THE INFLUENCE OF MATURITY STATUS ON JUMPING PERFORMANCE OF INNER LONDON SECONDARY SCHOOL STUDENTS

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Abstract

Talent Detection (TDE) is a method for the identification of potentially talented athletes establishing the physical ability of an athlete without the presence of sport specific skill. TDE typically uses assessments that identify physical characteristics inherent with the given sport, with ambitions to find those with superior physical ability. These protocols are traditionally aimed at set chronological ages, as low as ten years old. However, it has been established that youths will enter the adolescent process at different ages, and will go through the process at different rates. Therefore we know that it is possible to have a selection of athletes of the exact same chronological age, with as much as a few years difference in biological age (from the onset of puberty). Maturation of athletes has been explored and a selection of non-invasive methods has been established as valid protocols for biological age assessment. This research looked to establish relationships between maturity and jumping performances across the vertical (VJ) and horizontal (HJ) jumps, both highly used assessments within TDE. 72 girls and 65 boys were assessed for maturity and performance of jumps were taken using a jump mat for VJ and a tape measure for HJ. The results concluded a strong relationship with maturity and VJ and HJ in the boys, and a very strong relationship with peak power in both VJ and HJ in the boys and girls. The limitations of this study surround the dependency on adjustment equations due to the equipment used, and the use of the prediction equation for maturity. However there is strong evidence that suggests biological age should be considered when undergoing assessments as used within TDE, to allow for fair comparison across athletes of the same chronological age, and further research needs to be done overcoming the limitations of this study.

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Word Count 11,768

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Glossary of Terms

DMSP – Developmental Model of Sports Participation.
This is an overview / theoretical model of sports participation and performance. It features both recreational and performance pathways and outcomes.

HJ – Horizontal Jump
A physical exercise/assessment commonly featured in TID. The athlete uses a countermovement and attempts to jump as far forwards/horizontally as possible.

LTAD – Long-term athlete development model
The LTAD is a theoretical model for sports performance that suggests various stages for development from childhood into adolescence and into adulthood. The concept suggests different training needs at each stage and appropriate training.

PHV – Peak height velocity
During the adolescent process, the body will undergo a period of rapid growth; the growth spurt. This is where a youth will endure rapid upward growth. The time of most growth attained is known as the moment of PHV.

TDE – Talent Detection
The process of identifying potentially talented athletes who have no current experience in the given sport, tested through non skill based physical assessment.

TID – Talent identification
Talent identification is a process usually associated with the identification, selection and development of youths in preparation of adult professional sport. This is done through the use of various assessments associated with the given sport or activity.

VJ – Vertical Jump
A physical exercise/assessment commonly featured in TID. The athlete uses a countermovement to jump as high/vertically as possible.

Introduction

Talent is a term that is commonly misunderstood and difficult to define. The term itself has been interchangeably used and has become inconsistent in definition and conceptual clarity (Tranckle & Cushion, 2006). Although the dictionary may define it as a natural amplitude or skill, this is too vague to appropriately explain the true complexities of talent (Tranckle & Cushion, 2006). Gagné (2004) has suggested that there are two ends to talent; one being the untrained and spontaneous natural amplitudes or skills, in a specific domain, within the tenth percentile of their peers; with the other end being the development of ability and knowledge systematically, in a specific field of activity, also within the tenth percentile of their peers. Further to this, Gagné (2004) also states that natural amplitudes or skills are more appropriately labelled as “gifts”, which is where the phrase “giftedness” seems suitable to term this group of individuals. Conversely those who have systematically developed their skills and knowledge to the tenth percentile have achieved this as a product of a developmental process, which we know as talent development. Giftedness may result in the enhanced development towards talent, however it does not solely predict who will be a talented individual, due to the element of ‘chance’ being a key requirement to this success (Gagné, 2004). Chance is linked with the argument around nature vs. nurture. Chance may be the culture an athlete is raised within, positive and negative occurrences that happen throughout life, access to facilities and persons, or the athletes motivations and psychological state towards developments, to list a few (Tranckle & Cushion, 2006). Chance can also be linked to genetic profiling, with glimmers of testing within DNA to establish athletic potentials (Miah & Rich, 2006). Chance is of course unquantifiable and it is relevant to acknowledge, but also out of our hands to manipulate or observe for a performance outcome. Therefore, giftedness may be a good sign for the identification of a talented athlete, but it will come down to the development of talent, and chance, that these developments are possible.

The other side to the argument is the element of practice, or more precisely, deliberate practice. This has been coined by authors such as Ericsson, Krampe & Tesch-Römer (1993). Deliberate practice is the accumulation of hours practicing a skill in a manner that is specific to enhance performance

(Macnamara, Hambrick & Oswald, 2014; Ericsson, 2008). It is believed that a specific (but varying) length of hours of deliberate practice is required to attain a set level of mastery per discipline by an individual (Ericsson, Krampe & Tesch-Römer, 1993; Ericsson, 2008; Macnamara, Hambrick & Oswald, 2014). This was first explored and identified within musicians, and believed to be transferable across other activities. Later understanding of deliberate practice was recognised in memory challenges and board games (Ericsson & Pool, 2016). It has since been further explored around the role of deliberate practice in sport, although undefined times are suggested per discipline (Ericsson & Pool, 2016).

Regardless of either theory, we do know that deliberate practice plays an essential role to the development of talent, which is agreed in Gagné's model of giftedness. But understanding how we develop or identify giftedness or talented individuals remains a process constantly evolving in sports science. A further model identified for the development of sports persons is the Developmental Model of Sports Participation (DMSP) (Côté, Lidor & Hackfort, 2009; Côté & Hay, 2002). The DMSP offers a set of pathways, acknowledging the reality that early specialisation is commonly practiced, but also offering what is deemed a far more appropriate method for retention, development and performance (Côté, Lidor & Hackfort, 2009; Côté & Hay, 2002). This alternative model starts with the concept of deliberate play, which develops onto deliberate practice, and then resulting in either recreational attendance or specialisation into the sport of choosing (Figure 1). It is believed that multiple sports should be undergone from entry of sport, so the athlete can be developed in all aspects of physical requirement, as well as social and psychological developments. This aligns to the work of Ericsson (2008) and the concept of deliberate practice for the mastery of skill, however including an element of deliberate play as the engaging mechanism to make sport fun and therefore increase retention that opens greater opportunity to establish talented individuals. This has also been observed in the well-known Long-term Athlete Development Model (LTAD) produced by Higgs, Balyi and Way (2013). This later inspired other authors such as Lloyd & Oliver (2014) to develop the Youth Development Model building upon what they and others deemed as errors in the LTAD.

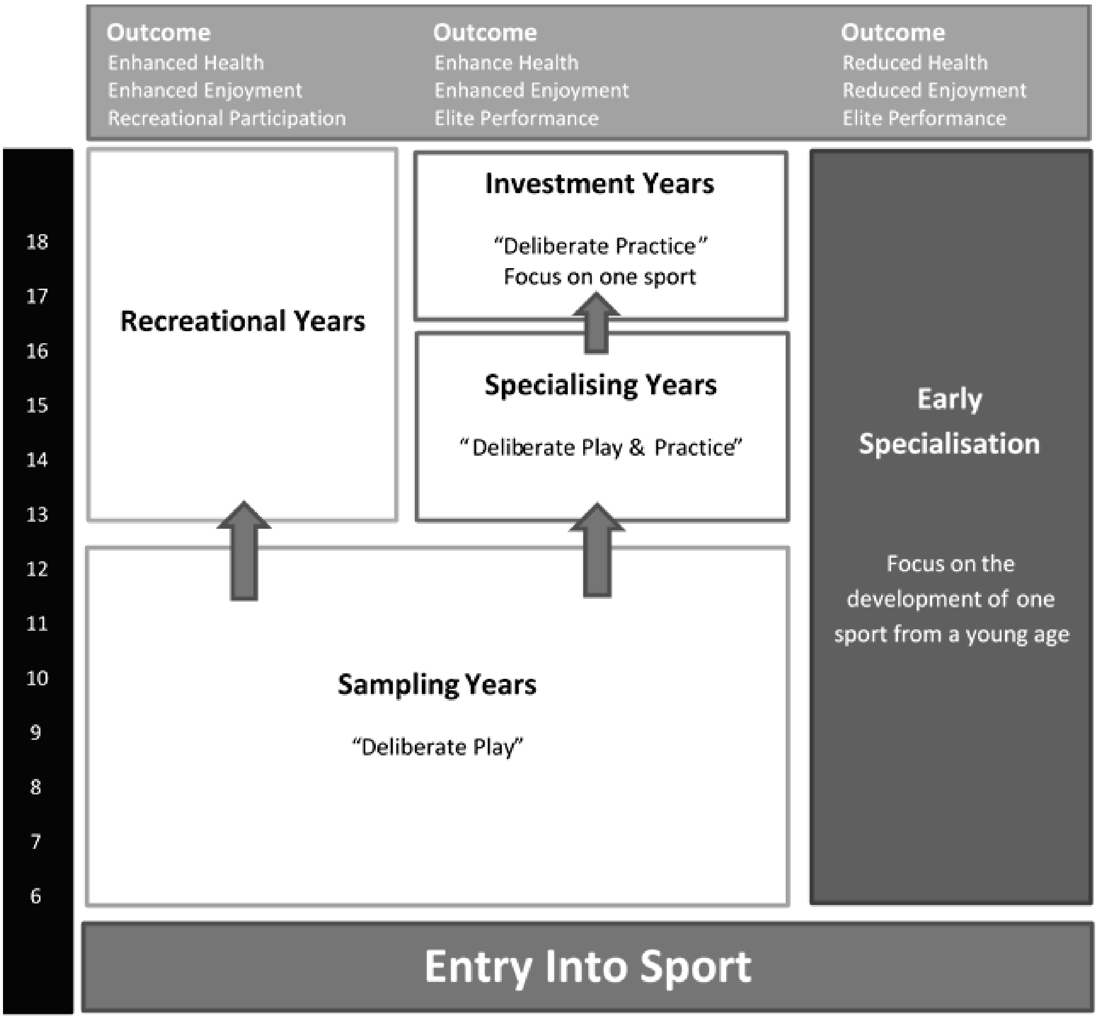

Figure.1 *An adapted image of the Developmental Model of Sports Participation by Côté (adapted from Côté, Lidor & Hackfort, 2009; Côté & Hay, 2002).*

Conception of Talent Identification

Talent Identification (TID) is a mechanism in elite sport that looks to expose, identify and develop athletes deemed as having a high potential to succeed (gifted or talented), specific to a sporting discipline (Baker, Cobley & Schorer, 2011; Bailey & Collins, 2013). With origins noted predominantly from the Soviet bloc countries (Lidor, Côté & Hackfort, 2009), TID was stated to be the essential components for the introduction into elite sports development for both team and individual sports. This has since evolved to what we have and use today worldwide, accepted as an assessment for potentially talented sports persons. For both financial viability and coaching efficiency, small cohorts of athletes are usually selected to undergo elite training interventions to attain sporting success (Woods *et al.*, 2016). TID has been used for a number of years and is integrated into different sports performance pathways in a variety of capacities

(Baker, Cobley & Schorer, 2011). TID not only features within national governing bodies (NGB) and major sporting organisations, but similarly features in schools and smaller regional organisations, termed as the Gifted and Talented (G&T) programmes (Croston, 2013). It has been said that some of the best persons to identify talent are sports coaches, however there is a large danger that coaches will select with either a conscious or unconscious bias, selecting athletes that look the correct size and shape, even over those athletes with a superior skill set (Cripps, Hopper & Joyce, 2016). This has been identified by a number of researchers across a range of sports such as Soccer (Vandendriessche et, al., 2012; Cripps, Hopper & Joyce, 2016), Swimming (Lätt et, al., 2009), Weightlifting (Mero & Vuorimaa, 1990) and both short and long distance running (Mero & Vuorimaa, 1990), to list a few. Therefore, a more objective way to identify, produce and develop talent is to go through athletic profiling traditionally found within TID.

A number of NGBs and organisations have used, and continue to use TID, such as the English Institute of Sport with such initiatives as Sporting Giants and Power to Podium, and NGBs such as Gymnastics and Handball to list a few (Baker, Cobley & Schorer, 2011). The process of TID traditionally features a number of different entry points, a development pathway and an exit route into the performance pathway (Figure.2). During the entry points of TID, athletes will usually undergo a number of assessments that are used to determine the current standard of each athlete and / or make a projection of future athletic ability. The successful athletes will then be developed with the hopes to proceed on to the performance pathway once adequately prepared (known as talent confirmation) (Vaeyens *et al*., 2008).

