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Pathway Development Experiences of Talented Japanese Athletes

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Abstract

Establishing trajectories and collecting insights of athletes to better understand sport expertise development is an important step for illustrating developmental milestones for the next generation of athletes. The purpose of this study was to use a transdisciplinary approach with a large cohort of talented Japanese athletes to investigate the holistic development of sport expertise. The national athlete development pathway survey was conducted with 604 athletes across 53 sports. The talented athletes were categorized into three groups: youth international level (n = 100), youth national squad (n = 437), and potential sporting talents (n = 67) based on the highest competition levels achieved in their main sport. The facilitators and barriers to athlete development were analyzed for the three groups. The key complementary factors for the development of talented athletes in Japan included: deliberate play; sport sampling; structured practice and competition in other sports; deliberate practice; and deliberate planning/programming, including talent identification and talent transfer. The pathway trajectory (milestones) of talented athlete development revealed in this study can be used as a helpful guide for the next generation of athletes. Finally, this study addresses the various challenges associated with systemic culture, and its impact on athlete development.

Keywords

Athlete development pathways, FTEM, talent identification, deliberate play, deliberate practice, deliberate programming, culture

Introduction

Communicating real experiences of elite athletes has been well documented in the area of expertise and expert performance in this journal (Campitelli & Hambrick, 2018). Establishing pathway trajectories and collecting insights from individual athletes to understand the entire span of sport expertise is an important step for documenting and setting developmental milestones for the next generation of athletes. The development process from grassroots to podium is a long and winding pathway (Kinugasa, Morley, et al., 2019). It is known that the process of athlete development is complex and multi-dimensional, and the combined interaction of these factors penetrate throughout the whole athlete development pathway (Gibbons et al., 2002; Gulbin & Weissensteiner, 2013). Moreover, the development pathways of athletes are modulated by a range of catalytic factors related to the athlete, environment, system, and chance events, which combine and impact idiosyncratically as the athlete transforms from non-elite to pre-elite, and then to an elite athlete (Gulbin & Weissensteiner, 2013). The collective insights of the real experiences and

recording of actual developmental milestones of individual athletes may lead to optimized athlete development.

Some researchers in talent development have been using retrospective study designs with small sample sizes to understand some significant transitions within the athlete development pathways (Côté, 1999; Côté et al., 2009; Weissensteiner et al., 2009). For example, Côté et al. (2009) suggested that early sampling does not hinder elite sport participation where peak performance is reached after maturation. That is, for late specializing sports such as basketball, rowing, and triathlon, elite performance is usually preceded by a period of sport sampling. Conversely, when peak performance occurs before maturation (e.g., gymnastics and figure skating), sport sampling is not advantageous. However, many of the researchers have focused on relatively few aspects of athlete development (e.g., anthropometric, physiological), whereas a transdisciplinary approach that involves sport practitioners and researchers with diverse theoretical perspectives has been recommended (Toohey et al., 2017). The transdisciplinary research is driven by real-world problems and the approach may allow us to explain the complex and multi-dimensional interplay of factors related to athlete development.

Other researchers have conducted larger cohort studies to provide valuable and realistic insights into talent development in Australian, German, and Canadian national representative athletes (Gulbin et al., 2010; Güllich, 2017; Hopwood et al., 2015). For example, the national survey in Australia was effective in recording the development pathways of Olympic athletes by chronicling key environmental and intrapersonal catalysts related to sport sampling, deliberate practice, quality coaching, parental support, training and competition investment, motivation and volition (Gulbin et al., 2010). The findings of such developmental characteristics and milestones in elite athletes can therefore have important practical implications specific to youth development and talent identification and development (TID) at a system level.

Recently, an extended review of athlete development and talent development based on the keywords search of "athlete development " and "talent identification and development" in peer-reviewed English articles was conducted (Kinugasa, Morley, et al., 2019) and broadly revealed a range of internationally advocated practices in youth development and TID as summarized in Table 2 (see Appendix). Adopting and understanding evidence-informed frameworks based on 'best practice' for specific developmental stages has been strongly encouraged by the International Olympic Committee (IOC) (Bergeron et al., 2015).

In Japan, sporting club activities tend to be school based, and therefore lay the foundation for youth development (Nakazawa, 2011). There is no other country in the world where the scale of school sports club activities provides the mainstay of youth sporting development activities (Nakazawa, 2011). In this context, Japan Sport Council (JSC) has been promoting youth development and TID programs within and outside the schools at the prefecture (local government) levels as part of the national government sport policy. Japan is divided into 47 local government prefectures, and these local TID programs have been expanded into 34 different sport programs (Kinugasa et al., 2018). Based on the Japanese government's Sport Basic Plan (The Ministry of Education, Culture, Sports, Science and Technology, 2012), JSC currently supports three TID models of talent detection, talent selection, and talent transfer at the local levels with differing target age groups dependent upon the prefecture (Kinugasa et al., 2018).

There is a clear paucity of data available in peer reviewed English articles that have focused on Asian athletes. At the national elite level, development program insights and separate organizational reports of the Japanese Olympic Committee, have to date been published only in Japanese. Consequently, detailed transitional trajectories and magnitudes of athlete development pathways in Japanese athletes are still largely unknown. Therefore, the purpose of the study was to (1) test predictors of youth athletic achievement in Japan based on current theories of expertise in sports science, (2) examine young athletes' perceptions of facilitators and barriers to expertise, and (3) compare and contrast

these findings to those in the current literature, typically emanating from Western countries.

Methods

Participants

A total of 1,724 talented athletes (ranging from 11 to 24 years) from 26 local (prefectural) TID programs were invited to participate in the study. Participants chose to complete either a postal mail survey or an internet survey (Survey Monkey Inc., USA) between December 2017 and October 2018. The response rate was 35.0% (604 respondents; 290 males aged 15.0±2.3 years and 314 females aged 15.0±2.0 years from 53 Olympic sports). Informed consent was provided by all participants and parental consent was obtained for athletes under the age of 20 years. Ethical approval was obtained from the Japan Institute of Sports Sciences Ethics Committee.

