Journal of Physical Education and Sport ® (JPES), Vol. 22 (issue 7), Art 223, pp. 1792 – 1798, July 2022
online ISSN: 2247 - 806X; p-ISSN: 2247 – 8051; ISSN - L = 2247 - 8051 © JPES

Original Article

Effects of practice frequency on the physical fitness profile of Talent Identification in fourth graders practicing soccer and swimming

JUNJIRO KUBO[1], KEIICHI TAMAKI[2], HIDEYUKI ARIKAWA[3]
[1] Faculty of Sports and Health Studies, Heisei International University, JAPAN; [2] Department of Health Science, Musashigaoka College, JAPAN; [3] Faculty of Education, Saitama University, JAPAN

Published online: July 31, 2022
(Accepted for publication July 15, 2022)
DOI:10.7752/jpes.2022.07223

Abstract
Introduction: The physical fitness profile of children is one of the Talent Identification and Development (TID) methods, but there is little evidence to support the measurement data. In this study, we investigated the effect of practice frequency on the physical fitness profile of fourth grade children participating in a TID project. Methods: We surveyed the sports habits of children who applied for children's sports lessons and the number of practices the children attended each week. The children were engaged in soccer (n=220) or swimming (n=256). For the TID, height, weight, and performance in the 20 m Shuttle Run, 30 m Sprint Run, Standing Long Jump, and Horizontal Jump Repetition were assessed. Results: Regarding the 20 m shuttle run, children in both the soccer and swimming groups that practiced 3 to 4 times a week and 5 or more times a week performed significantly better than children practicing 1 to 2 times a week. Regarding the 30 m run, in the soccer group, children that practiced 5 or more times a week performed significantly better than children practicing 1 or 2 times a week. There were no significant differences in the number of practices per week and performance in the Standing Long Jump and Horizontal Jump Repetition in both groups. Discussion and Conclusions: Our results suggest that fourth grade children who participated in either soccer or swimming and who practiced more often had more endurance ability, but similar power or agility compared to children who practiced less often. These results indicate that children's endurance ability during this period is easily acquired, but should be used with caution as a method for evaluating talent.
Keywords: endurance ability, child, long term athlete development, 20 m Shuttle Run

Introduction

In countries that are considered sports powerhouses, talent identification and development (TID) efforts to identify and nurture children with increased potential to succeed in sports have always been a priority (Malina 2010, Zeng et al. 1992). Over the last few decades, TID in many countries has increased, and the number of research reports examining TID, as well as its methods and outcomes has increased in many countries. In Japan, many sports organizations and prefectures have engaged in TID with the Tokyo Olympic and Paralympic Games (Kinugasa et al. 2018). Currently, TID activities are considered important, are systematized in both sport powerhouse countries and smaller countries, and have produced many athletes who are active worldwide (Lidor et al. 2009, Regier 2019).

While TID methods vary widely, the majority of cases involve anthropometric and physical fitness measurements, with assessment of the subject's physical profile (Johnston et al. 2018, Zhao et al. 2019). However, the physical growth and development phase of children is not uniform across the population, and may be highly individualized and marked by varying levels of maturity (Malina et al. 2004). In fact, it is unclear whether the characteristics of physical fitness in children are similar to those in adults. Many reports have described difficulty in predicting future success, especially in TID targeted at a younger generation (Barreiros et al. 2014, Bergeron et al. 2015, Vaeyens et al. 2009).

The physical fitness of a child is influenced by exercise habits and lifestyle habits, in addition to the inherent attributes of the child. In a similar way, individual physical fitness factors, such as explosive power and endurance of a child, may be influenced by exercise type, intensity, and frequency in children. However, few reports have examined the training of children and their responses to that training (Armstrong & Barker 2011, Lesinski et al. 2016). Therefore, it is difficult to construct evidence-based Talent Identification methods at this time. Much more knowledge about children's training and their response to that training is needed to build a better talent identification system. These findings would also be useful in clarifying human growth and development.

Human exercise volume, intensity, and duration can be quantitated by heart rate monitors, pedometers, physical activity monitors, and accelerometers (Böhm et al. 2019, Murakami et al. 2016, Veijalainen et al. 2019).