However, a number of issues present themselves through this method of TID that has been challenged by numerous research authors such as being one dimensional, advocating early specialisation and being inappropriately discriminative (Vaeyens *et al*., 2008; Bailey & Collins, 2013; Rees *et al*., 2016; Wolstencroft, 2002; Lidor, Côté & Hackfort, 2009). The success rate of TID is

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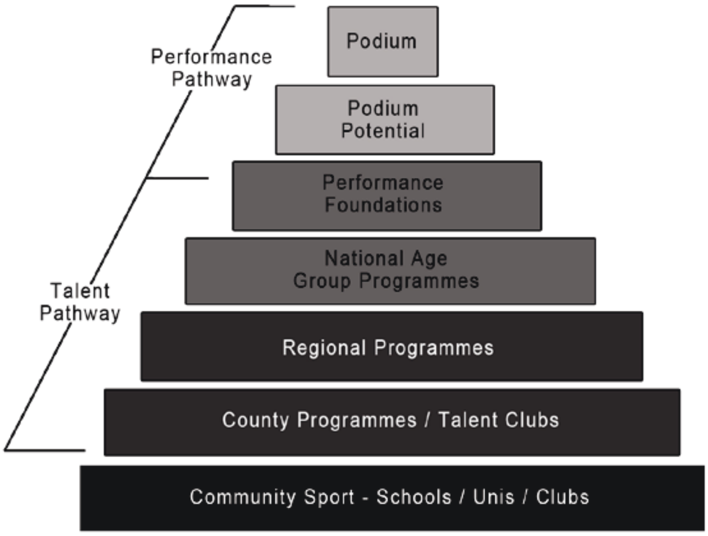

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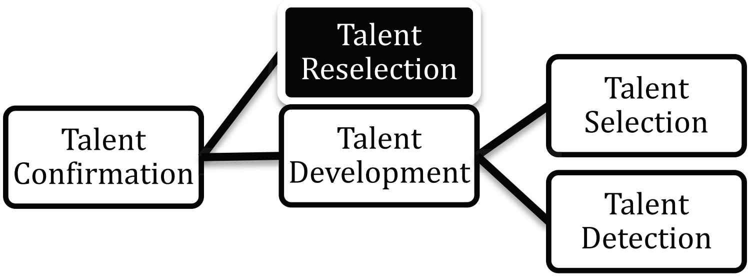


Figure.2 *The talent identification process. Image A provides an example of the club / participation pathway from grassroots to elite. Image B) provides an overview of the typical TID method from detection/selection to confirmation.*

also questionable, with a number of sports deemed as easier to predict such as closed skill sports (rowing, cycling, athletics as examples), whilst open skill sports suffer a reduced potential to determine athletic success due to the high quantities of variables and unpredictable outcomes inherent with open skill sports (Vaeyens *et al.*, 2008). Furthermore, there is only a very select amount of sports that are truly deemed as early specialising sports (example; gymnastics, diving), with a vast majority leaning towards late specialisation. Various alternative models that have demonstrated sporting success at major events, such as the system implemented by Australia, have noted numerous external determinants that may have influenced and resulted in their successes, especially considering they have failed to show replication within other nations (Abbott, 2006). Moreover, little success rates have been established or reported from TID models to date (Abbott, 2006; Vaeyens *et al.*, 2008). It is uncertain as to why this is, but it is constantly eluded to the issues lying within the unilateral direction currently used, neglecting psychological and sociological aspects of athlete development (Vandendriessche *et al.*, 2012) and a focus on chronological age with complete neglect to biological developments, a confounding variable to the youth athlete development (Lätt *et al.*, 2009; Mero & Vuorimaa, 1990; Vandendriessche *et al.*, 2012).

Talent Identification Process

TID traditionally has two entry points; talent detection (TDE) and talent selection, although a third entry point can also be noted: talent transfer. During each of these entry points, athletes will undergo a selection of assessments, which may include physical, anthropometric and psychological assessments (to list a few). Whereas talent detection looks to engage with athletes who have not previously been involved in the assessed sport, talent selection tries to identify high potential athletes that are currently engaged and potentially competing in the assessed sport. Talent transfer looks to transfer athletes who may compete at a high standard in other sports, which may be more suited for athletic success in the assessed sport (for example: gymnastics to diving). For this reason, sport specific testing will usually feature in talent selection and talent transfer, whereas it would not usually feature in talent detection. Talent detection would therefore feature exercises that exhibit the required characteristics for the tested sport, with the removal of skill specific demand. A variety of researchers have established the strong determinant of skill specific testing within talent selection (Lätt et, al., 2009; Vandendriessche et, al., 2012). Unfortunately, in the UK it seems that a bias lends itself to talent selection and talent transfer, resulting in the loss of potential success discovered via talent detection from athletes who may not currently exhibit sports specific ability, even when they demonstrate physical characteristics that are directly inherent with the sport (Bailey & Collins, 2013; Pearson, Naughton & Torode, 2006). We may postulate that this generally stems from the belief that early specialisation is the key to talent development and elite success (Bailey & Collins, 2013; Vaeyens *et al*, 2008; Pearson, Naughton & Torode, 2006), therefore disregarding those with little to no experience regardless of physical prowess, especially at older age brackets. This proves problematic in itself, as there is no literature to data that proves early specialisation as a superior method to early diversification (Côté & Vierimaa, 2014; Moesch *et al.*, 2011), or that athletes are unable to transfer from sports that exhibit similar physical demands. Furthermore, It has even been noted that some athletes who are active in sport from young across multiple disciplines, who specialise in the later years, achieve higher elite performance outcomes when changing sports (Moesch *et al.*, 2011). Conversely, those that attain national and international youth and junior team success will unlikely transition into senior team success (Moesch *et al.*, 2011). Additional research has concluded that sports practitioners will select athletes who look to have the sports desired size and shape (anthropometry), over those who are less developed, regardless of skill and ability (Cripps, Hopper & Joyce, 2016; Vandendriessche *et al.*, 2012). It is evident that a focus on early specialisation heavily neglects a number of variables associated to the appropriate training of youths; the development of fundamental movement skills and physical literacy, reduction of injury potential and ensuring a positive experience is attained for continual sporting participation (Myer *et al.*, 2015; Baker, 2003; Fraser-Thomas, Côté & Deakin, 2008; Kite & Bailey, 2017). A review of current practice of various sporting governing bodies noted that their development models lack the wider developments of an athlete and focus purely on performance developments (Bruner *et al.*, 2010; Côté & Vierimaa, 2014). In addition to this, it highlights the lack of consideration towards the difference in maturation between individuals of the same age and the detection of athletes who exhibit strong physical characteristics deemed as strong determinants to success in the given sports, which are critical themes to this study (Pearson, Naughton & Torode, 2006). Not only is talent detection a highly underused method of discovered and developing athletes to elite success, It has been highlighted that biological age being is an essential element that needs to be featured in modern TID assessment (Vandendriessche *et al.*, 2012; Mero & Vuorimaa, 1990).

Talent Detection

TDE is linked to the concept of giftedness (Gagné, 2004), where individuals may possess a higher natural physical ability then that of their peers, but have not actively engaged in sport or a specific discipline. With the knowledge that a host of sports have a high dependency upon set physical attributes as a determinant of success, it is clear that TDE can play an essential role in discovering potentially talented athletes whom currently lay dormant. It is likely that these individuals may also be unaware of their own abilities, or may not have had the opportunity to realise their given potential within their suited sport. Therefore the concept of TDE allows practitioners to establish the physical standard of an athlete outside of skill-based assessments, offering an unbiased outcome when compared to those who may be familiar or actively engaged within the given sport (Vanezis & Lees, 2005; Focke *et al.*, 2013). This is a current issue associated with TID (Vaeyens *et al.,* 2008), of which it is belief of the author that TDE can overcome. Beyond selection through TDE, the acquisition of skill will become an observed process to ensure that the physical traits are transferable, therefore confirming or deselecting talent over time, as required. It is postulated that this may result in the enhanced identification of potentially talented athletes to a far less discriminative manner then at present, capturing future talented athletes who are currently slipping through the net.

The assessment process to the TDE protocol usually consists of “scoring” through the use of physical and sometimes psychological assessments. Physical tests usually include anthropometric assessments and exercises / movements that expose characteristics inherent with the sport (Vaeyens *et al*., 2008, Vandendriessche *et al.*, 2012; Lätt *et al.*, 2009; Mero & Vuorimaa, 1990), whereas psychological measurements will generally look to establish motivation and aspirations of an individual (Lidor, Côté & Hackfort, 2009), an area outside the scope of this research. However, the selection of exercises within the TDE protocol should be carefully considered, as should the scoring process. It has even been proposed that team sports should not only assess athletes on an individual ability, but also within group activities (Lidor, Côté & Hackfort, 2009). Furthermore, Lidor, Côté & Hackfort (2009) state that exercises of high familiarity and natural ability are of great advantage within TDE (such as catching, running, jumping & throwing). However when these exercises are manipulated to integrate specificity, the action becomes artificial and unfamiliar to execute, thus not displaying the true characteristics of an individual. Jumping ability has proven to be one of the most popular assessments of athleticism to date (Vanezis & Lees, 2005; Focke *et al.*, 2013), with the pervasive argument for the use of jumps being the simplicity and natural familiarity to its execution (Vanezis & Lees, 2005, Wang, Lin & Huang, 2004). The vertical jump (VJ) in particular has been found to have a very low technique requirement and is used to determine an athlete's ability to express force, with a potential to highlight those with muscle fibre dominance towards peak force production (Vanezis & Lees, 2005). A variety of executions have been used, from rebound jumps, unilateral and bilateral, jumping over or on to objects, with the most common being the counter-movement vertical and horizontal jumps (Pearson, Naughton & Torode, 2006; Vanezis & Lees, 2005; Wang, Lin & Huang, 2004). These exercises are commonly used in a wide variety of sports such as high profile TID in the NFL combine, to swimming, weightlifting and sprinting (Mero & Vuorimaa, 1990). A research by Wang, Lin & Huang (2004) demonstrated that the utilisation of the stretch shortening cycle in young adults was far greater then prepubescent youths, ultimately suggesting that the depth of a jump and the usage of elastic energy, via muscular tendon stiffness, characterises higher performances in jumping skills. We also know that the development of muscular stiffness is inherent with puberty, and therefore those who are early maturing are less likely to take advantage of this mechanism over those further along the adolescent process. This research will not identify tendon stiffness or assume elastic energy potential, but it will look to establish further details of these differences between individuals currently going through the adolescent process, and how maturity effects outcome of jumping ability.

Genetic testing, as briefly mentioned previously, has been explored by a variation of researchers. However, there is a wealth of researchers that have backed the notion of genetic testing to show no links to talent prediction, whilst also a potentially dangerous and questionably unethical practice (Guth & Roth, 2013; Webborn *et al.*, 2015). For time being, genetic testing has been side lined until further evidence has been established.

Biological Age

Age is a compelling factor of TID that is traditionally only measured chronologically, neglecting the wider and more insightful methods of monitoring. The measure of maturity and its benefits have been established in a number of studies, providing insights towards appropriate training interventions, and mechanisms that can be employed in TID (Lloyd & Oliver, 2014; Mirwald *et al.*, 2002; Malina *et al.,* 2005; Cumming *et al*., 2017; Fransen *et al*., 2017). The gold standard for measuring maturity is using a bone scan of the wrist, as has been done in a variety of studies (Mero & Vuorimaa, 1990), although such procedures require heavy financial investment. Other methods of assessment of maturity have been used in research such as the Tanner method of self-assessment (Lätt *et al*., 2009), which involves identifying your stage of puberty based on breast and pubic hair development. This is however not always a comfortable process for the participant to endure and would veer away from such process especially based on being self-assessment, and a high dependency on truthfulness from the young participant. Further to this is the process of using a prediction equation to establish offset of maturity such as the Khamis-Roche (Cumming *et al*., 2017) and Mirwald's equation (Mirwald *et al.,* 2002; Vandendriessche *et al.,* 2012). The benefit of using each of these prediction equations is the non-invasive and simple collection of variables required to undergo such predictions. In both the Mirwald and Khamis-Roche methods, anthropometric measurements will determine biological age, with the Khamis-Roche requiring additional measures from the parents. The outcome of each test is slightly different, with the Khamis-Roche displaying the percentage of adult stature, whilst the Mirwald equation states years + or – from the moment of peak height velocity (PHV). Whilst there are stated issues with the use of the Mirwald equation (Kozieł & Malina, 2018) it may be of benefit to use both methods in unison. However it may be problematic to collect parental height logistically, as in this study where assessment is done within a school physical education session and access to parents is difficult. Furthermore, being able to identify an athlete's age beyond PHV offers an advantage that the Khamis-Roche potentially lacks. Given the fact that this study looks to understand performance across all standards of maturity, it might be concluded that the Mirwald equation be the most appropriate of the two at present.

TID protocols should consider the wider variation that individuals enter the maturation process between genders and within genders. Studies have reported that the average girl will enter adolescence around one year prior to the average boy (girls = 12.0yrs ±1.09, boys = 13.0yrs ±0.8; Cole, Pan & Butler, 2014), whilst other researchers have noted a variation of skeletal age in youths of the same chronological age, by as much as 2yrs (Figueiredo *et al*., 2009; Mirwald *et al*., 2002; Vandendriessche *et al.,* 2012). It has also been noted that there is a different tempo to maturation, with the early maturing individual going through the adolescent process faster then the average or late maturing individual (Cole, Pan & Butler, 2014; Mirwald *et al*., 2002; Hauspie, 2009). If we consider that an early developing individual will possess an advanced biological development due to an increased tempo of growth, it is of little surprise that the early developer will likely be able to outperform their peers in more physically demanding activities such as jumping and sprinting (Korff *et al*., 2009; Meylan *et al*., 2012; Vandendriessche *et al.,* 2012). This questions the inclusivity when testing potentially talented athletes based off chronological age, which may be magnified when performances are based on a one-day "snapshot" of assessments at isolated year brackets. Researchers have stated the problems of using purely physical testing on youths surrounding these maturation related differences (Lidor, Côté and Hackfort, 2009; Fransen *et al.*, 2017; Cumming *et al.*, 2012; Cumming *et al.*, 2017). This somewhat defeats the objective of the TID process. Due to this issue, researchers have provided a number of ways to assess maturity that are non-invasive and require very little resources (Mirwald *et al.*, 2002; Fransen *et al.*, 2017; Khamis & Roche, 1994; Sherar *et al.*, 2005). In recent studies biological age has been introduced within health assessments to establish whether it can offer further clarity around a national epidemic of obesity, with positive results (Gillson *et al.*, 2017). In addition to this, some researchers have been advocating an alternative approach by using a model of long-term development (talent confirmation) (Vaeyens *et al.*, 2008). Not only does this allow for sports practitioners to monitor rate of progress over time, but it also gives the athlete the time and opportunity to realise there true potential, established through the correct stimulation through the course of the process (Vaeyens, *et al.,* 2008). The drawbacks to such model are usually surrounding the lack of resources and finances available for facilities and workforce (Woods *et al*., 2016).