Group Categorization

The sport and athlete development framework "Japanese FTEM (Foundation, Talent, Elite, and Mastery)," which was developed based on insights from various sporting stakeholders in Japan, was applied in this study (Kinugasa, Funasaki, et al., 2019). The Japanese FTEM framework is adapted from the original FTEM framework (Gulbin et al., 2013) and has been modified to represent 4 macro and 11 micro stages: Foundation (F1, F2, F3), Talent (T1, T2, T3, T4), Elite (E1, E2, E3), and Mastery (M). The original FTEM has two Elite stages (senior elite representation [E1] and senior elite success [E2]) but the Japanese FTEM framework added another stage between the original stages to account for potential medalists who are able to reach competition finals. Eligibility for inclusion required all the respondents to have reached the highest youth competition level in their main sport (identified via the survey), thus allowing us to categorize the talented athletes into three groups: youth international level (T4; $n = 100$), youth national squad (T3; $n = 437$), and "potential sporting talents" (T2; $n = 67$) identified through local TID programs whose highest competition level was youth local/regional level of competition (Table 1, Appendix).

The National Athlete Development Pathway Survey

The national survey (23 main themes with 187 questions) was developed based on the systematic review (Kinugasa, Morley, et al., 2019) and internationally advocated practices from Foundation to Talent of the FTEM stages. Some of the representative questions used in this survey based on the international practices (e.g., deliberate play, sport sampling, etc.) are listed in Table 2, Appendix. The survey also included the following questions to estimate the age-related developmental milestones: start age for training and competition in sport; complete specialization exclusively in their main sport; the timing of a self-reported growth spurt (age of peak height velocity); and selection to national youth squads and national youth representatives (only for the T4 group). In addition, the external factors ("How did you start your main sport?") and internal factors ("What were the motives to begin your main sport?"), and perceived facilitators and barriers ("Please indicate the facilitators and barriers that you think are particularly important to your success as an athlete [e.g., 'quality coaching' and 'an obsession with winning']") were also recorded. The facilitators and barriers within the athlete development pathway were then analyzed. The reliability ($0.79 \leq r \leq 1.00$) and validity ($0.26 \leq r \leq 0.99$) of similar retrospective survey questions have been tested in other studies (Gulbin et al., 2010; Güllich & Emrich, 2014).

Data Analysis

Descriptive statistics (means, standard deviations, percentages) were used to characterize the sample group. Further analysis including Chi-square test and multiple comparison of means with Ryan's method (Ryan, 1960), and an analysis of variance (ANOVA) with post-hoc Tukey tests were conducted for group comparison with the significance level α set at 0.05. Cramer's V effect sizes (ES) (Mizumoto & Takeuchi, 2011)

and Hedge's *g* (unbiased Cohen's *d*) ES (Hopkins et al., 2009) were calculated where applicable. Statistical analyses were conducted using RStudio statistical computing software version 1.2.5033 (RStudio, Boston, MA).

To estimate relative age effects in the talented athletes in Japan, frequencies of birth dates in each calendar year quartile were calculated. The quartiles (Q) and corresponding months were as follows: Q1 (April–June), Q2 (July–September), Q3 (October–December), and Q4 (January–March of the following year). Differences in the distribution of birth dates between the talented athletes and the newborns to estimate expected frequencies of the general population in Japan (The Ministry of Health, Labour and Welfare, 2018) were evaluated using the Chi-square test with the program Excel (Microsoft Corporation, 2016). From the original data, odds ratios were calculated for Q1 vs Q4.

The birthplace effect and/or place of development was defined as where the respondent was residing for a majority of time in their late primary and early high school period (Woolcock & Burke, 2013). The national census statistics (proportion of child population equal to or less than 14 years) from the 2015 population census for Japan (Statistics Bureau of Japan, 2015) were used as the actual quartile reference comparisons to represent the Japanese data more accurately. Odds ratios were calculated across the different city sizes of the birthplace and/or place of development for the Japanese data. The odds ratios were calculated by dividing the odds of becoming a talented athlete by the odds of being born in a city of a specific size. A 95% confidence interval (CI) was calculated and any odds ratios with a CI range that contains the null value of 1 are considered not to be statistically significant.

Results

A total of 604 talented Japanese athletes responded to the survey, representing a response rate of 35.0%.

Foundation Stage Results

Based on the open-ended questions related to their early childhood, all of the groups mostly played the game of tag, dodgeball, and soccer (33.3%, 12.3%, 11.6%, respectively) (Table 3, Appendix). The majority of the athletes were second born or later (60% to 67%), and no group effects were observed ($p = 0.57$) (Table 3, Appendix).

The T2, T3, and T4 groups were 9.0±3.1; 8.8±3.1; 10.4±3.1 years of age, respectively when they started their sport (Table 4, Appendix). The T4 groups start training and competing later compared with the T3 groups ($ES = 0.49$, $ES = 0.44$, respectively $p < 0.01$) (Table 4, Appendix). In total, the respondents on average experienced fewer than three sports (2.7±2.3 sports). The T3 and T4 groups experienced significantly more sports compared with the T2 group ($ES = 0.47$ and 0.46, respectively, $p < 0.01$) (Table 3, Appendix). About 30% of the respondents mentioned that diverse sports experiences were very helpful for their current main sport.

The respondents of the T2, T3, and T4 groups specialized in their main sport at 10.0±2.8; 11.3±2.6; 12.8±2.7 years of age, respectively (Table 4, Appendix). The T3 group specialized significantly earlier than the T4 group ($ES = 0.34$, $p < 0.01$) (Table 4, Appendix). There was no group difference in the timing of growth spurts ($p = 0.99$). During the elementary school period (the upper grades), more than 90% of the respondents had a coach or coaches in all groups (90.9%; 95.9%; 91.9%, respectively) (Table 3, Appendix). The respondents mentioned that the coaches during the junior high school period were most influential across the developmental period in all groups. In terms of family support, the highest percentage of the emotional support from childhood to the high school period in all groups was provided by mothers with fathers ranking second highest (Table 3, Appendix). There was a trend of increasing support of coaches with age, especially in the T4 group.