Corresponding Author: JUNJIRO KUBO, E-mail: kubo@hiu.ac.jp

However, these instruments are not suitable for surveying a large number of people, in particular, children. On the other hand, the frequency of exercise is suitable for surveying a large number of people, as it only surveys the number of exercises per week.

The purpose of this study was to investigate the effect of practice frequency on the physical fitness profile of fourth grade children participating in a TID Project. We investigated children engaged in soccer and swimming, while participating in a TID project in Saitama Prefecture, Japan. Soccer and swimming are popular sports for children around the world, and it is important to clarify the effects of these sports on the physical fitness of children. Our hypothesis is that endurance ability was most sensitive to the number of sport practices, while other abilities were more influenced by the difference of maturity level and the inherent attributes of the child.

Methods

Subjects

The subjects of this study were 220 children who played soccer regularly and 256 children who swam regularly that participated in a TID Project for fourth graders in Saitama, Japan in 2014. The age (mean ± SD) of the soccer group was 9.2 ± 0.4 years, while that of the swimming group was 9.3 ± 0.4 years. This TID was not a project specialized to one sport, but, after being selected, a suitable competition was selected for the children based on their own characteristics. Therefore, the measurement of physical fitness performed in this study assessed general athletic ability, and not soccer or swimming skills.

Prior to conducting this study, approval was obtained from the ethical review committee established in the Saitama Sports Science Committee. In addition, at the start of participating in the TID project, the children and their parents were provided written instruction and their consent was obtained.

Questionnaire investigation

Before participating in the TID, we surveyed the parents of children who applied for these types of children's sports lessons and documented the number of practices per week that each child experienced. The analysis was performed by assigning the number of practices per week as 0, 1 to 2, 3 to 4, and 5 or more practices.

Measurement of physical fitness in the TID

For the TID, the following physical fitness measurements were performed by a member of the Saitama Sports Science Committee, familiar with the measurement, in addition to the measurement of height and weight.

20 m Shuttle Run

The child reciprocates along a 20 m line in time with an electronic sound, which increases in tempo every minute. The child steps on the 20 m line according to the electronic sound, changes direction, and, then, reciprocates. If the child misses the electronic sound twice in a row, the assessment is complete. The examiner judges as to whether the child's reaction was in time for the electronic sound. The maximum number of 20 m turns was recorded.

30 m Sprint Run

The child's performance in the 30 m sprint was measured using a photocell system. In order to reduce fluctuations in measured values due to flying starts and delays, each child was started arbitrarily at 1 m before the measurement point (accelerated running). The time taken to run from 1 m ahead of the starting point to 30 m was measured by the photocell system. The time was indicated to 0.01 seconds for analysis. If there was an obvious mistake such as a stumbling at the start, the test was re-started.

Standing Long Jump

Each child stands on a thin mat, and, with both feet, jumps forward using the whole body. The distance (cm) from the toes at the start to the end of the heel at landing is measured twice, and the higher value is used for analysis.

Horizontal Jump Repetition

The child stands on the center line of three lines drawn at 1 m intervals, and crosses or steps on the line in the order of right, middle, and left as quickly as possible for 20 seconds. The examiner visually measures the number of times the child crosses the line or steps on the line. The value is measured twice, and the higher value is used for analysis.

Statistical analysis

A general linear model was used to analyze the effect of sports events (soccer and swimming) and practice frequency on physical fitness. The general linear model was constructed with the physical fitness parameter as the dependent variable, and the sports events and practice frequency as independent variables. All models were confirmed previously to be free of interactions (the sports events and practice frequency per week). The practice frequency was treated as a four-rank ordinal nominal scale (0, 1 to 2, 3 to 4, and 5 or more practices per week). The analysis used one or more practices per week. Estimated mean, standard errors (SE), and 95% confidence intervals (95%CI) were calculated. A P-value of <0.05 was considered statistically significant, and all P-values were two-sided. All statistical analyses were performed using SPSS statistics version 23.0 (IBM Japan, Ltd., Tokyo, Japan) software.

Results

In the soccer group, 157 children practiced 1 to 2 times per week, 57 children practiced 3 to 4 times per week, and 6 children practiced 5 or more times per week. In the swimming group, 238 children practiced 1 to 2 times per week, 8 children practiced 3 to 4 times per week, and 10 children practiced 5 or more times per week (Table 1). There were no significant differences in height and body mass between the soccer and swimming groups for each practice frequency (Table 1).

