 10 years, researchers from Cardiff Metropolitan University have been at the forefront of research examining the physical development of children and adolescents and the interaction between training, growth and maturation. The research examines the role of growth and maturation on the development of physical fitness and the reduction of injury risk in youth populations. Collaborations with national and international associations, National Governing Bodies (NGBs) of sports, schools, and professional sports clubs have been central to the programme of research and body of empirical research, narrative reviews, and position statements that underpin this impact case study. Collectively, the research has directly influenced policy and practice and stimulated subsequent scientific enquiry.</p> <p>The importance of incorporating the interaction of growth, maturation and training to optimise the trainability of youth was initially signalled by the publication of the Long-term Athlete Development (LTAD) model by Istvan Balyi and colleagues in 2004. While the LTAD model was quickly popularised among leading NGBs in the UK and abroad, a seminal review published by Lloyd and Oliver in 2011, challenged the scientific underpinnings of the model [R1]. Specifically, the theory of "windows of opportunity", in which children must target specific modes of training at particular stages of development, or risk not reaching their full athletic potential, and the need to accumulate 10,000 hours of extensive training. Nearly a decade later, this review remains the fourth most read paper of all time in the <i>Journal of Sports Sciences</i> (>68,971 reads), was republished in the journal's 30th Anniversary Edition of ground-breaking research, and was instrumental in initiating debate among researchers and practitioners as to the most appropriate training approaches for youth.</p>		

Following the review, **Lloyd** and **Oliver** published the **Youth Physical Development model** [R2], an alternative model of training, which unlike its predecessor, was based upon a large body of empirical research. The central tenets of the model were that: children and adolescents are able to realise meaningful improvements in a range of fitness components, irrespective of their stage of maturation; exposure to developmentally appropriate training including muscle strengthening activities should start in early childhood; and, training structure should increase over time. Since its publication in 2012, the manuscript remains the *Strength and Conditioning Journal's* second most read and second most downloaded paper of all time. Subsequent research by **Lloyd** and **Oliver**, including that which examined interactions between maturity status and training responsiveness in children and adolescents, provided further empirical support for the **Youth Physical Development model** [R3, R4]. This research also proposed the concept of "synergistic adaptation" which reflects the benefits of complementing training stimuli with the adaptive processes experienced as part of natural development. This concept has received >60 citations within the field of paediatrics and was acknowledged in the annual review of the *Pediatric Exercise Science* journal as one of the leading findings in the field of paediatric neuromuscular physiology and training for the year 2018.

In a sizeable body of subsequent research, **Lloyd** and **Oliver** also examined the influence of maturation on key risk factors of lower limb injury. Research part-funded by the Union of European Football Associations (UEFA) and *Fédération Internationale de Football Association* (FIFA) revealed how neuromuscular control is altered as a result of fatigue in young female soccer players at different stages of maturity [R5]. These findings have helped inform maturity-specific injury prevention programmes and fed into the UEFA B Licence Coach Education Programme. More recent research with Premier League soccer academies into the influence of maturation and neuromuscular function on injury risk in young male players identified a number of factors associated with injury risk in this population [R6].

3. References to the research (indicative maximum of six references)

All of the outputs listed below were published in international peer-reviewed journals within the fields of sport medicine and sport and exercise science. [R1], [R2] and [R4] remain in the top 5% of all research outputs scored by Altmetric©. The research reported in [R5] was an output from UEFA-awarded funded research (€20,000). In combination with the other publications, the collection of works helped provide the rationale for two European-funded PhD studentships in collaboration with Sport Wales and Wales Golf (£144,000 total), a FIFA-awarded research grant (\$20,000), research funding from the Waterloo Foundation (£55,000), and an international collaborative grant from the National Strength and Conditioning Association (\$50,000).

[R1] Ford, P.A., De Ste Croix, M.B.A., **Lloyd, R.S.**, Meyers, R., Moosavi, M., **Oliver, J.**, Till, K. and Williams, C.A. (2011). The Long-Term Athlete Development model: Physiological evidence and application. *Journal of Sports Sciences* 29(4), 389-402, DOI: 10.1080/02640414.2010.536849

[R2] **Lloyd, R.S.** and **Oliver, J.L.** (2012). The Youth Physical Development model: A new approach to long-term athletic development. *Strength and Conditioning Journal* 34(3), 61-72, DOI: 10.1519/SSC.0b013e31825760ea

[R3] **Lloyd, R.S.**, Radnor, J.M., De Ste Croix, M.B.A., Cronin, J.B. and **Oliver, J.L.** (2016). Changes in sprint and jump performance after traditional, plyometric, and combined resistance training in male youth pre- and post-peak height velocity. *Journal of Strength and Conditioning Research* 30(5), 1239-1247, DOI: 10.1519/JSC.0000000000001216

[R4] Meylan, C.P., Cronin, J.B., **Oliver, J.L.**, Hopkins, W.G. and Contreras, B. (2014). The effect of maturation on adaptations to strength training and detraining in 11-15-year-olds.

