Systematic Review: Mechanism of Relative Age Effect in Sport

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The importance of talent identification (TID) in sports development could not be denied where it could be a change on career pathway for an athlete, and this is also might cause the talent loss when scouting the team and this are very crucial at grassroots to elite youth level. The relative age effect (RAE) has been studied widely in sports where there is an advantages and disadvantages occurred and lead to the talent loss. Many of the sports does not have a standardized TID process which most of them are based on try and error and expose to biases. Literature on this paper was obtained from computer based sources. This research paper will discuss and elaborate more on the mechanism that might be affecting the present of RAE which are maturity, playing position, gender and performance and its possible solution which is important for the future development to help researchers, sports & health professional, coaches and athletes understand the concept of RAE and the solution selected.

Keywords: Relative age effect; maturity; performance; sport development; birthdate

I.INTRODUCTION (TALENT IDENTIFICATION)

In sports, there are essential areas within sports development and one of the main areas is talent identification. Talent identification is considered as crucial part in ensuring the higher potential of an athlete can be achieve with the right sport and synonym with grassroot level. The word talent means a special or an innate ability to achieve a success (Larkin and Reeves, 2018). While talent identification is known as a process to identify a future successful athlete within the time of observation by making a prediction (Larkin and Reeves, 2018). Talent identification aims is to identify, capture, choose and promote the athlete who has the most potential, skills and capabilities to increase the chances for success and achievement in the future and to be developed to be a top player (Pruna, Miñarro Tribaldos and Bahdur, 2018). In football, the process of TID involves measuring the player physical and physiological to find out the potential success outcome (Pruna, Miñarro Tribaldos and Bahdur, 2018). By measuring those factor from time to time may predict the athletes performance and this performance characteristic are based on the required skills used during the games (Pruna, Miñarro Tribaldos and Bahdur, 2018).

Many of the sports does not have a standardized TID process which most of them are based on try and error and expose to biases. Most of the sports academy are using certain cut-off date to identify a group of talent based on their chronological age. One of the biases that may occur during this process is the sports specific physical needs which lead to give effect on

relative age. This effect known as relative age affect where selected athlete is likely overrepresented in older athlete who tend to be more developed in terms of physical and physiological who give advantages during the selection (K. Suppiah *et al.*, 2020) and cause uneven sports development for those who born later with the same year. In the following, this paper will discuss on the mechanism of RAE in sports which are maturity status, playing position, gender and performance.

II.MATERIAL AND METHOD

Literature on the relative age effect in sport focusing on grassroots to elite level was obtained from several computer based sources. Relevent articles were located by using google scholar, ResearchGate and ScienceDirect. The following keywords were used: "relative age effect", "birthdate", "performance", and "maturity". All articles are from original English version containing relevant data on relative age effect in sport.

III.RELATIVE AGE EFFECT (RAE)

Relative age effect (RAE) is known as a situation which there is the different in terms of performance where children born early in the same year tend to be more perform than children born later for the same cohort (Aune *et al.*, 2018). These situation or phenomenon has been widely studied and proved since 1980's. The present of RAE can be found in basketball (Safranyos *et al.*, 2020), football (K. Suppiah *et al.*, 2020), handball (Saavedra and Saavedra, 2020), athletics (Brustio *et al.*, 2019) and other sports both in female and male category. This section will discuss on the existence of relative age effect (RAE) in sports and the mechanism of (RAE).

A. The existence of RAE in sports

The displayed of better performance for older children and adolescent which usually come with heavier and taller than the elder seem to be the RAE to occur (Barrenetxea-Garcia *et al.*, 2019). Moreover, according to (Tribolet *et al.*, 2019), in the study for U10 to international level, RAEs appears between age 10-12 to senior professional competition. However, the existence and the intensity of RAE bias are vary depending on the countries, clubs, and a different level of talent (Doyle and Bottomley, 2019) and agreed to be more observed in grassroot to elite youth level.

B. Mechanism in RAE

1. Maturity Status

The progress towards adult state is referring to biological maturity (Hill *et al.*, 2019) and the state of biological maturity at the time it is observed known as maturity status (early, average and late maturing) while maturity timing is refer to the specific maturational event occur (ages at peak height velocity) (Myburgh, Cumming and Malina, 2019). In most sports, athletes are grouped according to their chronological age which however might consist of difference biological maturity (Cumming *et al.*, 2017).

According to (Müller *et al.*, 2018), biological maturity proved to have a strong relationship with the RAE where this might lead to the talent lost. This is exactly what was reported in (Brazo-Sayavera *et al.*, 2018) where the authors mentioned that maturity status and sport organization can give negative impact to the chances for late developers to success from a long-term sport performance. This finding is supported by (Cripps *et al.*, 2017) players identified onto the AFL TP at the U16 level are likely to be more biologically mature (typically advance in height and heavier) than their non-talent identified counterpart. The 'maturation-selection' hypothesis as a mechanism for RAEs was highly supported (Brazo-Sayavera *et al.*, 2018). To identify the maturity status in sports, the used of non-invasive method are popular, safe and cheaper than the invasive method.

