ANALYSIS OF BASKETBALL ENGLAND'S

HOME-BASED 8-WEEK ATHLETIC DEVELOPMENT PROGRAMME

DURING THE 2020 NATIONWIDE LOCKDOWN

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SUMMARY OF FINDINGS

The findings of this research project provide important information to shape the youth athletic development practices of youth basketball players in the UK. The main findings include:

- Mature players display greater control in the single leg squat that less mature players. Similarly, mature players displayed better jumping ability than less mature players.

- In the overhead squat movement pattern, stage of maturation was not found to be a factor differentiating performance. Across all stages of maturation, youth basketball players displayed difficulty in maintaining the overhead arm position, and in attaining full flexion of the hip, knee, and ankle joints.

- The 8-week athletic development programme showed some improvement in movement control in the single leg squat and hamstring bridge test for strength endurance. There were significant improvements found for single leg squat performance on the left leg in response to the training programme.

- The programme was found to be successful, overall. Individual case studies showed substantial improvements in test scores in response to the 8-week training period.

- Results from the post-programme survey suggested that goal setting may have improved player motivation levels and increased the effectiveness of the programme.

- Future projects should consider how best to engage players, parents, and coaches to increase levels of motivation and programme compliance.

The findings of this project have implications for the content and implementation strategy of Basketball England's neuromuscular training-based warm-up that is currently being developed. In addition, these findings provide strong justification for the development of movement control in youth players, not only to reduce risk factors for injury, but to develop movement skills and prepare them for more advanced strength and conditioning-based training.

INTRODUCTION

In 2020, following the announcement of a nationwide lockdown in response to the COVID-19 global pandemic, the Basketball England Sports Science and Medicine Team devised an 8-week athletic development training programme for youth basketball players to develop foundational movement skills and physical fitness qualities. In addition, the programme aimed to reduce risk factors for injury in basketball by targeting balance, stability, and non-basketball specific movement skills.

Alongside publication of the programme, a research element provided the opportunity for players across the basketball community to submit home-administered test results to be used for data analysis. This research would be used to inform the England Development Plan (EDP) relating to the Physically Robust Pillar.

RESEARCH RATIONALE

Non-sports specific movement skills that are considered important in the development of a broad spectrum of movement. Importantly, youth-athletic development related research suggests that non-sports specific movement skills should be developed during childhood and across all stages of maturation. Developing movement skills provides foundations that can be continually built upon as young individuals grow and mature. In addition, the development of diverse movement skills is thought to offset issues relating to repetitive loading of muscle, tendon, and ligament structures. This contrasts with early single sport specialisation, which places emphasis on sports-specific movement patterns and is related to increased risk of injury and burnout. Furthermore, during periods of accelerated growth and after the occurrence of PHV, coordination of movement can become temporarily affected. This is termed adolescent awkwardness and is thought to be linked with a heightened risk of injury. To combat these effects, non-sports specific movement skill development can help to restore coordination of balance and movement control.

In players that have gone through their growth spurt, substantial changes in height, body mass, and muscle strength create challenges for these young individuals. In females, changes to body mass are not accompanied with the proportional increases in strength found to occur in males. This difference accounts for females having a greater risk of injury to the knee joint. In males, the increases in muscle force can also mask deficits in movement control that may present different risk factors for injury. Therefore, movement skills of a non-sports specific nature are understood to be important in the enhancement of movement control and neuromuscular function in the adolescent player. Moreover, many of the non-sports specific patterns typically included in neuromuscular training programmes form the foundations for strength training using external resistance. For example, in DiSE (Diploma in Sporting Excellence) institutions, where strength and conditioning (S&C) training forms an integral part of the training programme, possessing competency in these skills enables S&C practitioners to advance players' training in a more time effective manner, creating a larger window of opportunity for physical development across the two-year period of the diploma.

Although there is good evidence within the scientific literature to support the implementation of non-specific movement skills and general neuromuscular training programmes in youth sports practices, there is limited research relating to youth basketball players in the UK. The purpose of this research was to examine the effects

of an 8-week home-based athletic development programme on the movement control and neuromuscular performance in youth basketball players in the UK.

RESEARCH DESIGN

After the initial programme launch in June 2020, there were 476 responses from parents providing online consent along with child assent for their children to take part in the research. After the initial responses, 312 players' parents had provided test data and video footage to be used in the research. However, from this, 193 met the test protocol requirements to be included in the research. At the end of the 8-week period, there were responses from 52 parents who provided post-programme test data. However, based upon the inclusion criteria, the final number of participants included in the final analysis of the 8-week programme was 28.