Table 1. The number and physical profile of soccer players and swimmers.

	Soccer Players			Swimmers		
Number of Practices/week	**1-2 times**	**3-4 times**	**5 or more times**	**1-2 times**	**3-4 times**	**5 or more times**
Number	**157**	**57**	**6**	**238**	**8**	**10**
Height (m)	**1.357**	**1.368**	**1.341**	**1.346**	**1.362**	**1.373**
SD	**0.008**	**0.010**	**0.024**	**0.007**	**0.021**	**0.019**
Body Mass (kg)	**30.1**	**30.6**	**28.7**	**29.6**	**30.4**	**30.4**
SD	**0.6**	**0.8**	**1.8**	**0.5**	**1.6**	**1.4**

Regarding the 20 m shuttle run, children in both the soccer and swimming groups practicing 3 to 4 times a week and 5 or more times a week performed significantly better than those practicing 1 to 2 times a week (Fig. 1).

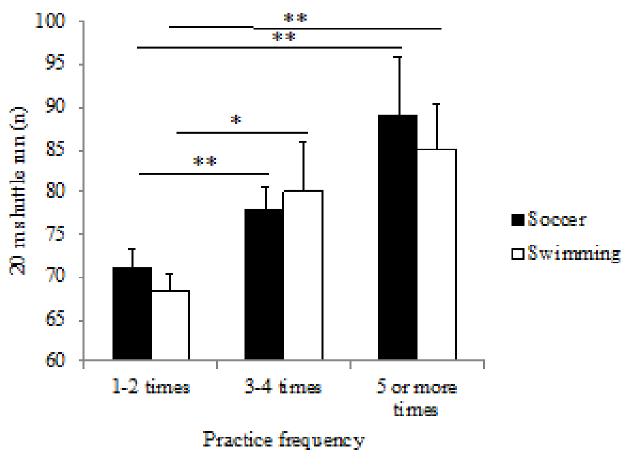

Figure 1. 20 m shuttle run and practice frequency in the soccer and swimming groups.
*** < 0.05, ** p < 0.01**

Regarding the 30 m run, in the soccer group, children practicing more than 5 times a week performed significantly better than children practicing 1 or 2 times a week (Fig. 2). In the swimming group, there was no significant difference in the number of practices per week and the 30 m sprint performance (Fig. 2).

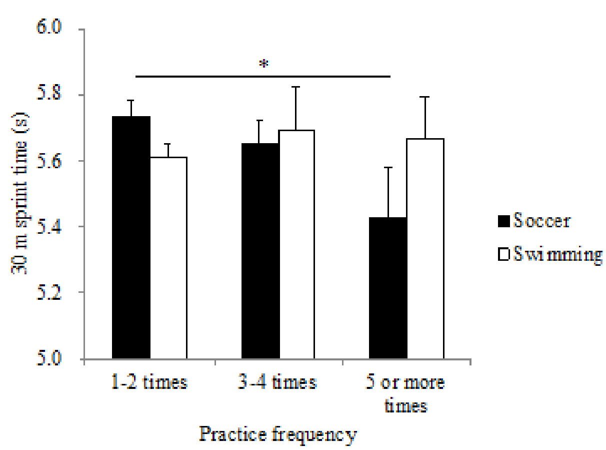

Figure 2. 30 m sprint and practice frequency in the soccer and swimming groups.
*** < 0.05**

There were no significant differences in the number of practices per week and performance in the Standing Long Jump and Horizontal Jump Repetition in both the soccer group and the swimming group (Figs. 3, 4).