Talent Stage Results

In the T4 group, 44.3% experienced talent transfer ($ES = 0.15$, $p < 0.01$) (Table 5, Appendix) via the local TID programs at the age

of 12 years, and they were initially identified by the coaches and parents. Interestingly, the T4 group experienced significantly more structured training/practice (twice per week or more, with a coach) and competition in other sports compared with the other groups (*ES* = 0.17, $p < 0.01$) (Table 5, Appendix).

In contrast with the general population in Japan, some asymmetries in birth-month distribution were shown in the talented Japanese athletes. Overall, there were significant relative age effects within all talent groups ($p < 0.01$), but there were no between group difference ($p = 0.39$) (Table 6, Appendix). As shown in all groups, Q1 talented athletes were substantially overrepresented and Q4 talented athletes were substantially underrepresented compared to the expected Japanese population (odds ratios 3.19-5.81) (Table 6, Appendix). In terms of birthplace effects, about 36-55% of all the respondents were born and/or developed in the large city size (> 1,000,000 population) (the odds ratio of 3.25, 3.08, 6.51, respectively) (Table 7, Appendix).

As shown in Figure 1, a significantly higher total training volume (both main and other sports) was found in the T4 group compared with the T2 and T3 groups during the junior high school periods (*ES* = 0.99 and 0.55, respectively $p < 0.01$). The difference between the T4 and T3 groups was also found during the university or employment period (*ES* = 0.79, $p < 0.01$).

The factors that positively or negatively affected transitions in athlete development were similar in the groups, especially the T4 and T3 groups. Demonstrating *passion/will, having an obsession with winning*, and *learning skills* were classed as the facilitators, while *injury/illness, quality of daily training environments*, and *quality coaching* were perceived as the barriers (Table 8, Appendix).

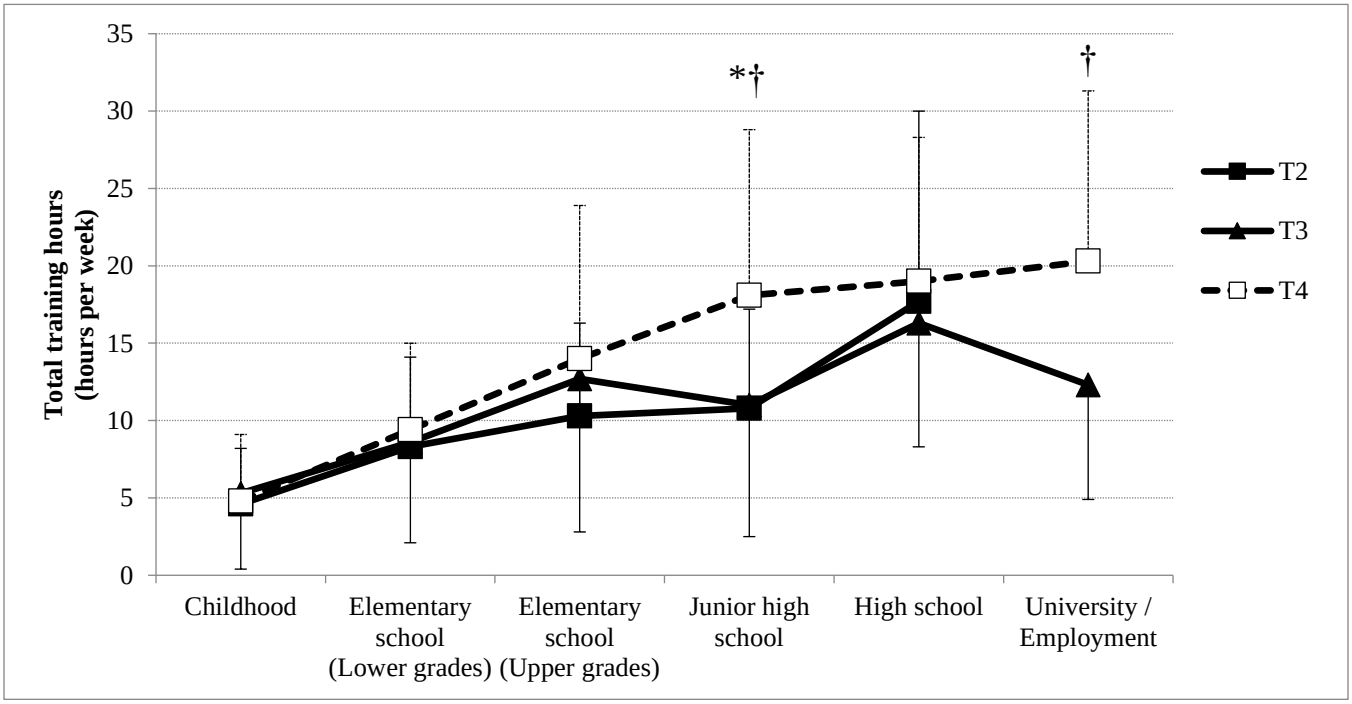

Figure 1. Total training volume throughout the scholar transitions in talented Japanese athletes (T2 = potential sporting talents, T3 = youth national squad, T4 = youth international level).

Note. * Significantly different between the T4 and T2 groups, $p < 0.05$; †Significantly different between the T4 and T3 groups, $p < 0.05$.

Discussion

What kind of experiences are needed to become an elite athlete, both in general and within specific cultural and social environments? This study addressed this question using the transdisciplinary approach on the development of sport expertise to understand youth development and TID initiatives in Japan. In total, 604 talented Japanese athletes across 53 sports from local TID programs completed the national survey. At the time of data collection, 16.6% of the respondents achieved the national representation status at the youth international competition level. It has been highlighted in previous studies exploring athlete development that they have predominantly focused on a small cohort of athletes across a limited range of sports (Gulbin et al., 2010). Furthermore, athlete development studies have mostly emanated from continents other than Asia (e.g., Australia, Europe, and North America). Therefore, the current research of talented Japanese athletes based on a large cohort ($n > 600$) is a novel contribution to the global literature.