Therefore, to maximise the value of the data collected, two approaches were adopted: 1. A cross-sectional approach was used to analyse the pre-programme test data submitted for the 193 players. The cross-sectional analysis is useful for providing information of a group from single moment in time, which in this case was deemed of value to establish trends in the data based upon the players stages of maturation (pre-, within-, and post-peak height velocity (PHV); and approach 2. A comparison of pre-programme and post-programme test data to assess the effectiveness of the 8-week home-based programme. The data analysis was undertaken by two undergraduate students, Zachary Churn, and Grace Gunn, supervised by interim head of strength and conditioning at Basketball England, and principal-researcher in this project, Mark Williams.

Upon completion of the analysis, individual reports were sent to player's parents displaying pre- and post-programme test scores. In addition, a survey relating to motivation and enjoyment was sent parents for players to complete. These responses of the completed surveys were analysed and included in the results.

MAIN FINDINGS

From the 312 players that submitted test results, a total of 100 players were from Basketball England's Aspire programmes, 18 players reported that they had England representative honours, five stated that they were Welsh junior level representatives, and 26 reported that they were Great Britain junior representatives (this number included players who were home nations representatives).

CROSS-SECTIONAL ANALYSIS

From the 193 players that were included in the cross-sectional study, 121 were male and 72 were female.

Only six males met the inclusion criteria for all the included tests (countermovement jump, overhead squat, and single leg squat) and therefore, analysis was carried out on each test separately, based upon maturation status. From the male cohort, the overhead squat group consisted of 55 youth male basketball players (20 pre-PHV, 16 circa-PHV, and 19 post-PHV). The single leg squat group consisted of 36 male youth basketball players (11 pre-PHV, 13 circa-PHV, and 12 post-PHV). Countermovement jump group consisted of 28 youth basketball players (17 pre-PHV, and 11 post-PHV). There was a statistically significant effect of maturation on single leg squat performance (Figure 1), with the pre-PHV and circa-PHV scores being worse than the post-PHV group. However, there was no significant difference between the pre-PHV and the circa-PHV group.