Bio-banding is a term recently established to describe the grouping of individuals by attributes of growth and maturity, instead of the traditional method of chronological age (Cumming *et al.,* 2017). This can then be applied in a variety of mechanisms such as competitions or sports training, strength and conditioning and talent identification (Cumming *et al.,* 2017). As discussed above: individuals enter puberty at different ages, so it becomes problematic to project the potential of an individual at adulthood, based on chronological age.

This is where bio-banding removes potential bias and allows a more detailed comparison of not only the chronological age of an individual, but the maturity status, when considering performance. Although Bio-banding is a new tool recently introduced into sports performance, it has been used heavily in sports such as football and rugby. One of the most notably uses is within New Zealand rugby, where athletes are grouped depending on weight. Those who are outside of the weight category for their age group will play up (heavier individuals) or down (lighter individuals) an age group to ensure they play amongst those of a similar size and weight (Krause *et al.,* 2015). The FA has also embraced the concept of Bio-banding and is implementing both research and interventions to support its development as a model. It is assumed to have a positive effect to play an athlete either up or down chronological ages to provide the appropriate stimulus and avoid injury. To what length this process exceeds is currently unknown, and will need to be monitored and reported back to practitioners for recommendation through robust methods of research.

Usually once maturity is attained, researchers may choose to group individuals into three groups: early, average and late maturing individuals (Mirwald *et al.,* 2002). This has a number of issues attached due to the criteria; limiting individuals to groups that may have only a few days difference. Grouping is traditionally done by the length of time from the onset of PHV, using a formula created that includes both anthropometry measures and age (Mirwald *et al.,* 2002). Many researchers have carried out longitudinal assessments of height during adolescence to observe changes, which can be seen in figure.3 (Molinari, Gasser & Largo, 2013). PHV is in essence the most growth that occurs in the course of time during adolescence (usually measured in years). The Preece-Baines growth model is commonly reproduced in most studies as it eloquently details that as youths start to grow, towards the end of puberty they will have an onset of rapid growth in height and limbs. The peak of this growth curve is known as PHV. Beyond this point youths will gradually decline in growth over the next few years. The average years of age for PHV velocity for boys is 13.7yrs and girls are 12.1yrs, and both will continue to grow until early twenties (Granados, Gebremariam & Lee, 2015).

With the identification of maturity researchers have tended to categories the cohort into three types of groups; average maturing (1 standard deviation from the mean of the group either way), early maturing (2 standard deviations under

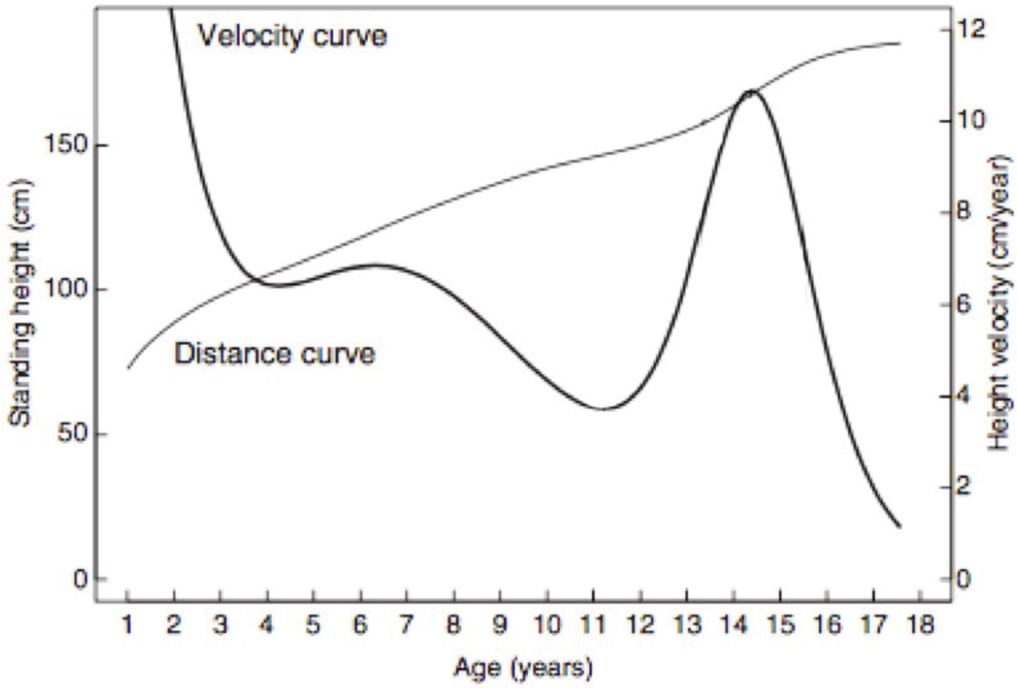


Figure.3 *The average growth of an individual from birth through childhood and adolescence, into early adulthood. Image taken from Molinari, Gasser & Largo (2013).*

the mean of the group), and late maturing (2 standard deviations above the mean of the group). Therefore an individual with 1 year and 1 day from PHV would be labelled as a late maturing, whereas another individual with 364 days would be labelled as average maturing, regardless of the fact they have 2 days separating them from the onset of PHV. This issue has been addressed by grouping people by their clusters and means, establishing where the mass of individuals' lie across the entire spectrum and then assigning groupings (Vandendriessche *et al.,* 2012).

The issue with this results in a non-repeatable process, and an assumption of maturational state. Considering the population will be average time to the onset of maturity, you may test a cohort that lacks many, if any, late maturing athletes. Therefore it has hard to establish true late maturing athletes, over those who are the back end of average maturing athletes.

Activity Status

Although not a primary objective, it would be of interest for this research to capture information to offer brief insights around the ideas of talent (practice) and giftedness (natural ability), but more so to offer clarity of the athletic abilities to the participants of the study. Are we likely to establish that the more talented or gifted athletes are also the most active athletes? Activity status has been explored and researched across a range of topics. With some of the key findings being observations around development of bone density (Bailey et. al, 1999), predictors of cardiovascular disease such as diabetes (Ball, Marashall & McCargar, 2003) and perceived physical competence (Paxton, Estabrooks & Dzewaltowski, 2004) all being linked to activity status. With the notion of more practice meaning enhanced ability or talents, it can be postulated that activity status may provide a representation of talent potential, alongside the findings of physical competence being directly linked. A variation of questionnaires have been produced and verified for the use of activity status. Specifically the PAQ-A and PAQ-C have been deemed as the more robust methods to assess activity status, with a wealth of researchers choosing one of the two questionnaires (guided by the cohort age) (Kowalski, Kent & Crocker, 2004). The questionnaire consists of 9 to 10 questions that relate to the last 7 days activity. Participants are briefed from the beginning around how this is not a test and there are no wrong answers, to ensure honesty is used throughout. Upon completion of the paper the assessor can mark the questions and establish an average score for all the questions between one and five. This allows a ranking to be created, demonstrating the activity of your full cohort.

The impact of this study could be of high importance to changing the dynamics of Talent screening. With an abundance of research stating the current issues within the current typical TID model, as stated above, it is essential that new interventions be integrated within the protocol. Given the fact that nearly all TID will assess anthropometry, there is little to no extra work required ‘in field’ to attain measures of biological age using Mirwalds prediction equation (Mirwald *et al*., 2002). Other methods of assessments can also be used, such as Khamis-Roche method (with requirements of parental height), but would refrain from methods that require heavy financial investment or the professional development of practitioners for equipment (such as bone scanners). Once established, the data can be entered into a prediction equation during data analysis and used in conjunction with performance outcomes for practitioners to establish meaningful outcomes based on maturity. Where it is acknowledged that it is not a novel finding to establish athlete dominance in those who are more biologically advanced, it would be a novel and innovative outcome to establish a set of performance measures based around biological age and performance, over raw performance, and recommended within the TDE model. National Governing bodies and large sports organisations should consider the outcome of this research when assessing youths for talent potential, and sports clubs should consider monitoring these metrics for training appropriation. Academies such as Arsenal have been working with such tools with good success to date, as an example of the adoption of maturation within the academy model. This study looks to support such inclusions, amongst integration of TDE as a standard model across all sports testing.

The aim of this study is to establish whether physical testing in commonly used and natural to execute movements such as jumping can be directly linked to maturity status. With this knowledge it can be accounted for and assessed within the use of Talent detection for sports academies and national governing bodies alike.

In this study, bio-banding will be used as a tool to compare jumping ability to observe the relationship between performance and biological age. This offers an opportunity to create a continuum that allows practitioners to compare athletes jumping ability specific to maturational age, and to observe standards between athletes of a similar biological age, instead of chronological age. Outliers above the average may be deemed as a talented athlete, or talent potential. It can be hypothesised that a linear relationship with jumping ability and maturation will be observed, which can then be directly applied to TDE models to allow for a more inclusive method of assessment. Furthermore the identification of activity will be monitored to observe the difference and relationship the status has on jumping ability, maturation and TDE. It is of interest of this research to observe if those who are above the average for jumping ability of their specific biological age, are also those whom are deemed as more active, forming a potential link to the development of talent. However the primary objective is to establish a relationship between biological age and performance, and whether a continuum can be developed for the use of TDE that considers biological age as a stronger determinant of athlete identity then chronological age, or skill specific testing as found in TID.

Methodology

Participants

Prior to athlete recruitment, ethical consent was attained from the University of East London research ethics committee, and was determined to be in line with the Helsinki declaration. 137 Bengali school students, aged 11-18 years with mixed ability and sporting experience were recruited to take place in this study. Due to the age of the participant, assent forms and gatekeepers were used to gain consent per participant, with testing being done during school physical education classes. The session was initiated with verbal and written information on the assessment for approval. The participants were divided into 72 girls (age = 13.09yrs ±1.63) and 65 boys (age = 14.14yrs ±1.91). Further details on participant information can be found in table 1.

Procedures

Participants were organised to attend testing sessions during school PE lessons. Students completed consent forms and had a briefing on the research, and then underwent a familiarisation day allowing the opportunity to practice using the testing equipment without exerting themselves at least 24-hours prior to the main testing session to avoid fatigue. On testing day, participants underwent a standardised warm-up that consisted of a light jog and dynamic stretching to adequately prepare the body for testing (Fully detailed protocol for the warm-up can be found in the appendix). Testing was carried out on a laminated wooden floor, which forms part of a school sports hall.

Activity Questionnaire

To calculate activity status per individual, participants were asked to complete the Physical Activity Questionnaire for adolescents (PAQ-A). The full assessment can be found in the appendix. Before beginning, the participants were re-assured that it was not a test, and that full honesty was required for an accurate outcome. The investigator checked for any missing or unchecked details before proceeding to practical elements of the research.