The main findings were discussed in line with the international advocated practices in youth development and TID (Table 2, Appendix).

Foundation Development

A number of studies have confirmed that high amounts of unstructured physical activities (i.e., deliberate play) in early childhood builds a solid foundation of intrinsic motivation and long-term participation in sport (Côté & Vierimaa, 2014). In our study, the talented Japanese athletes mostly played tag, dodgeball, and soccer in their early childhood (Table 3, Appendix). Previously, Japanese researchers found that children who experienced free (unstructured) play within childcare have higher physical fitness than those who have experienced structured exercises (Mori et al., 2010). Moreover, a psychosocial environment including a higher number of siblings, stable family structure, and abundant playmates has a positive influence on physical fitness (Yoshida et al., 2004). In short, the change in the psychosocial environment may not have a direct impact on the level of physical fitness, but more opportunities can be provided for promoting physical activity by changing the perceptions of parents and caregivers in childcare to increase more children's free play experiences (Yoshida et al., 2004). Thus, some interplays may exist between a particular psychosocial environment, playing experiences, and physical fitness in early childhood.

Interestingly, all groups had a higher proportion of being the second or later born child, with an increasing trend observed from the T2 to the T4 groups. Although there are fewer studies on sibling dynamics compared with parental influence in sport expertise, a similar trend was found in Australian and Canadian elite athletes who were unlikely to be first-born children (Hopwood et al., 2015). The elite athletes were also more likely to have participated in regular physical activity, and these data suggest siblings may play a key role in athlete development as role models, motivators, and sources of emotional and instructional support (Hopwood et al., 2015).

Some researchers have recommended that early sampling does not hinder elite sport participation where peak performance is reached after maturation (Côté et al., 2009). It is also known that international medalists maintained engagement in other sports over more years and specialized later than the non-medalists (Güllich, 2017). In our study, the T3 and T4 groups experienced slightly more sports, and the T4 group specialized slightly later than the T3 group. Thus, the T2 and T3 groups specialized into their main sport during the elementary school period (the upper grades) and the T4 groups specialized later during the junior high school period. Moreover, the T4 group had more experiences in other sports compared with the other groups. The respondents in the survey mentioned that the diverse sports experiences were very helpful for their main sport as they enjoyed the exposure to various physical activities and the ongoing development of fitness in general. The main motivations for undertaking sports in all groups were as follows: *loving the feeling of winning*, *the desire to be an elite athlete*, and *enjoyment of competition and*

training. It was interesting to note the increasing motivation to *win* during development, and the concomitant decrease in the *fun* aspects of competing and training (Table 3, Appendix). In addition, all groups perceived *passion/will* as one of the main facilitators of successful FTEM transitions in athlete development. Thus, these findings reinforce the criticality of internal motivation rather than external motivation needed to be successful in sport expertise (Ryan & Deci, 2000; Vallerand et al., 1987) and parallel data from other elite athlete studies, where intrinsic motivators such as love of practice, desire to keep improving, and desire to prove something to oneself were the key drivers for performance advancement (Gulbin et al., 2010).

Injury/illness, *daily training environments*, and *quality coaching* were declared by the respondents as being barriers in athlete development (Table 8, Appendix). It is well known that access to quality coaching has a pivotal role in athlete development (Bergeron et al., 2015; Lara-Bercial & McKenna, 2018). By the upper grades of elementary school, more than 90% of the talented Japanese athletes had access to coaching. All the respondents acknowledged that the coaches during the junior high school period were the most influential noting that half of the coaches were schoolteachers during this period. As mentioned previously, sports clubs at school have been the foundation of the sporting community in Japan (Nakazawa, 2011). However, most coaches are generally schoolteachers, and some may not have interests in sport or have no previous sporting experiences (Nakazawa, 2011). As the quality of coaching was identified as one of main barriers for the talented Japanese athletes, this should be improved given the increasing interaction with coaches with athlete age, especially in the T4 group. Other researchers have discussed the influential coaching mechanisms related to athlete development beyond the physical and sport specific skills and broadly include high expectations and demands, genuine care, and transformational role modelling (Lara-Bercial & McKenna, 2018).

It is interesting to note that mothers provided full emotional support throughout the development stages and their children started the sport because of the mother's recommendation and ongoing family support (Table 3, Appendix). Moreover, the respondents' mothers were not currently engaging in regular physical activity and their highest sporting achievements were at the local levels. Although the mother's role in athlete development is still not clear in the literature, it has been observed that Spanish youth athletes received unconditional support from their mothers including emotional, logistic, and economic support (Palomo-Nieto et al., 2011). As fathers in Japan generally spend less time with children on weekdays due to longer work hours compared with fathers in other countries (National Women's Education Center, 2005), the mothers may have greater development responsibilities.

Taken together, these data indicate that successful negotiation of the Foundation stage of development includes the following: high amounts of deliberate (unstructured) play, early sampling (sport diversification), parental support (especially mothers), psychosocial interaction with siblings and/or peers, and access to quality coaching. These aforementioned elements appear to be essential to characterize developmental environments for young children that encourage their later investment in structured practice activities (Côté & Vierimaa, 2014; Hopwood et al., 2015).

Talent Development

In Japan, 65% of junior high school students engage in school sports clubs as their extracurricular activity (The Ministry of Education, Culture, Sports, Science and Technology, 2016). However, the students have limited choices to select the sports club activities as they can only choose from 31% of Olympic summer sports (Nippon Junior High School Physical Culture Association, 2012). For the rest of the summer sports, students need to join local external sports clubs or seek other options. Furthermore, only 9% of the Japanese students had experienced switching these extracurricular sport activities (The Ministry of Education, Culture, Sports, Science and

Technology, 2001). In this regard, the significance of the local targeted TID programs in Japan is that it has created development environments for Olympic sports outside of the school sports club activities during the elementary and junior high school periods (Kinugasa et al., 2018). These data are indicating talent transfer programs need to be implemented at a system level given sport choices and transfer opportunities are limited in the sports club activities within schools.