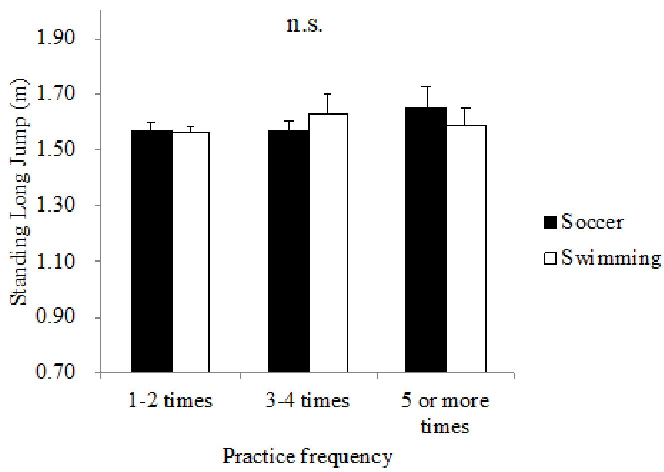

Figure 3. Standing long jump and practice frequency in the soccer and swimming groups.
n. s., not significant

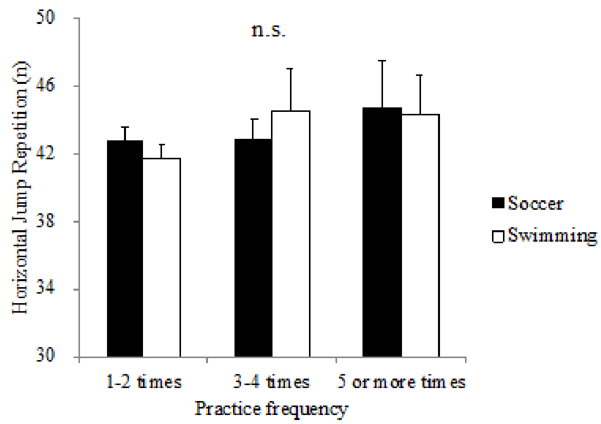

Figure 4. Horizontal Jump repetition and practice frequency in the soccer and swimming groups.
n. s., not significant

Discussion

This study investigated the effect of the number of practices per week on individual physical fitness factors for children with high physical fitness who participated in a TID and regularly practiced soccer or swimming. Our results demonstrate that the number of soccer or swimming practices per week greatly affects endurance ability (Fig. 1). In addition, practice frequency had a slight effect on running speed (30 m running) for children practicing soccer. However, other physical fitness factors, such as power (Standing Long Jump) and agility (Horizontal Jump repetition), were not affected by the number of practices in either sport.

A few longitudinal studies reported that maximum oxygen uptake (VO2max), a physiological index of endurance ability, improves markedly during a child's peak height velocity (PHV) period (Kobayashi et al. 1978, Geithner et al. 2004). The 20 m shuttle run used in this study was developed as a method for estimating VO2max (Léger & Lambert 1982). The subjects of this study were 4th graders, ages 9 to 10 years old, who were younger than the reported PHV period of boys of 13 years old (Kobayashi et al. 1978, Philippaerts et al. 2006). Although recent data suggests that the PHV occurs at 11 years old due to the premature aging of boys in Japan (Ohsawa 2015), according to the calendar age, the subjects of this study were examined prior to PHV. Regarding the effect of endurance training before, during, and after PHV, reports suggest that it is more effective in the during-PHV stage (Murase et al. 1981) and that there is no difference in the effect of endurance training before-PHV and after-PHV (Armstrong & Barker 2011). However, the results of the present study suggest that endurance ability is improved remarkably by increasing the number of practices per week even in this age group.

Results of this study suggest that endurance ability must be taken into consideration when evaluating the talent of a child during this period. It is difficult to determine if a child's ability stems from nature or nurture, and the training effect during the growth and development period appears to include different individual maturity levels. However, our results show that considerable endurance ability can be acquired during this period. Also, there are many sports, other than soccer and swimming, that require endurance ability for their performance. The amount of practice during this period (the number of practices per week) may be a major factor supporting performance during this period. While endurance ability might have a significant effect on performance in many different sports, as well as the evaluation of TID fitness during this period, it is necessary to evaluate the performance carefully. Currently, it is unclear how endurance ability that develops during this period affects future endurance.

With respect to the 30 m sprint run, since many short sprint movements are included in soccer practice (Bangsbo 1994), the increase in the number of practices per week might have appeared as a training effect (Fig. 2). In the swimming group, there is no similar movement during practice, and a training effect may not have appeared because the practice was performed in the water and a ground reaction force was not received.