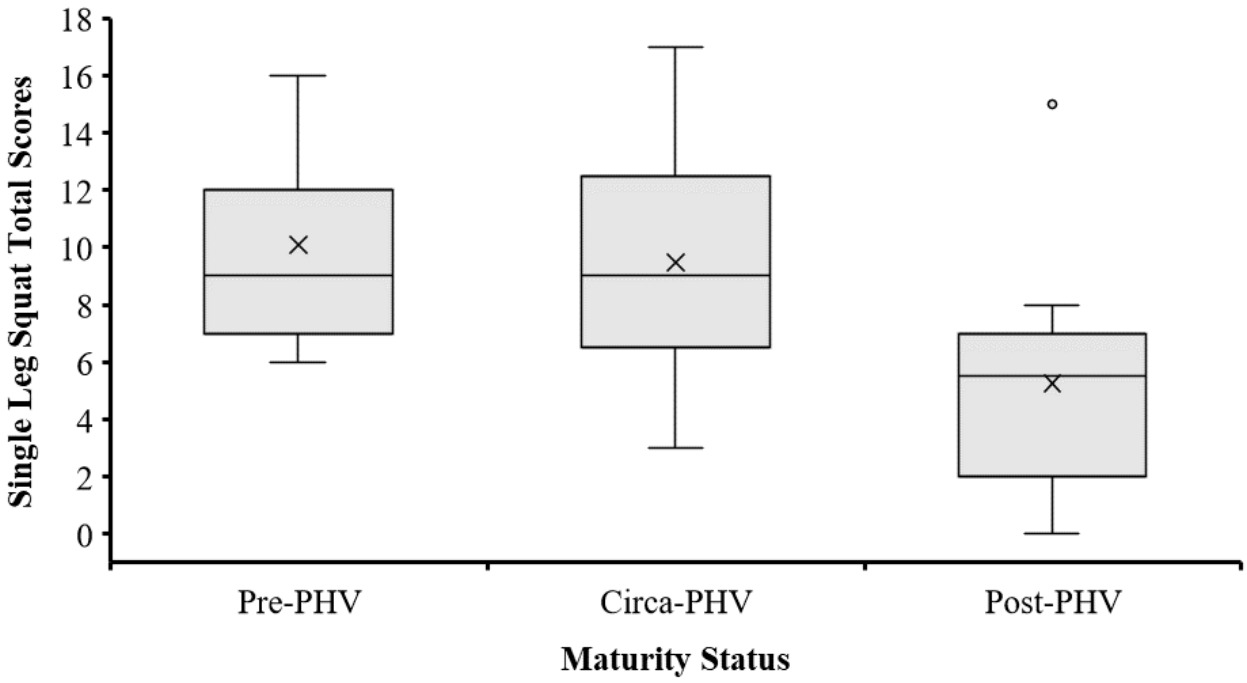
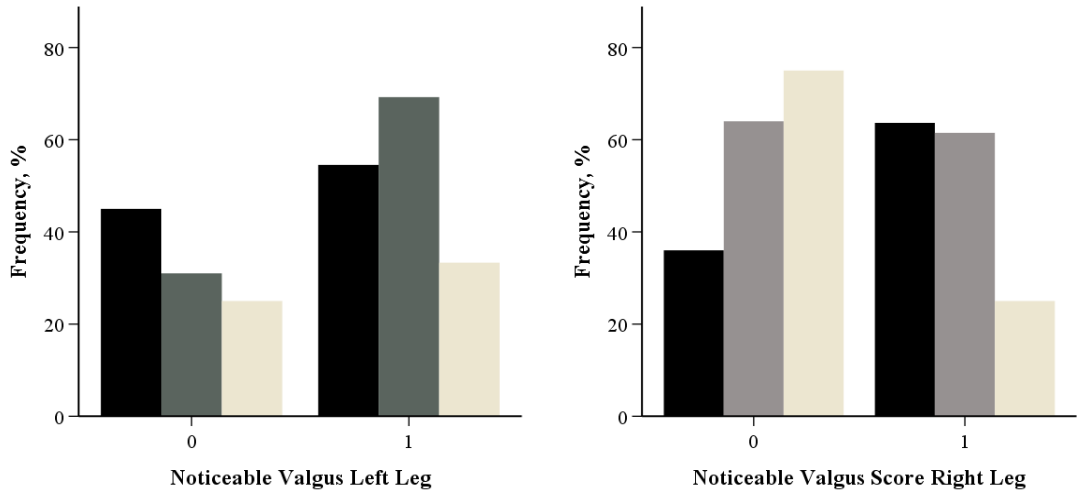


Figure 1. Single leg scores across stages of maturation for male players. A higher score indicates worse performance of the squat in terms of movement control.

Further analysis of the single leg squat revealed that knee valgus (the inward movement of the knee) occurred more frequently on the left limb compared to that displayed on the right (Figures 2.). Furthermore, this occurrence was more frequent in the circa-PHV, with the lowest frequency occurring in the post-PHV group.



Figures 2. Noticeable display of knee valgus during performance of the single leg squat for left and right limbs. (0 = no noticeable valgus; 1 = noticeable valgus). Black shaded columns represent pre-PHV; Gray shaded columns represent circa-PHV; light shaded columns represent post-PHV.

Regarding the overhead squat assessment, there was no significant effect of maturation on performance for pre-, circa- and post-PHV groups (Figure 4.). The upper body scores were similar for pre-, circa- and post-PHV. The triple flexion scores for the hip, knee, and ankle joints were similar for pre-, circa- and post-PHV. The hip control scores were similar for pre-, circa- and post-PHV. The results of the countermovement jump revealed a significant difference height between the pre-PHV and post-PHV groups (Table 1).

In the female players, analysis based on stage of maturation was not possible due to a disproportionate number of participants estimated as being post-PHV, with only a small number estimated as being circa-PHV, and no participants estimated as being pre-PHV. However, descriptive data for the females post-PHV group demonstrated similar overhead squat scores to that of the post-PHV. That is, they displayed good overall pelvis control; however, they tended to display limited ability to maintain the position of arms overhead and were unable to achieve deep flexion angles of the of the hip, knee, and ankle joints.