Talent transfer refers to the transition of an athlete with extensive and adaptable training backgrounds and transferable multidimensional skills and attributes into a sport with similar physiological or skill-set demands, with a view to reduce overall developmental timeframes (Bullock et al., 2009; Vaeyens et al., 2009). It was found that the T4 group had more talent transfer experiences (Table 5, Appendix) which may indicate deliberate practice accumulated in other sports were fast-tracked to an alternate pathway to expertise in the main sport. Further, the T4 group invested significantly more structured training/practice and competition in other sports compared with the other groups. This similar finding was reported in German international medalists suggesting early participation in other sports benefits long-term development of outstanding senior success in the main sport (Güllich, 2017). Indeed, previous sporting experiences, physical and physiological characteristics, and psycho-behavioral factors were emphasized for successful talent transfer (MacNamara & Collins, 2015).

The influence of birthdate and place has been known to shape athlete development (Turnnidge et al., 2014). The Japanese school calendar runs from April to March of the following year and the significant relative age effects were observed in all groups. It was also found that more talented Japanese athletes were born in Q1 and fewer were born during Q4, indicating a clear selection bias in birth dates in all groups (Table 6, Appendix). A similar trend has been widely reported internationally (Smith et al., 2018; Turnnidge et al., 2014) and nationally (Nakata & Sakamoto, 2011; 2012; Hirose, 2009). For example, Japanese researchers found that the relative age effects are dependent on gender and sports (i.e., baseball, soccer, and athletics for male and volleyball for female) (Nakata & Satamoto, 2012). While the impact of this relative age effect has been clearly articulated several decades ago (e.g., Helsen et al., 1998), the trend still exists in the Japanese sporting community. Although the mechanisms of the relative age effects need to be examined further, it is known that it is promoted by annual age-grouping (Cobley et al., 2009). One of the strategies to overcome annual age-grouping is to introduce bio-banding (Cumming et al., 2017; Mann & van Ginneken, 2017). Bio-banding involves the grouping and/or evaluation of athletes on the basis of size and/or maturity status rather than chronological age, which can reduce selection bias, especially when combined with visual reminders such as age-ordered shirt numbering (Mann & van Ginneken, 2017).

For the birthplace effect and/or place of development, previous researchers have reported a general trend for youth ice hockey participants to be registered in smaller cities (< 100,000 people) rather than very large cities and very small towns (Turnnidge et al., 2014). In general, small cities tend to have sufficient infrastructure such as sporting facilities, coaches, and large green spaces (Campbell et al., 2019). However, the respondents in our study were born and/or developed in the bigger cities (absolute population size > 1,000,000) (Table 7, Appendix). This absolute city size is in contrast with other studies, but this can be explained, and somewhat expected, in such a densely populated nation. Many of the local TID programs are running in the central area of the prefecture which are inherently densely populated. Thus, this data has reinforced that future 'place of development' studies, should look at relative rather than absolute city size, given population differences between various nations.

Developmental Milestones from the Foundation to Talent Stages

In this study, the talented athletes were 9.1±3.1 years of age when they first initiated sport and

then started competing at 10.0±2.6 years of age. Some researchers (Güllich, 2017; Gulbin et al., 2010) reported similar development milestones in German international medalists (9.1±3.7; 11.0±3.6 years, respectively) and Australian elite athletes (8.4±4.0; 10.2±3.2 years, respectively). Moreover, the talented Japanese athletes specialized in their main sport at 11.6±2.7 years of age and were selected to the national youth squad and achieved national youth representation at 14.2±2.1 and 15.7±1.4 years of age, respectively (Table 4, Appendix). While Australian elite athletes began their national youth levels at 16.2±1.7 years of age (Gulbin et al., 2010), the pathway trajectories have substantial variability with regard to starting age, pattern of ascent, and magnitude of transition (Gulbin et al., 2013). The process of athlete development is complex and multi-dimensional and the dynamic interactions of these factors and each individual need to be closely examined.

The total training volumes were higher in the T4 group compared with the T2 group during the junior high school periods (Figure 1). The small or moderate differences between the T4 and T3 groups were also found in the junior high school period and the university or employment period. This data may indicate that some athletes in the T3 group are still early in their TID/talent transfer transition while settling into their new sports. Thus, they could expect to be more closely approximating T4 habits with more time and subsequent transition. Further, the timing of specialization and TID and fast tracking to the new programs after TID/talent transfer need to be carefully considered and monitored to optimize athlete development. The deliberate programing by providing high-quality coaching, technical, and sport science and sport medicine support is crucial at the transition phase to ensure that talented athletes fulfil their potential (Bullock et al., 2009). Ultimately, all talented athletes need to adopt intensive, sport-specific training programs to be internationally competitive and successful, but these programs should only be implemented gradually at developmentally appropriate times (Côté & Vierimaa, 2014).

To summarize, this benchmarking exercise contributes to improved understanding of athlete development pathways and provides collective evidence for future athlete insights.

Limitations

One of the limitations of the study was a retrospective cohort research design. First, it is known that this type of research requires recall of activities and events over years, and the accuracy of the reported information can be subject to memory loss or respondent bias (Côté et al., 2005). Instead, more longitudinal, prospective cohort studies to better understand the entire span of athlete development pathways with reliable and validated measures (from the Foundation to Mastery stages in the FTEM framework), would be preferred and encouraged in future studies.

Another limitation was that the participants in the study were from various TID programs (talent detection, selection, or transfer) depending on the local (prefecture) resources (e.g., facility, cost etc.). Control data for comparative purposes (e.g., non TID athletes) has not been provided, therefore one cannot discount that variations in development might occur between TID and non-TID development.