Table 1. *Subject characteristics of boys and girls. Further breakdown of participants by age has been included to identify the grouping per age group. Data is displayed as a mean ± standard deviation.*

	Girls n = 72	Boys n = 65
Age (years)	13.09 ± 1.63	14.14 ± 1.91
Height (cm)	152.90 ± 8.35	161.89 ± 10.86
Seated Height (cm)	125.03 ± 5.24	128.29 ± 8.59
Mass (kg)	46.75 ± 10.46	55.80 ± 15.33
11-12 years	n = 19	n = 13
12-13 years	n = 17	n = 9
13-14 years	n = 16	n = 12
14-15 years	n = 7	n = 10
15-16 years	n = 9	n = 6
16-17 years	n = 3	n = 11
17-18 years	n = 1	n = 4

Maturity Status

Maturity status was estimated using Mirwald's equation (2002), estimating how far the participant is from PHV (in plus or minus years). This required a number of anthropometric measurements, where there interactions (multiplications) to one another are used within a regression equation. To calculate maturity status, the required anthropometric measurements are; standing height, seated height and bodyweight measures. Measures of stature were taken using a stadiometer (Seca, UK). Standing height was taken in accordance to the ISAK protocols (2001) for a freestanding measure, ensuring the participant maintained contact with the stadiometer with the heels, buttocks and upper back, and with the head in the Frankfort plane. A deep breath was taken in, and the measure was acquired at the end of the inhalation. Seated height was taken with the subject sat on a box and the same protocol as used with freestanding. Bodyweight was taken with a set of medical standard scales (Seca, UK) with the participant wearing shorts, t-shirt and socks. The recorded data was then entered into an excel spreadsheet that utilised the prediction equation provided by Mirwald *et al.* (2002) which is calculated as shown in equations 1 & 2 below where an interaction is the multiplication of the stated variables;

Maturity Off-set for Boys = -9.236 + 0.0002708 • leg length and sitting height interaction – 0.001663 • age and leg length interaction + 0.007216 • age and sitting height interaction + 0.02292 • weight by height ratio **(1)**

Maturity Off-set for Girls = -9.376 + 0.0001882 • leg length and sitting height interaction + 0.0022 • age and leg length interaction + 0.005841 • age and sitting height interaction – 0.00266 • age and weight interaction + 0.07693 • weight by height ratio **(2)**

Vertical Jump

The vertical counter-movement jump (VJ) was tested using a Just Jump mat (FSL Jump Mat, Ireland). Participants were informed that they are expected to bend the knees to initiate the jump and to absorb the landing, but whilst in the air they must keep the legs straight. Any tucking of the legs would result in a foul attempt that would need to be repeated. Participants were instructed to jump as high as they can, using a dip with a self-prescribed depth. Three jumps were taken, with a minimum of 60 seconds rest between jumps and demonstrating a readiness to repeat. Jump height was calculated using the Just Jump software, which utilises the equation: $h=g \cdot t^2/8$ (where h is height (m), g is the acceleration of gravity (9.81m/s^2) and t is flight time (sec)). An adjustment equation was used as jump matts have been proven to over predict jump height results, and therefore a validated equation can be used to ensure they are in line with what would be established using a force plate: $Y=0.987x-0.801$ (x being the jump mat score) (Caireallain & Kenny, 2010). A predication equation was then used to estimate peak force: $PP=60.7 \cdot Y+45.3 \cdot M-2055$ (Y is adjusted jump height (m), M is body mass (kg)) (Sayers *et al.,* 1999). The highest recorded jump was used for statistical analysis, whilst an observation of the coefficient of variance between jumps was also recorded. Those with a high coefficient of variance (>10%) were excluded from analysis due to questionable reliability.

Horizontal Jump

The Horizontal Jump (HJ) was measured using a tape measure. Participants were instructed to place there feet behind a marked start line, and to jump as far forwards as they can. A self-prescribed counter movement depth was used throughout. Measures were taken from the start line to the heel of the rear foot following a successful jump. A clean landing was required for an acceptable measure. Any loss of balance resulting in placing the hands on the floor or re-adjustment of the feet resulted in a foul attempt that would need to be repeated. Jumps had to be initiated from a standing start, and any re-adjustment of the feet moments before jumping resulted in a foul measure. Three attempts were recorded with a minimum of 60 seconds rest between jumps and a readiness to repeat. Measures were recorded to the nearest centimetre. The highest recorded jump was used for statistical analysis, and observations of coefficient of variance were recorded as with the VJ, with those reporting large variance (>10%) were removed from statistical analysis.

Statistical Analysis

Participant data was entered into a formulated excel spreadsheet to provide maturity status using the equation validated by Mirwald *et al.* (2002). Jump performance was recorded in addition to coefficient of variation to ensure valid and acceptable performances were recorded. Any results that demonstrated high levels (>10%) of coefficient of variation were removed from usage of further analysis. An adjustment equation was used to allow for transfer of results from jump matt to estimated force plate output, through a reliable equation developed by Caireallain & Kenny (2010) due to the differences between devices (although both demonstrate high reliability). Peak power was estimated using a formula validated by Sayers *et al.* (1999) to establish individual peak power performances. Participants PAQ-A's were scored in-line with the PAQ-A manual (Kowalski, Crocker & Donen, 2004) to establish activity status per participant. All data was then entered into statistical software (SPSS, Version 24) for further analysis. The data was checked for normality and skewness or kurtoses prior to undergoing correlation testing. If normality is attained, Pearson's correlation would be used, whereas if the data is not normally distributed, a spearman rank correlation would be used for statistical analysis. Relationships were established throughout these results using Hopkins (2006) measures of very small (<0.1), small (0.1-0.3), moderate (0.3-0.5), large (0.5-0.7), very large (0.7-0.9) and nearly perfect (0.9-1).

Results

Both the VJ and HJ data was checked for reliability using the coefficient of variation, where attempts within limits of 10% were permitted as acceptable, and those fewer than 5% being of high reliability. Any data that exhibited a number of jumps deemed as either questionable (11-15%) or unreliable (>15%), resulted in being excluded from statistical analysis, inline with other research methods (Brady, *et al.*, 2018; Atkinson & Nevill, 1998). This was more notable in the vertical jump then the horizontal jump, in both boys and girls. Out of the tested 72 girls, only 45 were valid for use in the vertical jump whilst 62 in the horizontal jump. From the 65 boys, 56 were satisfactory for use in the vertical jump and 62 were included in the analysis of the horizontal jump. This resulted in establishing two groups of tested cohorts per gender, some of which individuals featured in both groups, and some that only featured in one group.

The anthropometric data was used to estimate biological age as years from PHV using the regression equation from Mirwald *et al.* (2002). The results for both boys and girls are displayed below in figure 4. This was determined prior to statistical analysis giving that one of the variables to correlate would be the maturity status of participants. The graph displays where participants are in relation to PHV and chronological age, which is set at 0. Therefore a participant with a minus year status would be pre-PHV, and contrary those with a plus year would be post-PHV by the appointed time scale.

The data was tested for normality using Shapiro-Wilkes, and visual inspection of Q-plots. In all cases the results demonstrated significant findings in one or more variables, which resulted in using non-parametric statistical analysis. The data was run through a Spearman's Rank correlation and the data was analysed for significant correlations.

Relationships have been established throughout these results using Hopkins (2006) measures of very small (<0.1), small (0.1-0.3), moderate (0.3-0.5), large (0.5-0.7), very large (0.7-0.9) and nearly perfect (0.9-1). Any results exhibited that demonstrate less then 0.3 are regarded as too inferior to deem as acceptable to contribute towards the outcome.

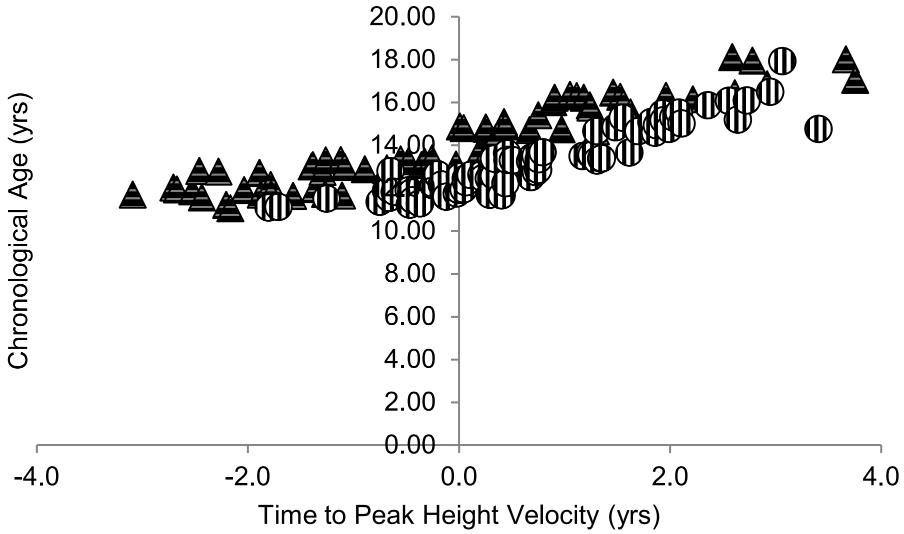


Figure.4 *The comparison of age and the predicted years from PHV for girls (dots) & boys (triangles) overlapped, using the Mirwald et al. (2002) equation.*

As noted in table 2 there were found to be a number of strong correlations with variables associated with the prediction equation from Mirwald *et al*. (2002), used in this study for prediction of maturity.

Table 2. *Correlations between maturation and associated variables to the Mirwald prediction equation. Data shows the correlation strength and the significant (p) value.*

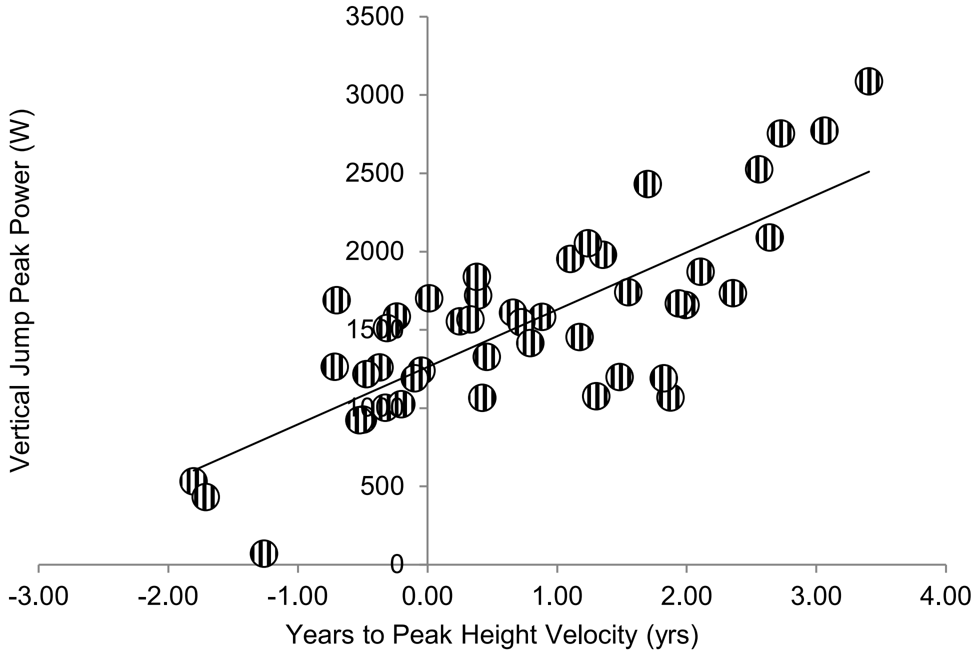
	Girls		Boys	
	VJ (n = 45)	HJ (n = 62)	VJ (n = 56)	HJ (n = 62)
Age (years)	0.922	0.887	0.930	0.930
	p = 0.00	p = 0.00	p = 0.00	p = 0.00
Height (cm)	0.693	0.739	0.890	0.903
	p = 0.00	p = 0.00	p = 0.00	p = 0.00
Weight (kg)	0.744	0.780	0.695	0.727
	p = 0.00	p = 0.00	p = 0.00	p = 0.00
Leg Length (cm)	0.518	0.484	0.685	0.707
	p = 0.00	p = 0.00	p = 0.00	p = 0.00

Results from the girls demonstrated that neither the vertical or horizontal jump had significant correlations with any other variable. However there were correlations established with peak power of both jumps. There was a large correlation to maturity using vertical jump peak power ($n = 45$, $\rho = 0.68$, $p = 0.00$) and a medium correlation using horizontal jump peak power ($n = 62$, $\rho = 0.4$, $p = 0.00$) (Figure.5). Further results for the girls demonstrated a very large correlation with leg length and height ($n = 45$, $\rho = 0.89$, $p = 0.00$) and nearly perfect correlation between maturity and age ($n = 45$, $\rho = 0.92$, $p = 0.00$). There were no correlations established between activity status and any other variables with the girls.

In the boys there were large correlations with vertical jumps ($n = 56$, $\rho = 0.58$ / 0.66, $p = 0.00$ / 0.00) and very large correlations with horizontal jumps ($n = 62$, $\rho = 0.71$ / 0.74, $p = 0.00$ / 0.00) with maturity and age respectively. Maturity also demonstrated very large correlations with both VJ peak power ($n = 56$, $\rho = 0.84$, $p = 0.00$) and HJ peak power ($n = 62$, $\rho = 0.82$, $p = 0.00$) (Figure.6). Chronological age also demonstrated a very large correlation with VJ peak power ($n = 56$, $\rho = 0.73$, $p = 0.00$) and HJ peak power ($n = 62$, $\rho = 0.8$, $p = 0.00$). Furthermore, the boys also exhibited nearly perfect correlations between maturity and age ($n = 62$, $\rho = 0.93$, $p = 0.00$), height and maturity ($n = 62$, $\rho = 0.90$, $p = 0.00$) and very large correlations with leg length and height ($n = 62$, $\rho = 0.88$, $p = 0.00$). The boys also displayed a small inverse relationship between activity status and weight ($n = 62$, $\rho = -0.27$, $p = 0.03$), but only within the group of athletes accepted from the HJ group. Figure 7 demonstrates a visual representation of both genders on the same graph and there relationships between maturity and different peak powers of each jump variation.