Scandinavian Journal of Medicine and Science in Sports 24(3), e156-164, DOI: 10.1111/sms.12128

[R5] De Ste Croix, M., Priestley, A.M., **Lloyd, R.S.**, and **Oliver, J.L.** (2015). ACL injury risk in elite female youth soccer: Changes in neuromuscular control of the knee following soccer-specific fatigue. *Scandinavian Journal of Medicine and Science in Sport* 25(5), e531-e538, DOI: 10.1111/sms.12355

[R6] Read, P., **Oliver, J.L.**, De Ste Croix, M.B.A., Myer, G.D. and **Lloyd, R.S.** (2018). A prospective investigation to evaluate risk factors for lower extremity injury risk in male youth soccer players. *Scandinavian Journal of Medicine and Science in Sport* 28(3), 1244-1251, DOI: 10.1111/sms.13013

4. Details of the impact (indicative maximum 750 words)

The influence of the research into the long-term athletic development of children and adolescents has been evidenced nationally and internationally through its impact on athlete certification and coach education programmes, and change to policy and practice:

1) The most prestigious and far reaching evidence of international impact comes from **Lloyd and Oliver** being invited to co-author a seminal text for the American College of Sports Medicine (ACSM); *The Essentials of Youth Fitness* [E1a]. Published by Human Kinetics in late 2019, and heavily influenced by **Lloyd and Oliver's** research and the **Youth Physical Development model**, the textbook serves as the core text for the ACSM Youth Fitness Specialist certification programme, **the first ever globally recognised youth training qualification** [E1b]. In addition, based on the content of the textbook Human Kinetics have developed a suite of continuing education materials (including an exam) that are accessible via their online platform [E1c].

2) Since its publication in 2012, the Youth Physical Development model **has been credited as "having one of the biggest impacts on how conditioning staff develop players in Premier League football academies"** (Premier League Head of Sport Science) [E2a]. In football alone, its sphere of influence has extended across all levels of competition (i.e. from grassroots to international), influencing athletic development programmes and coach education curricula both nationally (e.g. Premier League) and internationally (e.g. USA Soccer) [E2b]. This impact has been mirrored in other sports and extended to informing the professional practice and development pathways of sporting organisations around the world (e.g., Swim England, English Institute of Sport, Cleveland Indians Major League Baseball) [E2c].

3) The research is also central to the Sports Coach UK (now UK Coaching) **"How to Coach the Fundamentals of Movement" workshop**, which was also adopted by Sport Scotland and delivered to coaches and teachers across all youth sports throughout the UK [E3a]. Similarly, the Youth Physical Development model is **integral to the Level 2 Award in Multi-Skills Development in Sport**, designed by 1st4Sport Qualifications in collaboration with UK Coaching [E3b]. Since its launch in 2017, **4051** coaches have completed this award. In addition, bespoke resources drawing upon our research have been developed for Great British Cycling and Welsh Athletics to provide continuing professional development for coaches working with youth athletes [E3c]. Since their launch in the summer of 2016 and early 2017 respectively, **1830** delegates have attended the UK Coaching workshop while **232** coaches and athletes have attended the Welsh Athletics equivalent. The impact of the **UK Coaching and Welsh Athletics workshops have also been integral to the procurement of two Knowledge Economy Skills Scholarships funded PhD studentships** (circa £144,000) in partnership with Sports Wales and Wales Golf. The former will investigate the effects of an athletic motor skills training intervention delivered across Wales on the physical, psychological and sociological development of secondary school-aged youth, while the second project will examine the effectiveness of strength and conditioning on golf swing performance in youth golfers.