The athlete cohort was cross-sectionally representative of distinct phases of the FTEM framework and provides a temporally discrete snapshot of development. Our T2 and T3 cohorts ended up being quite similar in ages (essentially 7 months apart) and may help to explain why there were more age effects evident when compared against the T4 athletes who were 1.5 to 2.2 years older. Since many of the participants were still in the process of athlete development and talent confirmation, it is possible that the competition level attained at the time of the survey may not reflect the final level achieved. Future alternatives of interest to the researchers include: the prospective monitoring of individuals as they progress through the FTEM framework; a case-control study design, comparing developmental experiences of those who drop out versus those who stay; and the retrospective accounts of a finalized cohort of elite or mastery level (i.e.,

E/M) athletes describing their individual FTEM journeys.

Conclusion

Although the number of respondents was limited to talented athletes from the local TID programs, the results of this study appear generalizable and suggest that the current theories of expertise development are well reflected in the development of talented athletes in Japan.

The transitional trajectory (milestones) of talented Japanese athletes revealed in this study broadly parallels previous non-Asian centric international athlete development research, including commonly observed barriers related to injury/illness and quality coaching and daily training environments that are consistent with advocated practice. Furthermore, data reported here, can be used as a guide for the next generation of athletes, remembering however, that athlete development pathways are individually and culturally diverse and are impacted by intrapersonal, environmental, and chance factors.

The key features of youth development in Japan were as follows: deliberate play; sport sampling, structured practice, and competition in other sports; deliberate practice; and deliberate planning/programming, including talent identification and talent transfer. The youth international (T4) group had diverse sports (multi-sport) practice experiences as they had more experience in structured practice and competition in other sports and the age of specialization for their main sport was significantly later than current T2 and T3 groups. These results confirmed that early specialization was not necessarily advantageous in youth development. Athlete development requires enhanced cooperation and collaboration with key stakeholders, and the roles of the entourage including coaches, parents, and siblings have been significant. Diverse and inclusive approaches with a holistic support system need to be recognized to create a healthy and optimized athlete development pathway for Japanese sporting community. The cultural observations related to population density, the over-reliance of poor-quality school-based coaching, and access to a broader suite of sport options (especially Olympic and Paralympic sports) present future systemic challenges to advance high performance athlete development in Japan.

Practical Application

In the IOC's Consensus Statement on youth development the ultimate goal is to "develop healthy, capable and resilient young athletes, while attaining widespread, inclusive, sustainable and enjoyable participation and success for all levels of individual athletic achievement" (Bergeron et al., 2015). The adoption of the Japanese FTEM framework (Kinugasa, Funasaki, et al., 2019) aims to achieve the IOC's recommended benchmark, and provides a consistent approach to evaluate individual (micro), sport (meso) and system (macro) factors that impact talented athlete development. The current study has focused on the individual (i.e., the athlete), but it is clear that a more complete understanding and contribution to development can be achieved when sport and system factors are combined in this analysis.

In relation to sport factors for example, this study has confirmed the challenges associated with the quality of coaching offered in school-based daily training environments and with the need to address the barriers observed by the athletes. Currently, it is recognized that there is a lack of national sport coordination in Japan (Fujiwara, 2020), with closer cooperation and alignment between the national and prefectural sporting federations critically required to develop a shared vision and improve optimization of sport resources.

With respect to the macro system, the establishment of a national youth development strategy and framework through the improved alignment, coordination and cohesion of system partners is a current gap and one that been noted previously in large multi-governance sporting environments (Fuchslocher et al., 2013). Fragmented and decentralized environments increase the risk of not achieving a broader impact on athlete development at the system level.

Practically, there are relatively cost effective and realistic steps which can be implemented to improve the athlete development process through enhanced inter-agency cooperation. For example, it has been demonstrated that in dynamic and complex environments with a wide array of stakeholder groups often insufficiently resourced, advances in system outcomes can be achieved through improved governance, communication, alignment, capacity, and carefully identified "champions" (Keane et al., 2021).

Taken together, the findings provide additional evidence to guide and refine current practice and the support of athletes across the entire development pathway, at a gender and sport-specific level. Utilizing an evidence-informed approach—informed by the athlete voice—ensures that ensuing strategies supporting the athlete are grounded, relevant, and effective.

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The authors declare that they conducted the research reported in this article in accordance with the Ethical Principles of the Journal of Expertise.

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Appendix

Table 1. Group categorizations based on the highest competition levels achieved by talented Japanese athletes at the time of the study.

Group based on FTEM[a] stage	Level	Description
T4	Youth international level	National representatives at the youth international competition levels *n* = 100 (41 males; 59 females; mean age 16.4 ± 2.7 yrs)
T3	Youth national squad	Athletes within talent selection and talent transfer programs *n* = 437 (214 males; 223 females; mean age 14.9 ± 2.2 yrs)
T2	Potential sporting talents	Athletes within talent detection programs (Talent confirmation stage) *n* = 67 (35 males; 34 females; mean age 14.2 ± 1.1 yrs)

Note. [a]FTEM refers to the Foundation, Talent, Elite, and Mastery framework originally proposed by Gulbin, Croser, et al. (2013).

Table 2. Advocated practices and their representative questions in youth development and talent identification and development (TID) based on a systematic literature review (Kinugasa, Morley et al., 2019).