To further understand the impact of performance based on biological age, cohorts were further broken down into chronological age groups and performances analysed. Within each group, using mean and standard deviations, it was possible to divide participants into early, average and late maturing. From this data means were established per grouping to establish the average performance of early, average and late maturing individuals per group,

A)



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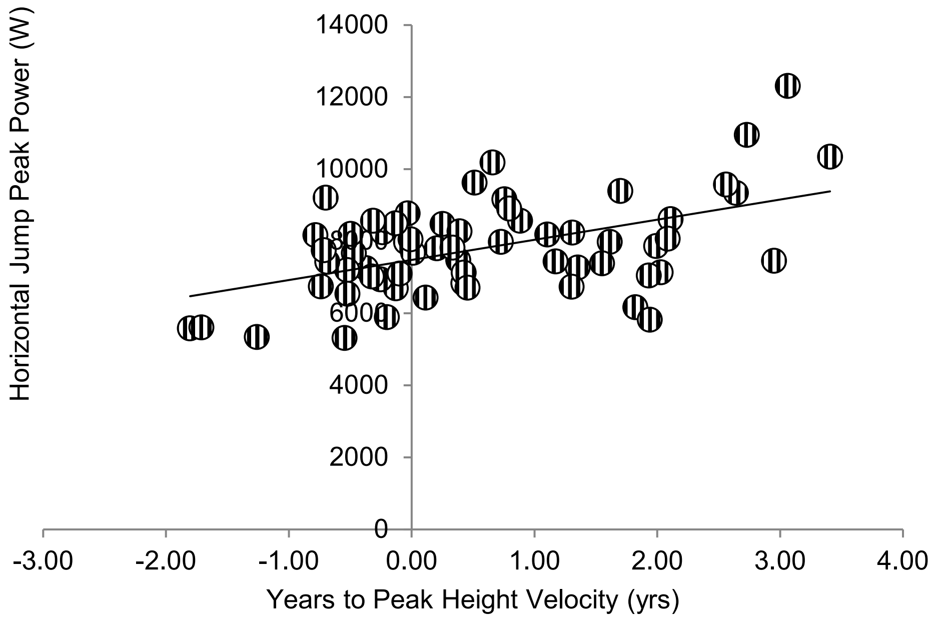
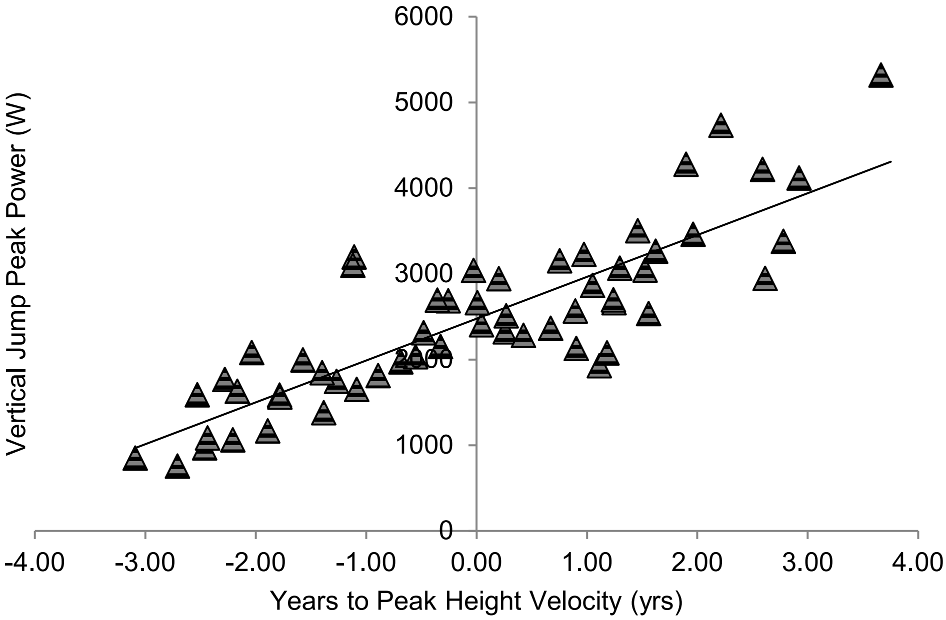


Figure.5 *The relationship between A) vertical jump, and B) Horizontal jump peak power and biological age amongst girls.*

a)



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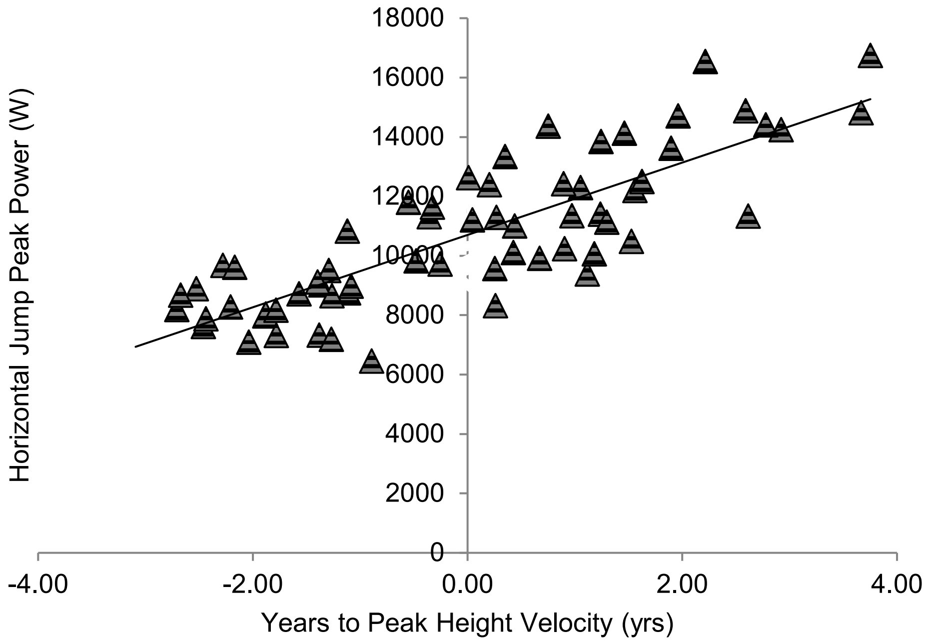
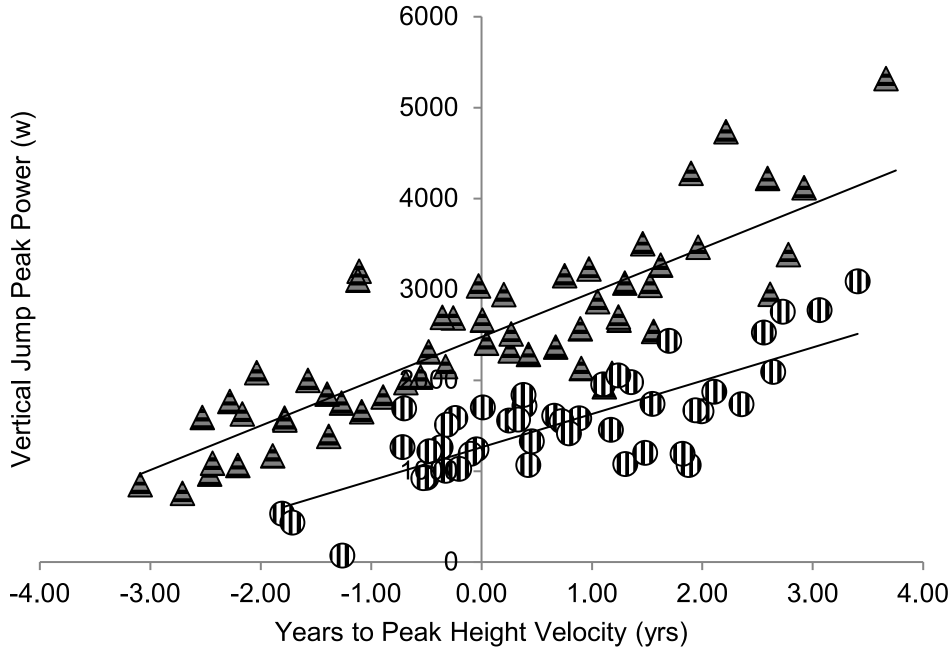


Figure.6 *The comparison of biological age and peak power results for vertical (a) and horizontal (b) jump performance in boys.*

A)



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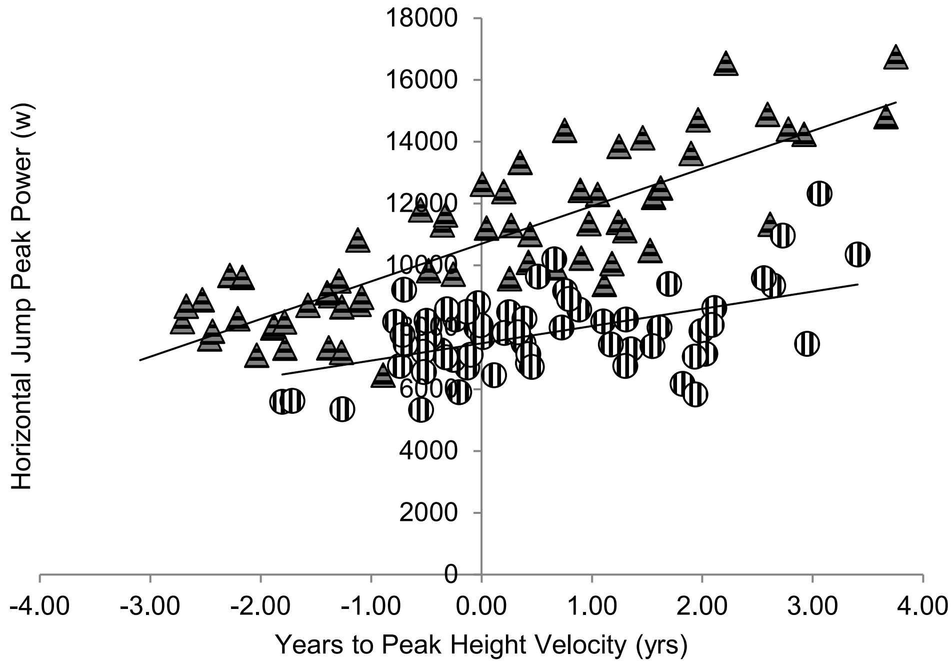

Figure.7 *The comparison of biological age and peak power in A) vertical jump, and B) horizontal jump in both boys (triangles) and girls (dots).*

and entered into SPSS to carry out a independent samples Kruskal-Wallace test. Within the girls it was established that there was a significant (p = <0.05) correlation between groups in both the VJ and HJ (n = 53). A difference was established between late (n = 9) and average (n = 35) maturing individuals in both VJ (p=<0.5, DF=1, 5.09) and HJ (p=<0.05, DF=1, 4.24), and late (n = 9) and early (n = 12) individuals in both VJ (p=<0.05, DF=2, H=6.54) and HJ (p=<0.05, DF=2, H=6.1). No significance was found between early and average maturing individuals in the girls. No significance was established within any of the variables of the boys.

Discussion

The utilisation of maturity assessment within talent identification and detection screening is currently lacking, which is arguably a key variable essential to pursue. There has been a strong advocacy of maturational assessment to be administered within the TID protocol to aid the inclusion of the children over excluding them (Vandendriessche *et al.,* 2012; Myburgh *et al.,* 2016; Cumming *et al.,* 2017). This lends to the use of TDE, so that the requirement of specific skills will not benefit one athlete over another in given tasks. The purpose of such assessments is to allow for fair screening and identification around age gaps biologically. This research has set out to provide detail around whether there truly is a relationship between typical TDE tests, such as jumping ability and maturity status, with strong results and support for its implication. As the results from this research demonstrate, there is a moderate relationship with maturation and both VJ and HJ with the boys, and a strong relationship between maturation and both VJ peak power and HJ peak power in both boys and girls, demonstrating and identifying a bridge between performance and biological status.

Maturity demonstrated a significant correlation with a number of the variables (age, height, weight, leg length), which was anticipated considering the equation to predict maturation requires the use of measurements from all of these variables. Therefore, it is encouraging to report on these correlations to support the works of Mirwald *et al.* (2002). In the cohort of athletes used in this study it is interesting to note that there was particular traits that seemed to align to specific genders. Both genders displayed correlations with height and weight, with maturity and age, but it was evident that the girls seemed to have stronger correlations with weight, whereas boys had a strong correlation with height. Although not thoroughly detailed throughout the work of Mirwald *et al.* (2002) it is clear to see a difference between genders within the equations, with a heavier weighting towards height for boys and an additional variable for the equation of the girls including further use of weight. We can postulate that our findings from this research support the use of differentiated equations based on weight and height biases per gender, in relation to maturity prediction. Furthermore the significance between all the associated variables clearly demonstrates good relations with the use of the equation, and potential to run a regression analysis, although the authors of this thesis did not endure this process as it was outside of the scope of the research question.

Jumping Performance
The essential question this research endeavoured to explore was the relationship between jumping ability and maturation. Due to the differences in the onset of maturation between genders, to answer this question it was important to explore the results firstly between genders. The results were able to demonstrate a large and very large relationship between both vertical jump and horizontal jump, and maturation in boys. However, we were unable to offer similar findings within the cohort of girls. With the use of Peak Power as a variable, the results demonstrated positive correlations across both jumping variables within both genders. No findings were found in relative peak power in either genders. These findings are similar to a number of other researchers who also found significance with Peak Power, yet no correlation to relative peak power (Pichardo *et al.,* 2017). This offers insights that athletic ability is potentially inherent with biological age as demonstrated with both vertical and horizontal jump performances in boys, and peak power performances in both boys and girls.