4) Our research has also helped shape professional practice through the publication of consensus and position statements. In 2014, **Lloyd** and **Oliver** co-authored the International position statement on youth resistance training. Endorsed by **ten of the world-leading professional organisations from the fields of sports medicine, exercise science and paediatrics** (e.g. American Academy of Pediatrics, American Medical Society for Sports Medicine, Federation of Sports Medicine, Faculty of Sport and Exercise Medicine), it led **the American Academy of Pediatrics to change their policy on youth resistance training** [E4a]. In 2015, **Lloyd** and **Oliver** were also invited by the National Strength and Conditioning Association to co-author the inaugural position statement on long-term athletic development, the **first position statement ever published on the topic** [E4b]. Despite only being published in June 2016 it has already become the second most read article on the journal's website, is in the top 5% of all research outputs scored by Altmetric® and has been cited on more than 150 occasions. These position statements also inform the guidelines forwarded in the ACSM *Essentials of Youth Fitness* textbook. Significantly, the **guidelines within the position statement have already been adopted by USA Ice Hockey, USA Soccer and USA American Football**, to help inform policy and practice for the respective athlete development pathways. Recently, the Aspen Institute *Project Play* identified that cumulatively, these sports attract more than 4.5 million child participants per year.

5. Sources to corroborate the impact (indicative maximum of 10 references)

Linked to the four areas identified in the previous section:

[E1] a) Faigenbaum, A.D., **Lloyd, R.S.** and **Oliver, J.L.** (2019). *American College of Sports Medicine Essentials of Youth Fitness*. Human Kinetics.

<https://uk.humankinetics.com/products/essentials-of-youth-fitness?variant=29902650802251>

Number of book sales since January 2020: 561

b) American College of Sports Medicine “Youth Fitness Specialist” certification contract. This demonstrates that **Lloyd** and **Oliver** were contracted to develop a certification and suite of supporting materials that will form the basis of a global certification.

c) Human Kinetics Essentials of Youth Fitness continuing education exam. This exam is based on the content of the ACSM Essentials of Youth Fitness Textbook and was created by Human Kinetics independently of **Lloyd** and **Oliver**.

<https://uk.humankinetics.com/products/Essentials-of-Youth-Fitness-With-CE-Exam?variant=31523495116875>

Number of CE examinations completed since January 2020: 151

[E2] a) Letter from Head of Sport Science, Premier League. This letter identifies the large-scale impact the Youth Physical Development model has had on changing the delivery of conditioning support to elite academy football players.

b) USA Soccer resources, which include a book commissioned by US Soccer and a workshop delivered by US Soccer that features the youth physical development model, and a letter from Senior Manager of High Performance Operations at US Soccer, confirming the influence of the Youth Physical Development model on changing practice in the US Soccer system.

c) Materials created and delivered by Swim England, English Institute of Sport and Cleveland Indians to provide professional development for coaches working in the physical preparation of young athletes.

[E3] a) SportsCoach UK (now UK Coaching) and Sport Scotland workshop booklet, letter of support and workshop material (available at

<https://www.ukcoaching.org/resources/topics/videos/youth-physical-development-model>

The booklet provides evidence our research underpins the workshop, also confirmed in the video. The letter of support from Coaching Children Lead provides further evidence from SportsCoach UK. More evidence available at <http://www.ukcoaching.org/site-tools/workshops/about-our-workshops/how-coach-fundamentals-movement>

Number of workshops delivered: 122

Number of coaches that completed the workshops: 1830

b) Qualification specification for the Level 2 Award in Multi-Skills Development in Sport designed by 1st4Sport Qualifications in partnership with UK Coaching. The qualification specification is available at <https://www.1st4sportqualifications.com/wp-content/uploads/2017/10/L2-Award-in-Multi-Skills-Development-in-Sport-QS-V2-011117.pdf>

Number of coaches that completed workshop: 4051

c) Welsh Athletics workshop booklet and letter of support. The booklet demonstrates that the continuing professional development of Welsh Athletics coaches is underpinned by **Lloyd and Oliver's** research. The letter of acknowledgement from the Track Coach Development Manager, on behalf of Welsh Athletics outlines the impact the research has had on the association and its practitioners. Evidence of the resources being used by the organisation can be found at <https://www.welshathletics.org/en/page/coaching-resources>

Number of coaches and athletes that completed the workshops: 232

Number of coaches in receipt of coach education resource: 343

[E4] a) **Lloyd, R.S.,, Oliver, J.L., et al.** (2014). Position statement on youth resistance training: The 2014 International consensus. *British Journal of Sports Medicine* 48(7): 498-505, DOI: 10.1136/bjsports-2013-092952 **Number of citations: [Scopus citations = 167]**

b) **Lloyd, R.S. ,....., Oliver, J.L.** (2016). National Strength and Conditioning Association position statement on long-term athletic development. *Journal of Strength and Conditioning Research* 30(6): 1491-1509, DOI: 10.1519/JSC.0000000000001387 **Number of citations: [Scopus citations = 86]**