The Standing Long Jump and the Horizontal Jump Repetition were not related to the number of practices in any group. In soccer, there are many movements that require Stretch Shortening Cycle (SSC) ability, such as sprint dash and direction change running (Bangsbo 1994), but neither item has a relationship with the number of practices (Figs. 3, 4). Lloyd, et al. (2011) examined Squat Jump (SJ), Counter Movement Jump (CMJ), Relative Strength Index (RSI) and leg stiffness in 7 to 17 years old and reported that the largest mean differences occurred between age groups of 10 and 11 years for SJ height, CMJ height, and RSI (Lloyd et al. 2011). Moreover, it is known that at the age before PHV there is a decrease in coordination ability due to the difference in the timing of the growth spurt of the legs and the trunk (Philippaerts et al. 2006). Therefore, these may increase the individual difference in both Standing Long Jump, which is an index of power, and the Horizontal Jump Repetition, which is an index of agility, and may not be seen to be related to the number of practices.

Few studies have examined the effects of training on children's muscle strength and power. The development of muscle strength and power improves significantly after PHV (cross-sectional study) (Malina et al. 2004, Armstrong & Barker 2011. Peitz et al. 2018). Peitz et al.(2018) reviewed research investigating short-term resistance training before, during, and after PHV, and reported a smaller training effect before PHV than observed during and after PHV. Therefore, for our subjects, it may be difficult to develop muscle strength and power, which may reduce the response of our subjects to practice to less than that of other periods. Overall, the difference in original strength and the difference in maturation were large, and it was difficult to be influenced by the number of practices. Therefore, the Standing Long Jump as an index of power might not have been affected by the number of practices. In addition, the Horizontal Jump Repetition, an index of agility, has a strong relationship with muscle strength (Sonoda et al. 2018) and similar results were observed.

Important factors that influence the training effect are training intensity, time, frequency, and mode (Fleck & Kraemer 2014). The only training content investigated in this study was weekly frequency of practice and sport practiced. There are instruments and methods for measuring the amount of exercise, strength, and practice time of an individual, but these methods are not suitable for surveying a large number of people. In addition, surveys targeting children are subject to various restrictions, making it difficult to target a large number of children. Therefore, few reports have investigated the training status and physical ability of children during this pre-PHV period.

The subjects of this study were children who participated in a TID project. Therefore, it was considered that the children were interested in sports and possessed a higher physical ability than children in the general population. In fact, according to a report from the Ministry of Education, Culture, Sports, Science, and Technology of Japan (e-Stat, 2018), the mean 20 m shuttle run for fourth grade elementary school boys is 47.03 ± 20.02 times, the mean standing long jump is 145.84 ± 17.8 cm, and the mean Horizontal Jump repetition is 39.95 ± 7.23 times. Thus, the physical ability of the subjects of this study was much higher than that of general population children. Our results on the daily training status and physical ability of children with outstanding physical ability presents valuable information.

A very popular model for athlete development includes the theory of Long-Term Athlete Development (LTAD) by Dr. Istvan Balyi, which includes periodization of the training plan for athletes (Balyi et al. 2013). This theory presents a training model step by step according to the maturity level of an individual, and is a method that has been adopted in Canadian, Australian, and British sports programs. However, there are some criticisms that the evidence behind the theory is poor (Federica 2016). As mentioned above, there are few studies that have examined training and physical ability of children at the age examined in this study. Johnson (2018) states that practical research is needed to build LTAD (DiFiori et al. 2014). Practical research results, such as that of this study, are important as evidence for constructing a theory for developing child athletes.

There are limitations to this study. First, the effect of differences in the practice content between clubs that the children attended was not examined. Therefore, clubs that practice more often per week might have been trained to improve their endurance ability. The survey of practice content in this study was the number of practices per week, and not the practice time or detailed practice content. Second, very few children in both the soccer and swimming groups practiced 5 or more times a week. It is necessary to increase the number of subjects and further validate the content of this study in the future.

Due to the increased competition and sophistication of sports in recent years, many junior athletes begin specialized training at a younger age, and there are concerns about the negative effects such as sport injuries and burnouts caused by severe training in younger children (DiFiori et al. 2014, Valovich et al. 2011). The results of this study suggest that increasing the number of practices per week might improve endurance ability and performance during that period. In other words, the more you practice, the more endurance you have and the better your performance becomes. Therefore, it is necessary to contribute to the construction of a sports environment desirable for children from a more comprehensive perspective by adding injuries and psychological surveys to this study.