A study by Radnor *et al.* (2017) detailed the development of the anatomical system inherent with plyometric tasks, describing the process of developments across maturity. This offers a strong explanation specific to both jump performance correlations and peak power correlations to maturity found in this research. Although Radnor *et al.* (2017) state a more long-term observation is required, the concept of physiological developments such as reflex contraction, motor unit recruitment and muscle architecture (to list a few) are plausible as rationale to explain such results found in this research. A similar study looked at the difference between youth and adult muscular ability, stating a lack of usage of higher threshold type ii fibre motor units as a key finding for youths (Dotan *et al.,* 2012). Other recent studies have looked at the plyometric landing ability across maturation, and found a consistent result in landing control of the knees across ages improving as the individual matures (Read *et al.,* 2018; Fort-Vanmeerhaeghe *et al.,* 2018). Although this does not directly support the results of this research, it provides further evidence aligned to the biological developments playing a role within the task of jumping. A study by Mero & Vuorimaa (1990) established that androgenic-anabolic activity plays an essential role in jumping ability, in particular testosterone/cortisol ratios. This specifically coincides with the process of puberty and aligns with the fact that those who are early matured will have more levels of testosterone, and therefore be able to outperform their peers who are average or late maturing. We also know that the levels of testosterone are far superior in boys then in girls, which we could estimate being one of the reasons it may not have as strong correlations with the girls. Lloyd *et al.* (2014) state the gender differences inherent with puberty, specifically the joint laxity, hamstring to quad utilisation ratio, to list a few within the females, which may also be related to our results. Considerations may need to be taken to establish a different set of exercises that are more appropriate to the female gender within TID and align to maturation.

The results from this study echo a previous research that labelled growth and maturation as confounding predictors of potentially talented athletes (Vandendriessche *et al.,* 2012). A downfall to the research by Vandendriessche *et al.* (2012) is the recommendation to remove elements of physical testing within TID due to not being able to account for the effects of maturation. Although it has been established in their research, as is in the current one, that those who are more physically developed will achieve higher performance scores, they missed the opportunity to develop a scaling process to account for biological age within the physical assessment process. Vandendriessche *et al.* (2012) note that a level playing field will be attained in physical development in adulthood, which we know from growth charts demonstrates a range of tempos specific to speed of biological age development. It is therefore of believe that skill based assessment can be used at young ages specific to set sports as agreed with the research of Vandendriessche *et al.* (2012) finding no bias present to biological age, however we would not support the notion of removing physical testing, but advocating the development of biological age scaling. In this study, it has been possible to create an average trend line that resembles the average peak power explicit to a biological age. Furthermore with our results we are able to create an average trend line of jumping performance for the boys, as significance was attained. It can therefore be postulated that those who are able to outperform this standard can be deemed as above average, otherwise termed as a “talent potential”. The essence of this implies that another athlete (assumed to be early maturing) of the same chronological age may produce a larger absolute peak power or jumping performance, however now be scored as a lower standard compared to the mean based on biological age. This allows a novel opportunity to identify athletes of great potential that may have previously have been deselected (to those with higher absolute jumping scores) within the TID process, through the method of TDE. Whether this model allows for a finer identification of talent and the “hidden gems” can only be speculated, but it certainly unveils a method not currently used that is both easy to include and to calculate. It can be postulated that, alongside current research, this method of assessment will certainly benefit the closed loop sports for talent prediction (Vaeyens *et al.,* 2008). It is unfortunate that at present the results of this research did not demonstrate the same relationship between jump performance and maturity with the group of girls. However it is not uncommon to demonstrate gender specific traits within Talent screening (Lätt *et al.,* 2009).

Traditional usage of maturity has resulted in grouping individuals into average, early and late maturing (Mirwald *et al.,* 2002). Although the aim of this research was to look at maturity on a continuum, it was within the interest of the research to identify whether on the whole there was a consistency of results from any of the groups. Although this research hypothesised advance biological aging will provide an advantage, it was clear from further statistics within the girls that a delayed biological age (late maturing, n = 9) did result in a disadvantage to performance in both VJ and HJ. These findings were not replicated within the boys however. The researcher is not aware of any other studies that have reported on such findings, but plenty who have speculated such results (Myburgh *et al.*, 2016; Cumming *et al.,* 2017; Lloyd *et al.,* 2014). However, this research was not able to identify that early maturing individuals (n = 12) outperformed average maturing (n = 35) individuals. It is suggested to take these results lightly, as an issue with such reporting may come down to the limited cohort of participants per maturity grouping. Although a substantial quantity fulfilled the mean (average maturing) cohorts, there were limited

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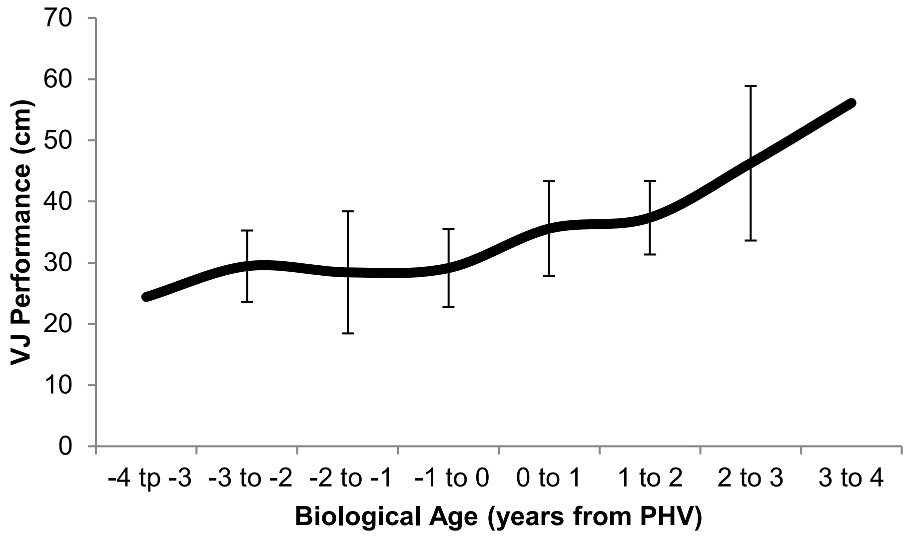

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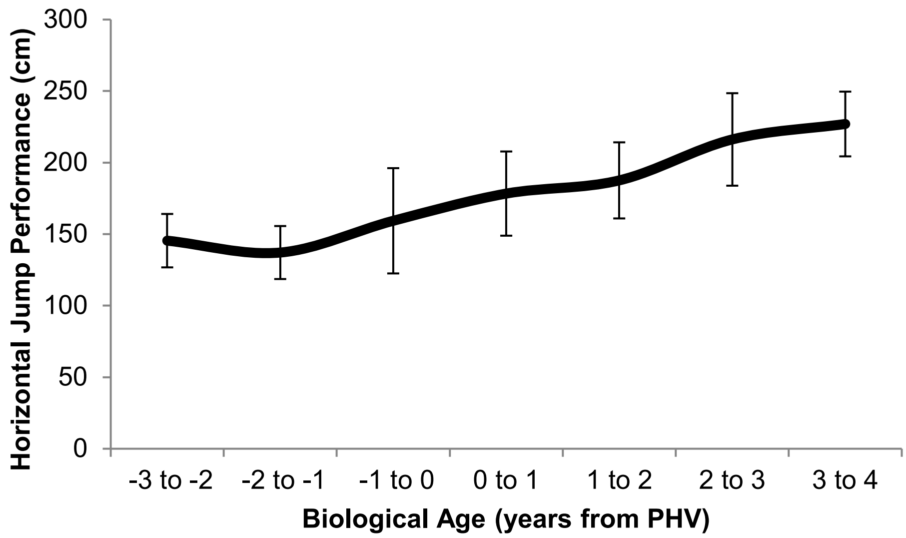

Figure.8 *The trajectory of mean performances per biological age as categorised by years pre or post PHV. The diagrams show both the mean and standard deviations for the VJ (a) and HJ (b) performance for boys of the current study.*

quantities representing the early and late maturing groups. This somewhat challenges the robustness of these findings and therefore determines their use to be nothing more of an observation within this research. It was of interest to note that the VJ, in both boys and girls, reported far higher incidents of

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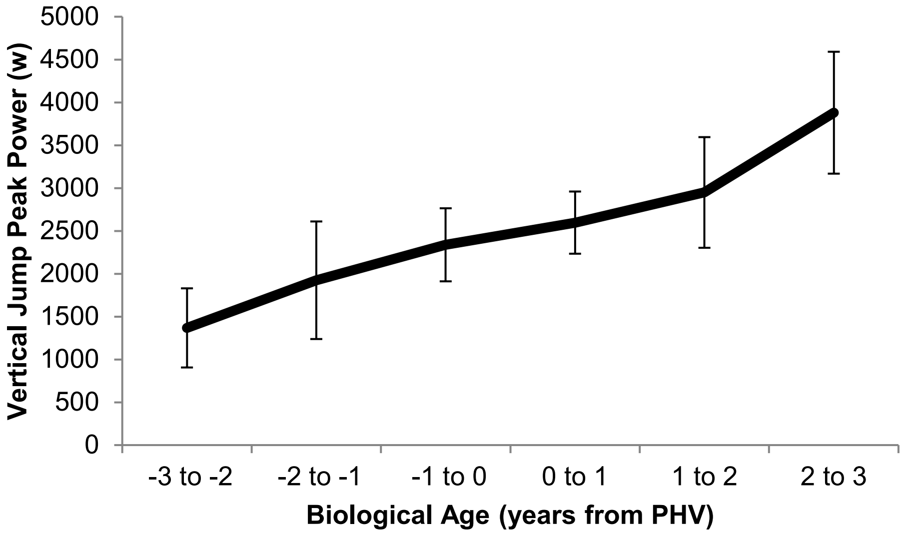

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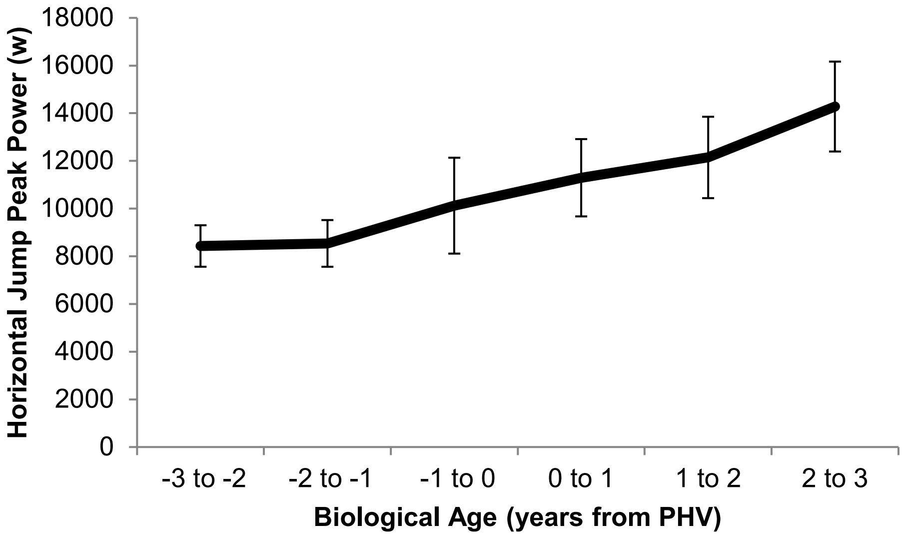

Figure.9 *The trajectory of mean peak power in boys across biological age pre and post PHV. The diagrams show the mean peak power and standard deviations for (a) vertical jump and (b) horizontal jump in the boys.*

unreliable variations between attempts, than that of the HJ. In the girls 38% of the participants were excluded in VJ compared to 14% in the HJ. For the boys it was 14% to 5% respectively. In both cases this demonstrated 2.8 times more error in the VJ then the HJ. Considering the VJ is the more commonly used exercise within the TID protocol, and research has deemed the VJ to be a very natural and inherent skill (Wang, Lin & Huang, 2004; Vanezis & Lees, 2005), it was of surprise to establish these results and especially when

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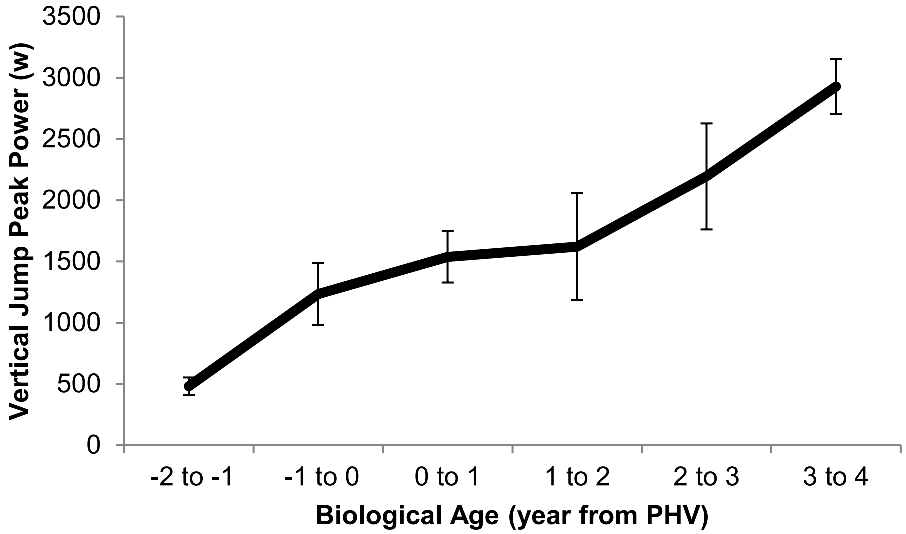