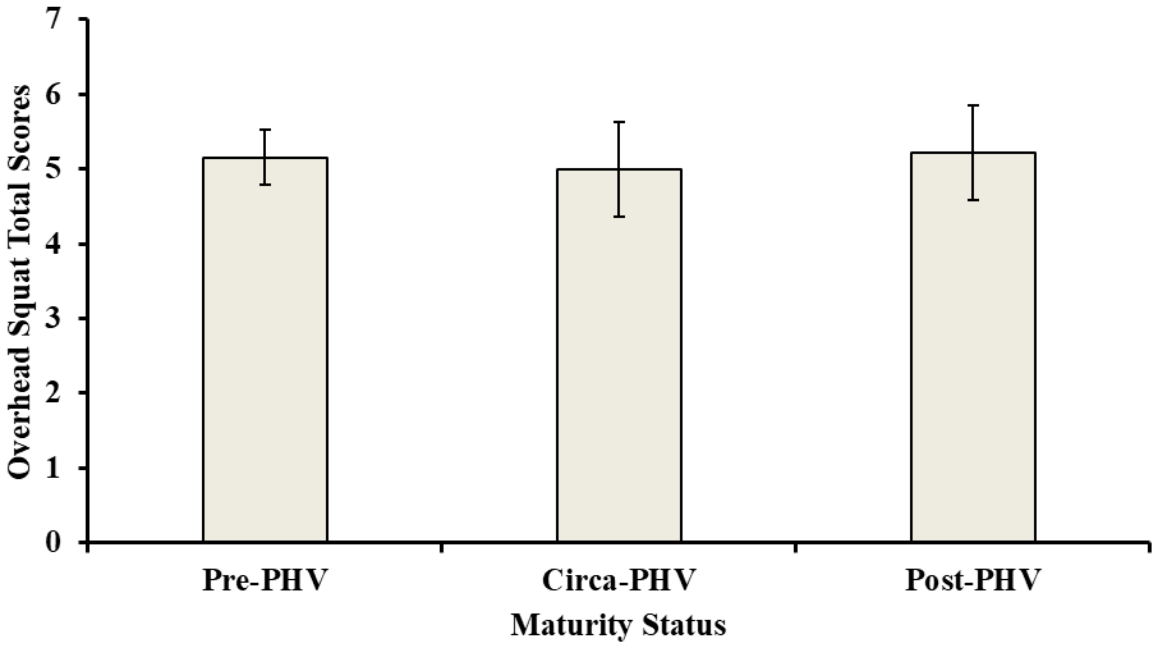


Figure 4. Overhead squat scores across stages of maturation for male players.

Table 1. Mean and standard deviation scores for the countermovement jump (CMJ) in pre-PHV and post-PHV groups for male players.

MATURITY STATUS	CMJ (CM)
Pre-PHV	22.29 ± 4.00
Post-PHV	34.20 ± 3.59

EFFECT OF 8-WEEK PROGRAMME ANALYSIS

Of the 28 participants who met the inclusion criteria, data for 17 males and 11 females were analysed. There were nine males estimated to be pre-PHV, five that were estimated to be circa-PHV, and three that were estimated to be post-PHV. All females were estimated to be post-PHV. Descriptive information relating to stature, body mass, and chronological age is displayed in Table 2.

Table 2. Mean and standard deviations (SD) for males' and females' height (standing and sitting), mass, and chronological age.

		STANDING HEIGHT (CM)		SITTING HEIGHT (CM)		WEIGHT (KG)		CHRONOLOGICAL AGE (YEARS)	
		Average	SD	Average	SD	Average	SD	Average	SD
Males	17	157.94	11.74	79.00	5.79	58.89	17.59	12.65	1.66
Females	11	153.96	11.69	84.14	25.25	56.96	10.10	11.82	0.98

Adherence to the programme was measured using an online training diary with an expected level of compliance set at 85% across the 8-week period. Out of the 28 participants only 15 met this level of compliance.

The main finding was that maturation was not a factor in effects of the 8-week programme. However, there was a tendency for single leg squat scores to improve across all groups in response to the programme (Figure 3.). To detect if there were any differences between each individual limb, further analysis was undertaken and revealed that the left leg had significantly improved compared to the right leg, with a medium effect size.

Regarding the hamstring strength test, a non-significant change was revealed with a small to medium effect size.