Few studies have been using the non-invasive method to identify the maturity status in their studies in sports. (Khamis and Roche, 1994) non-invasive method is popular among researchers who do studies in maturity. (Myburgh, Cumming and Malina, 2019) demonstrated that the use of percentage of predicted adult height (PAH) at the time of observation based on skeletal age (SA) in comparison with predicted age at peak height velocity (PHV) is correlated better. Both methods were classified as late, average or early maturing. Spearman's rank order correlations and kappa coefficients was used for the consistency of the classification. The results showed that all data in both sexes using percentage of predicted mature height, are moderate while the results are varied based on predicted age at PHV where there is positive and low in girls and negative and moderate in boys.

The percentage of predicted adult height has also been used as a measure the effect of biological maturity status and relative age upon self-regulation in male academy soccer player Cumming (biological maturation). This method required player to measure their height, weight, age and their parent's height (measured by staff or self-reported) to get the mid-parents height and the maturity status are defined based on the PAH where players with closer height with predicted adult height are more advance.

Another Peak Height Velocity (PHV) equation proposed by Mirwald (Mirwald *et al.*, 2002) has been used widely. Muller (Müller *et al.*, 2018) assessed the age at PHV as suggested by to calculate the maturity influences the relative age effect for the total of 222 male participants of the under-9 Euro championship Soccer Tournament 2016 held in. Standing height and sitting height, were taken from participants to identify the leg length. Based on the data, date of birth, actual chronological age on the testing date and body weight were used to calculate the predicted APHV. Players are then divided into three group of maturity level (early, normal and late) where most of the players was identified as normal maturing (168.5%), early (16.2%) and late (15.3%). No significant different was found from predictable normal distribution ($p = 0.007$). Further investigation has been done and the findings shows that there is significant difference between the observed and expected normal distribution. Q1 showed high percentage of late maturing (27%) and high percentage of early maturing (31%) while small percentage late maturing present (8%) in Q4. This results stress that the RAE is clearly present and the selection of the Under 9 player are strongly related with the relative age and biological maturity status.

To proof if the RAE and maturity occurrence in the sports participations selection, (Baxter-Jones *et al.*, 2020) study this phenomenon between selected and unselected in youth team from several sports. The biological age was identified using the age at PHV equation and the RAE was analyzed. It was found that there is a bias towards larger and mature participants which determine to have early in age at PHV and this is likely to be seen in males' sports. These results are differed in female sports participants except for hockey team where there is no maturity bias identified for both selected and unselected participants.

2. Position of players

In team sport such as football, there are several different playing positions that might be differ accordingly to the match tactical and role which includes difference physical characteristic need. Thus, this difference might influence the RAE based on the playing position and lead researchers' interest to study this occurrence. In the recent studies of U16 2018 AFC football tournament, overall birth distribution are higher with player born on the first quarter and the birth distribution are even across the playing position (K. Suppiah *et al.*, 2020). It is however different with the study in handball. According to (Fonseca *et al.*, 2019), the RAE was present among U19 handball athletes with most of the athlete born on the first two quarter. In terms of playing position, the birth distribution for goalkeepers and pivot position are fair and differ with wings and backs position where mostly are born in the first quarter (Fonseca *et al.*, 2019).

3. Gender

The differences of RAE presentation in sport between male and female athletes has been studied widely. Some of the findings showed that there is no RAE presentation for female athletes. This is supported by the recent study which found that there is no RAE in female participants medal winning group compared to male category in elite water polo players (Barrenetxea-Garcia *et al.*, 2019). Consistent with this finding, no RAE found in MSSM swimming overall female athletes in all age groups (Marapen and Jeffrey Low Fook Lee, 2015). In addition, it was found that RAE does not have linked to shooting performance even though the male performance is better than female (Mon-López *et al.*, 2020). However, several findings showed the existence of RAE in female athletes. For instance, (Costa *et al.*, 2013) found that the RAE presented for 12 years old swimmers and another studies in Spanish track and field sport showed the high presentation of RAE in both gender at U18 and U20 level (Brazo-Sayavera *et al.*, 2018). This phenomenon might happen due to the limited participants and competitiveness for female athlete compete in certain sport which lead to difficulty to do deeper study on RAE among female athletes (Musch and Grondin, 2001; Costa *et al.*, 2013; Brazo-Sayavera *et al.*, 2018).

This is different in males' findings where most of the findings showed the RAE presentation. In South Korean football analysis, RAE is highly represent for age U16, U17, U19, U20 and U23 with more players born in the first quarter of the year compared to those in the last quarter (Jeong *et al.*, 2019). According to research by (K. Suppiah *et al.*, 2020), the RAE was demonstrated in the 2018 AFC U16 soccer tournaments with the large number of older player in the qualified team. The RAE will less present in the senior team (Jeong *et al.*, 2019). This

finding supported by previous study in 2015, where there is presentation of RAE among overall male swimming participants except for U18 age group (Marapen and Jeffrey Low Fook Lee, 2015).