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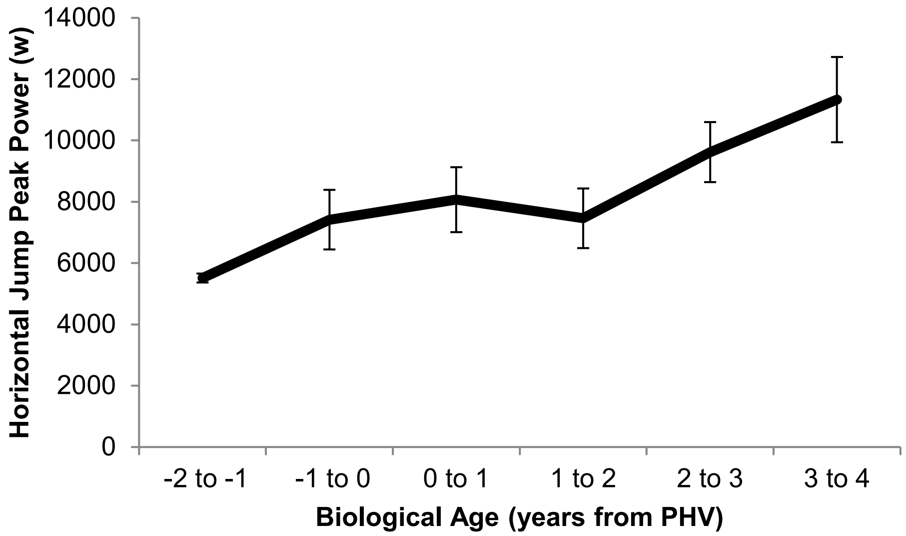

Figure.10 *The trajectory of mean peak power in girls across biological age pre and post PHV. The diagrams show the mean peak power and standard deviations for (a) vertical jump and (b) horizontal jump in the girls.*

compared to the HJ which anecdotally appears to be more challenging to execute (from observations). One belief may lie in the concept an external focus being more evident in the HJ considering there is a clear distance to aim for (Wulf *et al.,* 2007). This currently lacks in the VJ test employed in this research, which could be resolved with the use of equipment such as a vertec. This would allow a visible goal, and an external focus to attain and strive to reach. This method has been validated as a successful method to attain true representations of jump height over purely being instructed to "jump as high as you can" (Wulf *et al*., 2007). However, there are currently plenty of researches that do not operate with an external focus and have equally reliable results. Regardless, the HJ was clearly the more reliable of the two tests to use as an assessment as reported in this research. Furthermore, the variables we are able to establish using the VJ on force plates far outweighs the HJ and the use of a jump mat. Therefore it may be suggested to use VJ when there is such access to these resources, providing an in depth understanding of jumping ability through numerous validated variables, otherwise recommending HJ for improved reliability of results with little resources.

During the introduction of this study it was discussed between the difference of "giftedness" and "deliberate practice", the arguments of how professional skills are obtained between Gagné (2004) and Ericsson, Krampe & Tesch-Römer (1993). Gagné's belief being a natural born gift of talent, whilst Ericsson promoting the development of skill through intentional and focused practice. For this reason the study included the use of an activity status questionnaire to observe whether those who are more active, and therefore potentially encountered more athletic or fundamental movement exposure, would also be more likely to perform better in such assessments featured in TDE. Although this would not necessarily provide the answer to the debate, it offered an insight that those who are more active did not significantly achieve greater jumping performances to those who did not ($p=>0.05$). What was of particular interest was actually that the athletes who were isolated towards sports due to early identified athletic success, actually produced activity status results that were average for the cohort, and may not reflect them being particularly active compared to their peers. Additionally, there was no manner to identify whether those who did partake in more activities did so via deliberate practice, and therefore its unfair to interpret these results as a fair mechanism to answer this on-going debate.

Activity status is commonly used to provide feedback on the health and behaviour of individuals and populations (Chinapaw *et al.,* 2010; Lee *et al.,* 2011; Hagströmer, Oja, & Sjöström, 2006). In particular it is used to identify populations at risk from health diseases such as obesity and related issues such as diabetes (Lee *et al*., 2011). This is most commonly used with adults to predict areas at risk of health, although the verified assessments used are specific to adolescents for similar reasons (Chinapaw *et al*., 2010). Therefore it was of surprise to note that there was little to no relationships observed between weight and activity status. Further tests were also performed to establish whether BMI and activity status produced relations, with no significant outcomes to be established (p=>0.05). In one of the groups of boys there was a small correlation to weight, but this was not replicated in any other group. As stated from the start of this study, activity status was a secondary observation that would be recorded to establish whether there are any interesting results to be acknowledged, however we were unable to confirm any meaningful results for the use of activity status during this research.

The findings of this research truly magnify the need to further explore the role of biological age within athletic assessment. Furthermore it provides evidence for the use of TDE as a method of talent screening, over the commonly used TID methods. The results enabled the construction of gold standards for assessments that account for maturity within it’s grading criteria, to allow fair comparison between individuals of the same chronological age and different biological status. A study by Meyers *et al*. (2015) was able to demonstrate similar findings in boys sprint performances, with the advanced maturing individuals outperforming the average and late maturing individuals. Such questions have been asked within areas such as sports training, and aligns to current works of researchers who are at present using maturation as a variable for assigning players to specific age status teams, with early results looking promising (Cumming *et al*., 2017; Cumming *et al*., 2018; Lloyd *et al*., 2014). Other researches have confirmed the current trend to select players more biologically advanced then their peers, resulting in exhibiting superior physical ability (Myburgh *et al*., 2016), and even further acknowledgment that these advantages are short lived over the following years when the average and late maturing peers “catch up with them” (Kramer *et al*., 2017). This further supports the application of maturity within the Talent screening and selection process so not to expend unnecessary investments in developments to athletes who will endure short-lived success. This specifically benefits “closed skill” sports, whereas sports such as invasion team sports have recently benefitted from small sided games as a strong mechanism of identification where its been established that biological status does not impact performance (Vaeyens *et al*., 2008).

Limitations

A potential limitation of this study is within the use of the prediction equation for maturity itself. The prediction equation depends on accurate and consistent measurements by the researcher, with the most risk of variation with the sitting height measure that will significantly magnify an error using this equation (Koziel & Malina, 2018; Malina & Koziel, 2014a; Mirwald, Baxter-Jones, Bailey & Beunen, 2002). This can be reduced through the adoption of internationally accepted protocols, as this study does, but more so through qualifications in anthropometric assessments. In addition to this, it is noteworthy that the prediction equation has been studied to some length, and has been reported to demonstrate systematic deviation; it over-estimates PHV at older ages and under-estimated PHV of younger ages, for boys, and has a wider variation of estimation in girls' dependant on age during testing (Koziel & Malina, 2018; Malina & Koziel, 2014a; Malina & Koziel. 2014b). Further reports noted that more valid results were aligned to participants who are average maturing, whilst those who are early-, or late maturing reported an over- or under-estimation respectively (Koziel & Malina, 2018; Malina & Koziel, 2014a; Malina & Koziel. 2014b). Additional methods may offer more precise assessment or confirm maturity when aligned, such as the use of the Preece-Baines growth chart (Preece & Baines, 1978) or the Khamis-Roche method of assessing maturity (Khamis & Roche, 1994). Although none of these methods are perfect, with the landscape of bio-banding and the understanding around the variation in adolescent development process fast evolving, we can hope to see more robust methods to measure in the near future.

A similar limitation is the use of numerous equations to adjust the raw data due to lack of access to force plates. During the process of establishing peak power it is required to use an adjustment equation to recalculate jump mat data to align with force plate data (Caireallain & Kenny, 2010), and then a further equation can be used to estimate peak power (Sayers et. al, 1999). Although these equations have both been validated in isolation, it is uncertain how reliable they are working in unison. For this study the use of the jump mat brings the advantage to enhanced in-field testing, in line with the demands of talent identification. However, with the evolvement of scientific machinery in sports science, portable force plates have now been created that would undoubtedly establish more accurate results and remove the need for the adjustment and prediction equations, whilst offering far more variables on top of this. Should financial resources stretch to this demand, it would be suggested to use a portable force plate over a jump mat to enhance the accuracy of results.

In regards to the participants it was clear that the cohort of girls did not display any participants younger than -2 years from PHV, with a mass of the cluster around -1 years and a select few younger than this. This study was therefore unable to see the performance variations of athletes prior to PHV. The cohort of boys was able to demonstrate a better spread of biological ages and might be one of the reasons for enhanced results established in this study. It might be speculated that there may have been a difference in results if the cohort of girls had been younger, to match the range achieved by the boys.

Finally, it was apparent through observations that the motivations of various athletes hindered some of the results, in particular regards to the females. Where it was clear to see the younger girls were very much competitive with one another to out perform each other, it was clear that the older girls would intentionally be more reserved from true performance. This was notable from the higher variation in attempts from certain individuals, which was less apparent in the majority of younger girls and all of the boys.

Practical Applications

National governing bodies, sports academies and sports organisations alike, should considering the findings of this research for purposes of TDE. This research offers a firm rationale for the integration of biological age assessment as a part of athlete profiling within the TDE protocol, and it is therefore advocated that a replication of this process be utilised for further understanding and enhancing the TDE process within organisations current protocols. Furthermore, using a performance result measured against maturity may have a positive consequence of long-term success within athletic performance, although this requires further longitudinal research to confirm. The data presented has been adjusted to that of a force plate output and can be used in comparison with that of the gold standard. Figure 8 demonstrates a clear example of the results based upon biological status that can be used to understand the results based on biological standard. Further figures 9 & 10 can be used for both boys and girls for the comparison of peak power performances per biological age. Peak power has been reported by other researchers as a significant method interlinked with changes with maturation, similar to this study (Pichardo, 2017). This can allow for more long-term observations and clarification of true ability to be realised for all maturity statuses across both genders. Furthermore this overcomes some of the issues of discriminations against those less physically developed of the same chronological age, during selection.

Conclusion

This research was able to identify a relationship between jump performance and maturity within males. Furthermore it was able to demonstrate a strong relationship between peak power and maturity in both boys and girls. This offers insights that there is reason to account for maturity within a talent screening protocol. It was also evident that average and early maturing individuals significantly outperformed late maturing girls, further distinguishing the disadvantages present to those less developed physically. However a weakness within this research was within the cohort that lacked a younger biological age of the girls. Furthermore this research has a dependency on the use of adjustment equations, which can be removed with the use of force platforms during data capture. Similarly the use of a predication equation to establish maturity of individuals, which demonstrates systematic error in early and late developing individuals, but does however distinguish performance both pre and post PHV unlike other available equations. This report would suggest more research needs to be undergone to establish a stronger method to assess maturity, and if similar relationships between typical TDE tests and maturity can be established in other commonly used exercises such as linear sprints, isometric strength exercises, to list a few. However there is confidence that maturity does influence performance in protocols such as TDE. It is encouraged that organisations such as NGBs and sports organisations alike use this study to determine their own outcomes using a similar method of assessment, to allow a fair representation of performance based on maturation. Furthermore this study also suggests the improved usage of TDE as an appropriate screening tool to that of TID, offering an unbiased method of physical assessment that determines those with physical abilities superior to their peers with the removal of skill familiarisation, which may impact the success to talent selection. It is with confidence that maturity status plays an essential role within the talent screening process, which needs to be confirmed with further research overcoming the limitations of this study.

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Appendices

Appendix 1 – Standardised Warm-Up

Exercise.1 – Running with reaction drills

Participants run around cones set out in a big circle. On the action of claps, the participants will react according to the quantity of claps. Duration of run will be 5 mins.

1 clap – jump in the air

2 claps – touch the floor

3 claps – reverse direction of running

Exercise 2 – Stretches

Participants will undergo dynamic stretches of the lower limbs by undergoing the following exercises as a short circuit for two sets.

Inchworms x 5 reps

Lunges with twist x 3 reps per leg

Squats x 5 reps

Exercise 3 – Potentiation

Participants will undergo a short game of hurdle hops and hoop hops to prepare the body for the exercise of jumping. There will be 5 hurdles set out close together and 4 hoops set apart for distance. 2 sets of this will be executed.

Appendix 2 *Physical Activity Questionnaire for Adolescents (PAQ-A)*

PHYSICAL ACTIVITY QUESTIONNAIRE (ADOLESCENTS)

NAME:__________________________ DATE OF BIRTH :____________

SEX: M ☐ F ☐ CLASS/FORM:_______ SCHOOL: OAK / STEP / SJC MOR / SWAN

THERE ARE NO RIGHT OR WRONG ANSWERS – THIS IS NOT A TEST

PLEASE ANSWER ALL QUESTIONS AS HONESTLY AND ACCURATELY AS YOU CAN.