Conclusion

In this study, we investigated the relationship between the number of practices per week and physical ability in children who participated in a TID project targeting fourth grade elementary school children who regularly practice soccer and swimming. Our results suggest that fourth grade children playing soccer or swimming regardless of sports events and who practiced more often had more endurance ability, but no difference in power or agility compared to those who practiced less often. These results indicate that children's endurance ability during this period is easily acquired and should be used with caution as a method for evaluating talent.

Conflict of Interests: The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

Acknowledgements

This study was supported by Grants-in-Aid for Scientific Research (KAKENHI, No. 26350784) and Heisei International University research grants. We would like to thank all the children who participated in the Talent Identification and Development project in Saitama Japan and the members of the Saitama Sports Association.

Congresses

This manuscript was presented as oral presentation at the HEALTHY AND ACTIVE CHILDREN, that was held in Verona, Italy on 11-14 September 2019.

References:

Armstrong, N., & Barker, A. R. (2011). Endurance training and elite young athletes. *Medicine and sport science*, *56*, 59–83. https://doi.org/10.1159/000320633

Armstrong N, van Mechelen W. (2017). Oxford Textbook of Children's Sport and Exercise Medicine. 3rd ed. *Oxford Univ Pr*.

Balyi I, Way R, & Colin H. (2013). Long-Term Athlete Development. *Human Kinetics.*

Bangsbo J. (1994). The physiology of soccer--with special reference to intense intermittent exercise. *Acta physiologica Scandinavica. Supplementum*, *619*, 1–155.

Barreiros, A., Côté, J., & Fonseca, A. M. (2014). From early to adult sport success: analysing athletes' progression in national squads. *European journal of sport science*, *14 Suppl 1*, S178–S182. https://doi.org/10.1080/17461391.2012.671368

Bergeron, M. F., Mountjoy, M., Armstrong, N., Chia, M., Côté, J., Emery, C. A., Faigenbaum, A., Hall, G., Jr, Kriemler, S., Léglise, M., Malina, R. M., Pensgaard, A. M., Sanchez, A., Soligard, T., Sundgot-Borgen, J., van Mechelen, W., Weissensteiner, J. R., & Engebretsen, L. (2015). International Olympic Committee consensus statement on youth athletic development. *British journal of sports medicine*, *49*(13), 843–851. https://doi.org/10.1136/bjsports-2015-094962

Böhm, B., Karwiese, S. D., Böhm, H., & Oberhoffer, R. (2019). Effects of Mobile Health Including Wearable Activity Trackers to Increase Physical Activity Outcomes Among Healthy Children and Adolescents: Systematic Review. *JMIR mHealth and uHealth*, *7*(4), e8298. https://doi.org/10.2196/mhealth.8298

e-Stat. The Portal Site of Official Statistics of Japan by the National Statistics Center.2018. Available from: https://www.e-stat.go.jp/stat-search/files?page=1&layout=datalist&toukei=00402102&tstat=000001088875&cycle=0&tclass1=000001133904.

DiFiori, J. P., Benjamin, H. J., Brenner, J., Gregory, A., Jayanthi, N., Landry, G. L., & Luke, A. (2014). Overuse injuries and burnout in youth sports: a position statement from the American Medical Society for Sports Medicine. *Clinical journal of sport medicine : official journal of the Canadian Academy of Sport Medicine*, *24*(1), 3–20. https://doi.org/10.1097/JSM.0000000000000060

Federica A. (2016). Critical Analysis of LTAD model. *Psycho-social development in Sport,* 1-8.