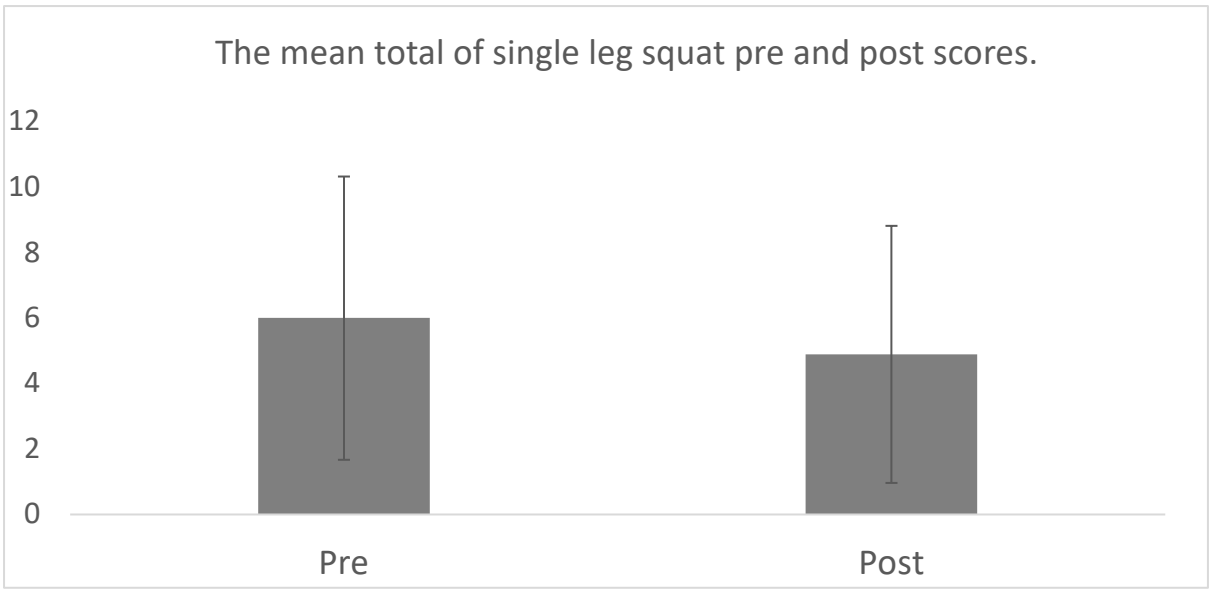


Figure 1. The mean total of the single leg squat pre and post intervention scores with error bars.

INDIVIDUAL CASE STUDY EXAMPLES

1. "Josh" was an under 14s player at the time of participation in the research and was part of the Aspire talent programme. Following completion of the programme, feedback was sent to his mother:

   "both by eye and through measurement, is Josh's vast improvement in his counter-movement jump heights. He attained 16.46 cm on average before the programme, and an average of 20.7 cm after. This is an incredible improvement! He looked so much more powerful in the retest videos, which was great to see".

   "Importantly, Josh looks as though he is approaching his period of accelerated growth – the adolescent growth spurt. Over the coming months, he will likely increase in stature and in this time, it is extremely important that he continues to work on the movement patterns and exercises from the 8-week programme. These will help him improve his coordination as his limbs increase in length."

   In the hamstring bridge test, Josh was able to hold the position for 10-seconds on his left leg, and 15-seconds on his right. Following the programme, Josh could hold the position for 40- and 38-seconds, respectively.

2. *"Isla"* was an under 18s player at the time of her participation in the research and is a Wales under 18s representative. As expected, she was calculated to be post-PHV. Following completion of the programme, Isla improved in her hip control in the overhead squat and showed substantial improvement in her movement control in the single leg squat, reducing her score (for error) from 10 out of 20 down to 3 from 20. In addition, Isla improved her vertical jump by a marginal level, 26.8 cm to 27.21 cm, which is not unexpected given she had already achieved full maturation. In the hamstring bridge, Isla scored 60- and 62-seconds for the left and right limbs, respectively. In the post-programme testing, she scored 122- and 124-seconds for the left and right limbs, respectively.

OTHER EXAMPLES OF IMPROVEMENTS:

Joe, a preadolescent player who was estimated to be approximately one year away from his adolescent growth spurt, improved his single leg squat total score from 7 to 4, and his jump score from 26.86 cm to 28.15 cm across the 8-week period.

Alice, an under 14 Aspire player, improved her average countermovement jump score from 23.02 cm to 26.6 cm.

A COACH'S PERSPECTIVE:

"The Basketball England Player Development Framework stresses the importance of our players being physically robust and this is a key factor when in assessment when we select players with potential talent.

The 8-week athletic development programme provided support for young basketball players to become more robust and increase their athleticism. Ultimately, this will have contributed to making the players more impactful on the basketball court".