FTEM[a] stage	Advocated practice in youth development and TID	Representative survey questions
Foundation	Deliberate play (Côté & Vierimaa, 2014): Characterization of the intentional and voluntary nature of informal sport games	What unstructured play have you experienced in childhood?
	Sport sampling (Côté & Vierimaa, 2014; Güllich, 2017): Engagement in multiple sports at the same time	Please list all the sports you participated in childhood.
	Quality coaching (Bergeron et al., 2015; Gulbin et al., 2010): Coaches are responsible for establishing positive training and competitive environments and the qualities of coaching may include well-developed pedagogical and technical qualities	Please indicate the presence of a coach(es) and the occupation of the coach during practice.
	Specialization (Baker et al., 2009; LaPrade et al., 2016): Prioritized commitment to one sport characterized by high volumes of structured practice	When did you specialize in your main sport?
	Family support (Bergeron et al., 2015; Evans et al., 2018; Gulbin, Croser, Morley, & Weissensteiner, 2014; Lloyd et al., 2016)	Who has been the most emotionally supportive of your sporting activities including father, mother, siblings, and relatives?
Talent	Talent transfer (Bullock et al., 2009; MacNamara & Collins, 2015): The transition of an athlete with adaptable training backgrounds into a sport with similar skill-set demands	Do you have any experience in talent transfer?
	Multi-sport practice experience (Güllich, 2017): Experience in participating in multiple sports during childhood and youth ages	Please indicate the type of activities (structured or non-structured) and time spent in your sporting activities.
	Relative age effect (Cobley et al., 2009; Cumming et al., 2017; Mann & van Ginneken, 2017; Smith et al., 2018; Turnnidge et al., 2014): The advantage of being relatively older within a specified cohort	What is your date of birth?
	Birth-place effect (Turnnidge et al., 2014): The association between the size of the city in which an individual is born and the development of sport expertise	In which city did you reside for the majority of your time in late primary and early high school?
	Deliberate practice (Ericsson et al., 1993): Expert performance is facilitated through 10 years or 10,000 hours of practice that is goal oriented, effortful, not inherently enjoyable nor intrinsically motivating	Please indicate your weekly training hours in your sporting activities including your main sport and other sports.
	Deliberate programming (Bullock et al., 2009): The provision of high-quality coaching, technical, and sport science and sport medicine support to ensure that athletes fulfil their potential	Do you have any experience in system organized TID programs with the provision of dedicated support services?

Note. [a]FTEM refers to the Foundation, Talent, Elite, and Mastery framework originally proposed by Gulbin, Croser, et al. (2013)

Table 3. Deliberate play, sport sampling, quality coaching, and family support in talented Japanese athletes (T2 = potential sporting talents, T3 = youth national squad, T4 = youth international level).

		T2 (n = 67)	T3 (n = 437)	T4 (n = 100)	p	Post-hoc p	Hedge's g (Effect size)
Deliberate play							
Unstructured play experience	Top 3	Playing tag (34.1 %), Dodgeball (9.8 %), Soccer (9.8 %), Skipping rope (9.8 %)	Playing tag (34.3 %), Dodgeball (14.1 %), Soccer (12.5 %)	Playing tag (31.9 %), Dodgeball (13.3 %), Soccer (12.4 %) Horizontal bar (12.4 %)	NA		
Second or subsequent siblings	%	60.7	61.6	67.0	0.57		
Sport sampling							
No. of sports	M (±SD)	1.8 (2.5)	2.8 (2.3)	2.9 (2.2)	< 0.01*	*T4> T2, *T3 > T2	0.47 0.46
How did you start your main sport (External factors)	Top 3	Recommended by mother (19.5 %)	Recommended by mother (15.8 %)	Participated in the local TID (25.2 %)	NA		
		Participated in the local TID (17.1 %)	Recommended by senior peers and friends (14.3 %)	Recommended by coaches and teachers (13.0 %)			
		After watching the game (14.6 %)	Recommended by father (12.9 %)	Recommended by mother (11.5 %)			
Motives for the main sport (Internal factors)	Top 3	Competition and training are fun (30.3 %)	I like to win (24.2 %)	I like to win (31.3 %)	NA		
		I like to win (25.3 %)	Competition and training are fun (22.5 %)	I want to be an elite athlete (19.1 %)			
		I want to be an elite athlete (13.3 %)	I want to be an elite athlete (19.1 %)	Competition and training are fun (16.5 %)			

Note. NA = not applicable; * $p < 0.05$. Table continues on next page.

Quality coaching							
Presence of a coach							
Childhood (< 6 yrs)	%	55.0	53.8	39.1	0.10		
Elementary school (Lower grades) (6-8 yrs)	%	90.0	81.8	71.1	0.15		
Elementary school (Upper grades) (9-11 yrs)	%	90.9	95.9	91.9	0.44		
Junior high school (12-14 yrs)	%	86.5	97.4	96.6	0.01*		0.11
High school (15-17 yrs)	%	12.5	62.5	83.1	< 0.01*	*T4, T3 > T2	0.21
Family support							
Support from entourage (e.g., mother, father, friends, coach, and other)							
Childhood (< 6 yrs)	Top 3	Mother (62.5 %), Father (12.5 %), Nil (12.5 %)	Mother (55.6 %), Father (17.6 %), Others (10.9 %)	Mother (61.2 %), Father (16.3 %), Others (10.2 %)	NA		
Elementary school (Lower grades) (6-8 yrs)	Top 3	Mother (57.1 %), Father (14.3 %), Friend (10.7 %)	Mother (54.5 %) , Father (23.4 %), Coach (5.9 %)	Mother (52.1 %), Father (24.7 %), Friend (6.8 %)	NA		
Elementary school (Upper grades) (9-11 yrs)	Top 3	Mother (57.1 %), Father (17.1 %), Friend (11.4 %)	Mother (46.9 %), Father (24.4 %), Coach (12.4 %)	Mother (50.0 %), Father (25.0 %), Coach (6.5 %)	NA		
Junior high school (12-14 yrs)	Top 3	Mother (52.8 %), Father (11.1 %), Friend (11.1 %)	Mother (44.3 %), Father (19.6 %), Coach (12.0 %)	Mother (37.0 %), Father (22.8 %), Coach (17.4 %)	NA		
High school (15-17 yrs)	Top 3	Nil (42.9 %), Mother (28.6 %), Others (28.6 %)	Mother (27.0 %), Father (14.9 %), Others (17.7 %)	Mother (28.1 %), Coach (19.3 %), Friend (17.5 %)	NA		
University / Employment (18 > yrs)	Top 3	-	Nil (37.5 %), Others (20.0 %), Mother (15.0 %)	Others (20.7 %), Friend (17.2 %), Coach (13.8 %)	NA		

Table 4. Age-related developmental milestones of talented Japanese athletes (T2 = potential sporting talents, T3 = youth national squad, T4 = youth international level).