1. Physical activity in your spare time: Have you done any of the following activities in the past 7 days (last week)? If yes, how many times? (Mark only 1 box per row)

	No	1-2	3-4	5-6	+7
Skipping	☐	☐	☐	☐	☐
Rowing / Canoeing	☐	☐	☐	☐	☐
In-line Skating	☐	☐	☐	☐	☐
Tag	☐	☐	☐	☐	☐
Walking for Exercise	☐	☐	☐	☐	☐
Bicycling	☐	☐	☐	☐	☐
Jogging or Running	☐	☐	☐	☐	☐
Aerobics Class	☐	☐	☐	☐	☐
Swimming	☐	☐	☐	☐	☐
Baseball, Softball	☐	☐	☐	☐	☐
Dance	☐	☐	☐	☐	☐
American Football	☐	☐	☐	☐	☐
Badminton	☐	☐	☐	☐	☐
Skateboarding	☐	☐	☐	☐	☐
Soccer	☐	☐	☐	☐	☐
Street Hockey	☐	☐	☐	☐	☐
Volleyball	☐	☐	☐	☐	☐
Hockey	☐	☐	☐	☐	☐
Basketball	☐	☐	☐	☐	☐
Ice Skating	☐	☐	☐	☐	☐
Cross-country Skiing	☐	☐	☐	☐	☐
Ice Hockey/ringette	☐	☐	☐	☐	☐
Other (please list):					
Weightlifting	☐	☐	☐	☐	☐
………………………	☐	☐	☐	☐	☐

2. In the last 7 days, during your physical education (PE) classes, how often were you very active (playing hard, running, jumping, throwing)? (Check one only.)

- I don't do PE ☐
- Hardly Ever ☐
- Sometimes ☐
- Quite Often ☐
- Always ☐

3. In the last 7 days, what did you normally do at lunch (besides eating lunch)? (Check one only.)

- Sat down (talking, reading, doing school work) ☐
- Stood around or walked around ☐
- Ran or played a little bit ☐
- Ran around and played quite a bit ☐
- Ran and played hard most of the time ☐

4. In the last 7 days, on how many days right after school, did you do sports, dance, or play games in which you were very active? (Check one only.)

- None ☐
- 1 time last week ☐
- 2 or 3 times last week ☐
- 4 times last week ☐
- 5 times last week ☐

5. In the last 7 days, on how many evenings did you do sports, dance, or play games in which you were very active? (Check one only.)

- None ☐
- 1 time last week ☐
- 2 or 3 times last week ☐
- 4 or 5 times last week ☐
- 6 or 7 times last week ☐

6. ***<u>On the last weekend</u>***, how many times did you do sports, dance, or play games in which you were very active? (Check one only.)

- None ☐
- 1 time last week ☐
- 2 or 3 times last week ☐
- 4 or 5 times last week ☐
- 6 or more times ☐

7. Which ***one*** of the following describes you best for the last 7 days? Read all five statements before deciding on the one answer that describes you.

All or most of my free time was spent doing things that involve little physical effort	☐
I sometimes (1-2 times last week) did physical things in my free time (e.g. played sports, went running, swimming, bike riding, did aerobics)	☐
I often (3-4 times last week) did physical things in my free time	☐
I quite often (5 – 6 times last week) did physical things in my free time	☐
I very often (7 or more time last week) did physical things in my free time	☐

8. Mark how often you did physical activity (like playing sports, games, doing dance, or any other physical activity) for each day last week.

	None	Little Bit	Medium	Often	Very Often
Monday	☐	☐	☐	☐	☐
Tuesday	☐	☐	☐	☐	☐
Wednesday	☐	☐	☐	☐	☐
Thursday	☐	☐	☐	☐	☐
Friday	☐	☐	☐	☐	☐
Saturday	☐	☐	☐	☐	☐
Sunday	☐	☐	☐	☐	☐

9. Were you sick last week, or did anything prevent you from doing your normal physical activities? (Check one.)

Yes ☐
No ☐

If yes, what prevented you?..

GIRLS VERTICAL JUMP			age	height	weight	LegLength	Maturity	VJ	PeakPower	Activity
Spearman's rho	age	Correlation Coefficient	1	.428**	.573**	0.285	.922**	0.169	.551**	0.025
		Sig. (2-tailed)	.	0.003	0	0.058	0	0.266	0	0.871
		N	45	45	45	45	45	45	45	45
	height	Correlation Coefficient	.428**	1	.662**	.891**	.693**	0.101	.593**	-0.096
		Sig. (2-tailed)	0.003	.	0	0	0	0.509	0	0.531
		N	45	45	45	45	45	45	45	45
	weight	Correlation Coefficient	.573**	.662**	1	.509**	.744**	0.019	.835**	0.033
		Sig. (2-tailed)	0	0	.	0	0	0.903	0	0.832
		N	45	45	45	45	45	45	45	45
	LegLength	Correlation Coefficient	0.285	.891**	.509**	1	.518**	0.047	.431**	-0.156
		Sig. (2-tailed)	0.058	0	0	.	0	0.757	0.003	0.305
		N	45	45	45	45	45	45	45	45
	Maturity	Correlation Coefficient	.922**	.693**	.744**	.518**	1	0.146	.678**	-0.023
		Sig. (2-tailed)	0	0	0	0	.	0.34	0	0.883
		N	45	45	45	45	45	45	45	45
	VJ	Correlation Coefficient	0.169	0.101	0.019	0.047	0.146	1	.472**	0.023
		Sig. (2-tailed)	0.266	0.509	0.903	0.757	0.34	.	0.001	0.882
		N	45	45	45	45	45	45	45	45
	PeakPower	Correlation Coefficient	.551**	.593**	.835**	.431**	.678**	.472**	1	0.111
		Sig. (2-tailed)	0	0	0	0.003	0	0.001	.	0.467
		N	45	45	45	45	45	45	45	45
	Activity	Correlation Coefficient	0.025	-0.096	0.033	-0.156	-0.023	0.023	0.111	1
		Sig. (2-tailed)	0.871	0.531	0.832	0.305	0.883	0.882	0.467	.

		N	45	45	45	45	45	45	45	45
** Correlation is significant at the 0.01 level (2-tailed).										

GIRLS HORIZONTAL JUMP			age	height	weight	LegLength	Maturity	HJ	PeakPower	Activity
Spearman's rho	age	Correlation Coefficient	1	.454**	.555**	.273*	.887**	0.112	.282*	0
		Sig. (2-tailed)	.	0	0	0.032	0	0.387	0.026	1
		N	62	62	62	62	62	62	62	62
	height	Correlation Coefficient	.454**	1	.706**	.856**	.739**	0.105	.356**	-0.08
		Sig. (2-tailed)	0	.	0	0	0	0.416	0.004	0.534
		N	62	62	62	62	62	62	62	62
	weight	Correlation Coefficient	.555**	.706**	1	.459**	.780**	0.103	.431**	0.044
		Sig. (2-tailed)	0	0	.	0	0	0.427	0	0.732
		N	62	62	62	62	62	62	62	62
	LegLength	Correlation Coefficient	.273*	.856**	.459**	1	.483**	0.018	0.21	-0.174
		Sig. (2-tailed)	0.032	0	0	.	0	0.891	0.102	0.177
		N	62	62	62	62	62	62	62	62
	Maturity	Correlation Coefficient	.887**	.739**	.780**	.483**	1	0.149	.399**	-0.017
		Sig. (2-tailed)	0	0	0	0	.	0.248	0.001	0.893
		N	62	62	62	62	62	62	62	62
	HJ	Correlation Coefficient	0.112	0.105	0.103	0.018	0.149	1	.925**	0.007
		Sig. (2-tailed)	0.387	0.416	0.427	0.891	0.248	.	0	0.955
		N	62	62	62	62	62	62	62	62
	PeakPower	Correlation Coefficient	.282*	.356**	.431**	0.21	.399**	.925**	1	0.007
		Sig. (2-tailed)	0.026	0.004	0	0.102	0.001	0	.	0.956

		N	62	62	62	62	62	62	62	62
	Activity	Correlation Coefficient	0	-0.08	0.044	-0.174	-0.017	0.007	0.007	1
		Sig. (2-tailed)	1	0.534	0.732	0.177	0.893	0.955	0.956	.
		N	62	62	62	62	62	62	62	62
** Correlation is significant at the 0.01 level (2-tailed).				* Correlation is significant at the 0.05 level (2-tailed).						

BOYS VERTICAL JUMP			age	height	weight	LegLength	Maturity	vJ	PeakPower	Activity
Spearman's rho	age	Correlation Coefficient	1	.775**	.499**	.629**	.930**	.657**	.733**	-0.113
		Sig. (2-tailed)	.	0	0	0	0	0	0	0.405
		N	56	56	56	56	56	56	56	56
	height	Correlation Coefficient	.775**	1	.618**	.877**	.890**	.532**	.777**	0.004
		Sig. (2-tailed)	0	.	0	0	0	0	0	0.976
		N	56	56	56	56	56	56	56	56
	weight	Correlation Coefficient	.499**	.618**	1	.486**	.695**	0.086	.786**	-0.137
		Sig. (2-tailed)	0	0	.	0	0	0.528	0	0.313
		N	56	56	56	56	56	56	56	56
	LegLength	Correlation Coefficient	.629**	.877**	.486**	1	.685**	.385**	.605**	0.093
		Sig. (2-tailed)	0	0	0	.	0	0.003	0	0.494
		N	56	56	56	56	56	56	56	56
	Maturity	Correlation Coefficient	.930**	.890**	.695**	.685**	1	.580**	.843**	-0.109
		Sig. (2-tailed)	0	0	0	0	.	0	0	0.422
		N	56	56	56	56	56	56	56	56
	vJ	Correlation Coefficient	.657**	.532**	0.086	.385**	.580**	1	.634**	0.169
		Sig. (2-tailed)	0	0	0.528	0.003	0	.	0	0.214
		N	56	56	56	56	56	56	56	56

	PeakPower	Correlation Coefficient	.733**	.777**	.786**	.605**	.843**	.634**	1	0.048
		Sig. (2-tailed)	0	0	0	0	0	0	.	0.724
		N	56	56	56	56	56	56	56	56
	Activity	Correlation Coefficient	-0.113	0.004	-0.137	0.093	-0.109	0.169	0.048	1
		Sig. (2-tailed)	0.405	0.976	0.313	0.494	0.422	0.214	0.724	.
		N	56	56	56	56	56	56	56	56

BOYS HORIZONTAL JUMP			age	height	weight	LegLength	Maturity	HJ	PeakPower	Activity
Spearman's rho	age	Correlation Coefficient	1	.784**	.545**	.634**	.930**	.740**	.796**	-0.204
		Sig. (2-tailed)	.	0	0	0	0	0	0	0.112
		N	62	62	62	62	62	62	62	62
	height	Correlation Coefficient	.784**	1	.666**	.881**	.903**	.678**	.788**	-0.126
		Sig. (2-tailed)	0	.	0	0	0	0	0	0.33
		N	62	62	62	62	62	62	62	62
	weight	Correlation Coefficient	.545**	.666**	1	.543**	.727**	.278*	.496**	-.269*
		Sig. (2-tailed)	0	0	.	0	0	0.029	0	0.034
		N	62	62	62	62	62	62	62	62
	LegLength	Correlation Coefficient	.634**	.881**	.543**	1	.707**	.468**	.572**	-0.049
		Sig. (2-tailed)	0	0	0	.	0	0	0	0.704
		N	62	62	62	62	62	62	62	62
	Maturity	Correlation Coefficient	.930**	.903**	.727**	.707**	1	.709**	.821**	-0.213
		Sig. (2-tailed)	0	0	0	0	.	0	0	0.096

		N	62	62	62	62	62	62	62	62
	HJ	Correlation Coefficient	.740**	.678**	.278*	.468**	.709**	1	.963**	0.04
		Sig. (2-tailed)	0	0	0.029	0	0	.	0	0.76
		N	62	62	62	62	62	62	62	62
	PeakPower	Correlation Coefficient	.796**	.788**	.496**	.572**	.821**	.963**	1	-0.005
		Sig. (2-tailed)	0	0	0	0	0	0	.	0.968
		N	62	62	62	62	62	62	62	62
	Activity	Correlation Coefficient	-0.204	-0.126	-.269*	-0.049	-0.213	0.04	-0.005	1
		Sig. (2-tailed)	0.112	0.33	0.034	0.704	0.096	0.76	0.968	.
		N	62	62	62	62	62	62	62	62

16th February 2017

Dear Richard,

Project Title:	**The influence of maturity status on jumping performance**
Principal Investigator:	**Nicholas Bourne**
Researcher:	**Rich Kite and Gary Doyle**
Reference Number:	**UREC 1617 44**

I am writing to confirm the outcome of your application to the University Research Ethics Committee (UREC), which was considered by UREC on **Wednesday 18 January 2017.**

The decision made by members of the Committee is **Approved**. The Committee's response is based on the protocol described in the application form and supporting documentation. Your study has received ethical approval from the date of this letter.

Should you wish to make any changes in connection with your research project, this must be reported immediately to UREC. A Notification of Amendment form should be submitted for approval, accompanied by any additional or amended documents: http://www.uel.ac.uk/wwwmedia/schools/graduate/documents/Notification-of-Amendment-to-Approved-Ethics-App-150115.doc

Any adverse events that occur in connection with this research project must be reported immediately to UREC.

Approved Research Site

I am pleased to confirm that the approval of the proposed research applies to the following research site.

Research Site	Principal Investigator / Local Collaborator
Assessment will take place at various schools across Tower Hamlets, in the School Halls or Gyms of the participants, with an open door policy.	Nicholas Bourne