Matthew Harber, Regional Talent Manager (South of England)

MOTIVATION SURVEY

There was a total of 14 respondents to the survey, with results from the most pertinent questions relating to the home programme described below.

In response to the question “in general how motivated were you to train at home?” five players responded with “always”, nine responded with “most of the time”, and one player responded with “sometimes”. Relating to the question, “did you feel motivated and willing to learn new skills in the home programme?” there were nine responses of “always”, three responses of “most of the time”, and two with the response of “about half the time”.

With regards motivation, the question “do you think your motivation would have increased if you used goal setting?” four players’ response was “definitely yes”, two players responded with “probably yes”, and seven players responded with “might or might not”. One player did not provide a response to this question. In response to the question, “do you think your skill level would have improved if you used goal setting?” there were four responses of “definitely yes”, five responses of “probably yes”, four responses of “might or might not”, and one player that did not return a response to the question. From the follow-up question “if someone created a tailored goal setting programme to aid you in improving your overall performance and motivation levels in your sessions, would you use it?” seven players responded with “definitely yes”, five players chose the response “probably yes”, one player responded with “might or might not”, and one player did not provide a response.

INTERPRETATIONS

CROSS-SECTIONAL ANALYSIS

The findings of this research provide valuable insights into differences in movement control across stages of maturation. Importantly, these results can be used to inform future national governing body initiatives, as well as the practices of coaches and sports science and medicine practitioners working within youth level basketball.

Assessment of the single leg squat revealed that more mature players display greater levels of control compared to players who are pre- and circa-PHV. This was further highlighted in the analysis of knee valgus across the maturational groups. This is perhaps unsurprising given that mature players who have already experienced their adolescent growth spurt likely possess greater levels of muscular strength to control the movement pattern when compared to less mature individuals. Importantly, for the pre- and circa-PHV group, the implications are that there should be emphasis given to improving lower body, single limb neuromuscular control. While muscle force capabilities are not as developed in pre- and circa-PHV players compared to post-PHV, improvements in movement control can be achieved through neural-related mechanisms. Moreover, in the circa-PHV players, it is plausible that the effects of the adolescent awkwardness phenomenon could have contributed to these results. During PHV, the accelerated rate of growth of long bones can lead to temporary impaired coordination. The single leg squat is a task that challenges balance, stability, and control, during the coordinated action of a single limb. Therefore, it is feasible that the single leg squat test presented the circ-PHV with movement task that exposed their impaired coordination. Therefore, in agreement with other youth-based research, it is important that caution is shown during this period and appropriate strategies are put in place. This can include a reduction in open-natured (live) elements of basketball practice, reduced competitive game time, and neuromuscular training – such as the 8-week athletic development programme. Such interventions can contribute to improvement movement control and coordination and reduce the risk factors for injury during this sensitive period.

In a similar fashion, unsurprisingly, the post-PHV displayed higher jumping ability in the CMJ compared to pre-PHV. Unfortunately, there were not adequate numbers of players to include in a circa-PHV group for analysis, therefore it is undetermined how jumping ability in players that are experiencing changes in stature and other physical changes, compares to the pre- and post-PHV groups. As with the results for the single

leg squat, the greater strength levels in the most mature group likely accounted for these differences, despite these individuals having to propel more mass than the pre-PHV group. Of importance, research into the use of plyometric exercise in youth populations across males and females has shown greater effects in younger individuals. In females, between the ages of 11 and 13, there are naturally occurring improvements that might be further enhanced with plyometric type training at the same time. A similar level of trainability may also exist in pre-PHV boys, who possess more *spring* type qualities compared to older boys. While this would not necessarily alter the differences in strength and, in turn, jumping ability across the pre- and post-PHV groups, acknowledging these potential periods of training sensitivity may help inform the physical development of young players. Conversely, while jump-based forms of training and other plyometric exercise remain an important preparatory training tool for adolescent players, in line with youth athletic development literature, strength-based training is understood to be more effective to coincide with increases of muscle mass and force capabilities.