4. Performance

To extend more knowledge on the impact of uneven birth distribution towards performance either individual or team sport, an analysis has been done by several researchers. For example, in the recent study of handball game for World Men's Handball Championship 2017, based on the final ranking, overrepresentation of athletes born in early month of the year in the quarter-finalists, octaves-finalist and bottom eight while for semi-finalist was evenly distributed (Fonseca *et al*>, 2019). Another study in rugby sport, stated that the recipient for AFLs best award and fairest award are more likely born in the first half of the year (Tribolet *et al.*, 2019). However, the results may vary depending on type of sports and age. To support this statement, it is found that in shooting sport, RAE are unlikely to have any impact on the shooting performance (Mon-López *et al.*, 2020). Further finding to understand the correlation between RAE and performance can be found in (Marapen and Jeffrey Low Fook Lee, 2015) where among swimming MSSM medal winners between male and female participants showed that there is no linkage in between medal winners and RAE.

IV.RESULTS & DISCUSSION

The purpose of this paper is to discuss the mechanism of the relative age effect in sports and mainly focused on grassroots to elite youth level. This discussion may be useful for researchers or sports practitioner to understand the mechanism of RAE and identify which mechanism of RAE affected their sports club setting the most to provide better solution of it.

The maturity status has proven to give impact on the selection biases. Thus, few researchers has started to identify the used of biological age in the selection and grouping according to the anthropometric measures which this idea was named as bio-banding (Baxter-Jones *et al.*, 2020). This can give solution to the maturity differences in sports (Webdale *et al.*, 2019). Two different method has been suggested to be used to identify the maturity status is by using (Khamis and Roche, 1994) predicted adult height and (Mirwald *et al.*, 2002) peak height velocity.

Playing position is one of the RAE mechanism and this mechanism are generally for team sports such as football, rugby, netball, and hockey. The differences of RAE presentation according to the playing position is probable due to the position specific requirements which is needed to perform specific skills during athlete's selection. For instance, back position in handball are to perform defense movement which need athletes with more bigger and higher strength level (Fonseca *et al.*, 2019). In general, early born athletes tend to be more biologically mature and have advantage for a greater strength, height, speed at the time of observation (Fonseca *et al.*, 2019; Tribolet *et al.*, 2019). The used of age-ordered shirt numbering might be used to reduce the relative age effect sports team where no athlete's information were given to the talent scout team including the playing shirt correspond to the

relative age (Mann and van Ginneken, 2017). However, since this method only has been tested once, more research is needed to ensure the reliability.

Athlete who have undergo long term development training where technically will increase their technical skill will overcome the player with physical advantage (Marapen and Jeffrey Low Fook Lee, 2015). The absent of RAE in female participant and successful athletes are likely due to the popularity of the sports itself which may be known as male sports and the level of participant's skills across the development process respectively (Marapen and Jeffrey Low Fook Lee, 2015). Thus, the sample size for female participants might influence the evaluation.

One of the solution as suggested by (Romann and Cobley, 2015) to reduce or eliminate the present of RAE, is a corrective adjustment after performance method that has been used in athletic sprinting and was successfully eliminate the RAEs. The used of corrective adjustment can be seen in golf where the handicap is being used to identify the athlete performance level (Romann and Cobley, 2015). In any proposed solution, it may have the strength and weaknesses. This method is easy to apply in any other sports but may be limited to individual sports. In addition, it is difficult to control the inter-individual variability which the relatively young athlete might have similar physical and skills with the relatively older athlete (Romann and Cobley, 2015). To support this finding, (Stephen Cobley *et al.*, 2019) has tested this method in swimming. The results showed that the RAE has successfully removed with the used of corrective adjustment method in 100m Freestyle swimming and this might reduce the effect of performance on RAE.

Some researchers proposed limit the player quota according to the quartile which is more sensitive to the physical characteristic individual variability (Barnsley, R. H., & Thompson, 1988; Helsen, Starkes and Van Winckel, 2000), delay selection to 15 or 16 years old to eliminate the early specialization and give experiencing to all youth ages (Cobley *et al.*, 2009). However, further research needs to be done to identify the effect to player development especially that relatively older player has advantages generally in physical characteristic.

Another proposed solution is by dividing the age group according to the age band or different cut-off date. Generally, in sports development program, the used of 12-month bands has been widely used especially in Malaysia. In this propose solution, the author suggest changing the age band into 9-, 15- or 21-month bands (Boucher and Halliwell, 1991; Brewer *et al.*, 1995; Musch and Grondin, 2001) to reduce the gap of age difference. However, this solution might just shift the RAE into different group and are not suitable for sport league where the teammates are always be changed (Webdale *et al.*, 2019). This encourage other scholars to identify solution for RAE according to the specific sport need.

V.CONCLUSION

In summary, there are a few mechanisms of relative age effect and possible solution can be used has been discussed in this paper. Furthermore, the results of this RAE are vary depending on the sample size, playing position and athlete sporting level. For example, small

sample size in female participation might hide the RAE appearance. Although there are many proposed solutions suggested to be used during selection and after performance, but it is important for sports organization to identify what is the mechanism of RAE occur in their own club so that the solution can be specifically addressed and therefore can improve the talent development program.

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