		T2		T3		T4				Hedge's *g*
		(*n* = 67)		(*n* = 437)		(*n* = 100)				
		M	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*p*	Post-hoc *p*	(Effect size)
Start training	yrs	9.0	(3.1)	8.8	(3.1)	10.4	(3.1)	< 0.01*	*T4＞T3	0.49
Start competing	yrs	9.8	(2.2)	9.8	(2.5)	11.1	(2.8)	< 0.01*	*T4＞T3	0.44
Specializing in the main sport	yrs	10.0	(2.8)	11.3	(2.6)	12.8	(2.7)	< 0.01*	*T4＞T3	0.34
Timing of growth spurt	yrs	12.3	(1.1)	12.2	(1.5)	12.2	(1.8)	0.99		
Selection to national youth squad	yrs	-	-	-	-	14.2	(2.1)	NA		
National youth representative	yrs	-	-	-	-	15.7	(1.4)	NA		

Note. NA = not applicable; * $p < 0.05$.

Table 5. Talent transfer and multi-sport practice experiences in talented Japanese athletes (T2 = potential sporting talents, T3 = youth national squad, T4 = youth international level).

		T2	T3	T4					
		(*n* = 67)	(*n* = 437)	(*n* = 100)	*χ2*	*df*	*p*	Cramer's *V*	Chi-post *p*
Talent transfer experience	%	31.0	26.2	44.3	11.30	2	< 0.01*	0.15	*T4 > T3, T2
Multi-sport practice experience									
Non-structured practice in other sports (< 2 times/wk, no coach)	%	12.1	20.8	18.0	2.67	2	0.26		
Structured practice in other sports (≥ 2 times/wk, with coach)	%	10.3	17.1	16.0	1.73	2	0.42		
Structured practice and competition in other sports	%	25.9	47.0	59.0	16.19	2	< 0.01*	0.17	*T4 > T3 > T2

Note. * $p < 0.05$.

Table 6. Distribution of birth quarter to identify the relative age effect in talented Japanese athletes (T2 = potential sporting talents, T3 = youth national squad, T4 = youth international level) against Japanese population.

	Q1 (Apr-Jun)	Q2 (Jul-Sep)	Q3 (Oct-Dec)	Q4 (Jan-Mar)	Total				
	n (%)	*n* (%)	*n* (%)	*n* (%)		$\chi 2$	*df*	*p*	*Odds ratio*
T2	31 (52.5)	12 (20.3)	11 (18.6)	5 (8.5)	67	25.7	3	< 0.01*	5.81
T3	187 (45.3)	104 (25.2)	76 (18.4)	46 (11.1)	437	104.9	3	< 0.01*	3.81
T4	34 (35.1)	32 (33.0)	21 (21.6)	10 (10.3)	100	13.5	3	< 0.01*	3.19
Japanese population[a]	233,180 (24.8)	245,035 (26.1)	241,948 (25.8)	218,659 (23.3)	938,822				

Note. The values represent ratios of the number of athletes by birth quarter to the total number in each category. Odds ratio of Q1 vs Q4.
* $p < 0.05$.; [a]Japanese newborns in 2018.

Table 7. Birthplace effect in talented Japanese athletes (T2 = potential sporting talents, T3 = youth national squad, T4 = youth international level) relative to the Japanese population.

Japanese population[a]		T2 (*n* = 67)	T3 (*n* = 437)	T4 (*n* = 100)	T2		T3		T4	
	%	%	%	%	OR	95% CI	OR	95% CI	OR	95% CI
> 1,000,000	16.0	38.2	36.9	55.3	3.25	[1.66, 6.35]	3.08	[1.57, 6.03]	6.51	[3.35, 12.64]
500,000-999,999	10.1	23.5	14.7	10.7	2.73	[1.23, 6.06]	1.53	[0.65, 3.60]	1.06	[0.43, 2.63]
100,000-499,999	28.0	27.9	40.2	27.9	0.99	[0.53, 1.84]	1.73	[0.96, 3.12]	0.99	[0.53, 1.84]
50,000-99,999	8.8	5.5	5.1	4.3	0.61	[0.20, 1.83]	0.56	[0.18, 1.73]	0.46	[0.14, 1.53]
10,000-49,999	26.2	4.7	2.9	1.8	0.14	[0.05, 0.39]	0.09	[0.02, 0.30]	0.05	[0.01, 0.24]
< 10,000	10.9	0.2	0.0	0.0	0.02	[0.00, 1.38]	0.00	[0.00, 47.67]	0.00	[0.00, 62.82]

Note. OR = odds ratio; CI = confidence interval; [a]Percentage under the age of 15 in each of the subdivisions of the 2015 Japanese census.

Table 8. Factors that enhanced/positively affected (facilitators) and impeded/negatively affected (barriers) the transitions in talented Japanese athletes (T2 = potential sporting talents, T3 = youth national squad, T4 = youth international level).

		T2 (n = 67)	T3 (n = 437)	T4 (n = 100)
Facilitators	Top 3	Concentration (34.3 %), Passion/Will (31.4 %), Endurance (31.4 %)	An obsession with winning (44.6 %), Passion/Will (39.2 %), Learning skills (38.8 %)	Passion/Will (46.7 %), An obsession with winning (46.2 %), Learning skills (42.7 %)
Barriers	Top 3	Daily training environments (30.0 %), Quality coaching (27.6 %), Injury/Illness (27.6 %)	Injury/Illness (44.3 %), Daily training environments (38.6 %), Quality coaching (38.2 %)	Injury/Illness (41.1 %), Daily training environments (38.9 %), Quality coaching (38.9 %)