In relation to the overhead squat, maturation did not appear to be a factor in the performance of this movement skill. Interestingly, there were similarities in the movement limitations across maturational groups, with an inability to maintain arms above the head while simultaneously bending at the hip, knee, and ankle joints. In addition, there were similar limitations to depth achieved during execution of the movement pattern across the groups. Moreover, this was also observed in the female group. This suggests that across stages of maturation in males, and in post-PHV females, there is a lack of ability to dissociate coordinated movement of the upper and lower body, leading to compensatory movement patterns in the task. While the overhead squat pattern itself unlikely a skill that well practiced by basketball players, the lack of coordination displayed across stages of maturation may well indicate a limited movement vocabulary. Limitations in movement skills can restrict movement capabilities and, overtime, may have implications for muscle imbalance related issues and overuse-type injuries. In particular, the lack of ability to fold the lower body and move through a full range of motion may indicate a reliance upon quadricep muscles of the front of the thigh, and less use of muscles at the back of the thigh and hip, also referred to as the posterior chain. Given that musculature of the posterior chain, such as the hamstrings and gluteals, provide a protective role in landing, it would appear important to improve their function and contribution in the performance in the overhead squatting movement skill. However, based upon these results, there is a lack of proficiency in the execution of this movement skill.

EFFECT OF 8-WEEK PROGRAMME ANALYSIS

Despite the lack of significant changes detected for the total single leg squat score for both legs, which is likely the resultant of a small sample size, there was a significant improved performance in the single leg squat for the left leg. This suggests that the programme was effective in improving single leg movement control in the less dominant limb. While perceived limb dominance / preferred limb was not assessed, it is speculated that the left leg may have represented the non-dominant limb, and therefore there was a larger window for improvement in movement control compared to the right limb. In this regard, players lacking movement control in their non-dominant leg may be inadequately prepared for basketball scenarios where they are required to perform actions with their non-preferred limbs, which may contribute to the risk of injury. This highlights the importance of neuromuscular training to reduce limb imbalances and enhance movement control as part of an injury reduction strategy.

Regarding the isometric hamstring bridge scores, while there was not a statistically significant change resulting from the programme, there was a tendency for scores to improve. The lack of statistical significance is possibly owing to the lack of players included in the analysis of for this test. Nonetheless, the improvements shown is encouraging and suggests some degree of programme effectiveness in improving hamstring strength endurance. This was further evidenced in the case study results for Josh and Isla, who both achieved substantial improvements in the test in response to the 8-week programme. As previously mentioned, the hamstring muscle group, along with contributions from the gluteals, represent musculature of the *posterior chain*. In landing and deceleration mechanics, such as in cutting, these muscles serve an important protective role for the knee joint. Moreover, in maturing females, this is of importance owing to structural changes around the pelvis that contribute to an increased the angle of action of the quadriceps. In addition, compared to males, females' strength levels and activation timing of the hamstring muscles does not improve without training intervention, which increases the risk for knee injuries occurring in female players. However, the results of this research indicate that use of bodyweight hamstring exercises, such as the isometric single leg hamstring bridge can provide a useful means of targeting hamstring strength as part of the injury reduction strategy.

MOTIVATION SURVEY

The survey added a dimension to the research that enabled us to get an understanding of the young player's feelings towards the home-based programme. Most notably, the responses to the questions relating to goal setting appear to suggest that this coaching tool would have encouraged greater levels of motivation and, in turn, may have improved the level of improvement in the movement skills targeted within the programme. While the distribution of the survey was limited to participants that had participated in the research and completed the programme in its entirety, it is speculated that motivation in the players who did not submit data at the end of the 8-week programme was low, which may have been a contributing factor to the low programme compliance. Understandably, the unprecedented circumstances relating to COVID-19, which likely created fear and anxiety in the population of young individuals, as well as much uncertainty regarding the return to basketball, may have affected motivation levels to engage with the programme. The results of the survey suggest that by engaging young players using goal setting, motivation levels towards the programme may have been increased. In addition, these conditions may have increased the level of skill development across the 8-week programme which, in turn, would feasibly have led to greater improvements in the post-programme test scores. Furthermore, while limited to speculation, it is also conceivable that goal setting could have encouraged more players who had initially volunteered to the research, to provide post-programme data having completed the 8-week programme.

LIMITATIONS

As with all research projects, there are limitations that have impacted our findings. A substantial limitation to this research is the nature of the data capture, with a reliance upon parents facilitating the test administration and video capture of the tests for submission and analysis. While video content was produced by the researchers to accompany the written explanations, ensuring that the testing protocols were standardised remained a considerable challenge. However, the data extraction and processing adhered to strict inclusion and exclusion criteria and the same researchers completed the data analysis from the submitted videos to improve the reliability of the data. Furthermore, the two researchers leading on the data analysis completed reliability tests to ensure consistency to their scoring of the tests. Nonetheless, the methods of data capture resulted in a loss of a considerable amount of data. In particular, the method for calculating jump performance in the CMJ used a smart phone app, which has been validated and shown to be reliable, proved to be problematic in our analysis. Owing to the video capture speed was of the submitted videos being highly variable, many datasets being removed from the analysis.

Another limitation relates to the volume of content contained within the programme, which for young (pre-PHV) players may have been regarded as being too high. As such, the prescribed totality of training may have discouraged players from participating, as well as affected levels of compliance. With the programme targeting youth players aged between 12 and 18 years of age, the programme content was largely generic and, while the exercises contained were all of value to youth basketball players, the programme may have been unrealistic in its expectations. The programme featured five sessions per week, which for some individuals may have represented a training volume that exceeded their normal levels of physical training. Furthermore, though the format of the training was tailored to limit the time required to complete each training session, the programme demanding on time.

In relation to the above-mentioned limitation, direct contact with participants throughout the 8-week programme might have increase motivation and programme compliance. Owing to the large numbers of participants volunteering to take part in the research project, maintaining personalised communication was not feasible and, in place of this, video messages posted on Basketball England's social media platforms were used to update participants with information throughout the 8-week period. There was also support from some regional talent managers who were engaging their playing groups, using online video platforms to deliver live sessions. However, it is likely

that parents of players may have discontinued because of a lack of direct communication throughout the 8-week programme. Future initiatives should aim to utilise strategies that engage parents and players through more personalised approaches, such as with newsletters, as well as providing online webinars for parents and coaches.

Lastly, regarding the effects of the programme, while there were improvements observed, a limitation that may have impacted the magnitude of the programme was that the single leg squat and hamstring bridge exercise did not feature in the programme until the second phase (weeks 5-8), which may have limited the magnitude of the changes observed. Similarly, the exercises were only prescribed once per week, with the hamstring bridge being performed in an alternating fashion, as opposed to a sustained hold – as per the conditions of the test. Therefore, it is possible that the effects of 8-weeks of exposure to these exercises, and the performance of the hamstring bridge as a hold, would have led to greater improvements in the post-programme tests. However, the justification of not including these exercises with greater frequency throughout the programme was to avoid simply training for the tests. Instead, the 8-week programme encompassed a diverse number of exercises intended to develop a range of neuromuscular qualities. In this regard, despite the previously mentioned limitations, the effectiveness of the programme is highlighted by the neuromuscular improvements occurring irrespective of the lack of exposure to the test exercises.

FUTURE PERSPECTIVES

Many lessons have been learned from this research project and these will be used to inform future practice in relation to the sports science and medicine practices with Basketball England. Overall, the findings of this project vindicate the development, and rollout, of Basketball England's own neuromuscular based warm-up, which will include elements from the 8-week development programme. The development of this warm-up, with valuable work from Dave Hall, sport therapist at the Sevenoaks Suns, and contributions from Great Britain player Renee Busch, will provide all coaches with the ability to include neuromuscular training exercises into their warm-up protocols. Through the implementation of this warm-up, it intended that the movement vocabulary and neuromuscular capabilities of young basketball players in the UK can be improved. This would not only contribute to a reduction of risk factors associated with injury, it would also serve to lay down important foundations of athleticism that can be developed with more advanced training forms, particularly as players progress along the talent pathway. Young players equipped with athletic movement skills, such as movement patterns including double-limb and single-limb squatting variations, serve as necessary building blocks to adequately prepare them for strength-based training using external resistance. In turn, players physical performance can optimally enhanced.

Other important considerations for the future relate to the design and implementation of home programmes. In the event of any future lockdown restrictions, the design of a home-based programme should offer more differentiated content to better account for the age ranges, as well as stages of maturation of youth basketball players. Moreover, the engagement of parents and coaches with direct forms of communication relating to the programme should be considered in any future projects of this kind. Providing such support would provide the opportunity to set performance-related goals, serving to increase motivation levels, which would likely increase levels of compliance. Importantly, however, this project highlights how players, with the support of parents, can improve aspects of their athleticism and reduce risk factors for injury by following a bodyweight exercise programme from home. Therefore, in addition to Basketball England's neuromuscular training warm-up, there is potential for further resources relating to the Physically Robust Pillar to be produced in a format that is designed for home completion.