Fleck SJ, & Kraemer WJ. (2014). Designing Resistance Training Programs. 4th ed. *Human Kinetics.*

Geithner, C. A., Thomis, M. A., Vanden Eynde, B., Maes, H. H., Loos, R. J., Peeters, M., Claessens, A. L., Vlietinck, R., Malina, R. M., & Beunen, G. P. (2004). Growth in peak aerobic power during adolescence. *Medicine and science in sports and exercise*, *36*(9), 1616–1624. https://doi.org/10.1249/01.mss.0000139807.72229.41

Johnston, K., Wattie, N., Schorer, J., & Baker, J. (2018). Talent Identification in Sport: A Systematic Review. *Sports medicine (Auckland, N.Z.)*, *48*(1), 97–109. https://doi.org/10.1007/s40279-017-0803-2

Kinugasa T, Fujiwara A, Waku T, & Gulbin J. (2018). Historical development of talent identification and development initiatives in Japan. *Sports Sci Elite Athlete Support,* 3, 15-26.

Kobayashi, K., Kitamura, K., Miura, M., Sodeyama, H., Murase, Y., Miyashita, M., & Matsui, H. (1978). Aerobic power as related to body growth and training in Japanese boys: a longitudinal study. *Journal of applied physiology: respiratory, environmental and exercise physiology*, *44*(5), 666–672. https://doi.org/10.1152/jappl.1978.44.5.666

Léger, L. A., & Lambert, J. (1982). A maximal multistage 20-m shuttle run test to predict VO2 max. *European journal of applied physiology and occupational physiology*, *49*(1), 1–12. https://doi.org/10.1007/BF00428958

Lesinski, M., Prieske, O., & Granacher, U. (2016). Effects and dose-response relationships of resistance training on physical performance in youth athletes: a systematic review and meta-analysis. *British journal of sports medicine*, *50*(13), 781–795. https://doi.org/10.1136/bjsports-2015-095497

Lidor, R, Côté, J, & Hackfort, D. (2009). ISSP position stand: To test or not to test? The use of physical skill tests in talent detection and in early phases of sport development. *Int J Sport Exerc Psychol,* 7(2), 131-146.

Lloyd, R. S., Oliver, J. L., Hughes, M. G., & Williams, C. A. (2011). The influence of chronological age on periods of accelerated adaptation of stretch-shortening cycle performance in pre and postpubescent boys. *Journal of strength and conditioning research*, *25*(7), 1889–1897. https://doi.org/10.1519/JSC.0b013e3181e7faa8

Malina R. M. (2010). Early sport specialization: roots, effectiveness, risks. *Current sports medicine reports*, *9*(6), 364–371. https://doi.org/10.1249/JSR.0b013e3181fe3166

Malina RM, Bouchard C, & Bar-Or O. (2004). Growth, Maturation, and Physical Activity.2nd ed. *Human Kinetics.*

Murakami, H., Kawakami, R., Nakae, S., Nakata, Y., Ishikawa-Takata, K., Tanaka, S., & Miyachi, M. (2016). Accuracy of Wearable Devices for Estimating Total Energy Expenditure: Comparison With Metabolic Chamber and Doubly Labeled Water Method. *JAMA internal medicine*, *176*(5), 702–703. https://doi.org/10.1001/jamainternmed.2016.0152

Murase, Y., Kobayashi, K., Kamei, S., & Matsui, H. (1981). Longitudinal study of aerobic power in superior junior athletes. *Medicine and science in sports and exercise*, *13*(3), 180–184.

Ohsawa, S. (2015). Determining the optimal age to begin physical fitness training: derived from an analysis of data from the MEXT new physical fitness test. *Japan J Human Growth and Development Research.* 69, 25-35.

Peitz, M., Behringer, M., & Granacher, U. (2018). A systematic review on the effects of resistance and plyometric training on physical fitness in youth- What do comparative studies tell us?. *PloS one*, *13*(10), e0205525. https://doi.org/10.1371/journal.pone.0205525

Philippaerts, R. M., Vaeyens, R., Janssens, M., Van Renterghem, B., Matthys, D., Craen, R., Bourgois, J., Vrijens, J., Beunen, G., & Malina, R. M. (2006). The relationship between peak height velocity and physical performance in youth soccer players. *Journal of sports sciences*, *24*(3), 221–230. https://doi.org/10.1080/02640410500189371

Regier, J. (2019). Talent Identification and Development within Para. *AV Akademikerverlag.*

Sonoda, T., Tashiro, Y., Suzuki, Y., Kajiwara, Y., Zeidan, H., Yokota, Y., Kawagoe, M., Nakayama, Y., Bito, T., Shimoura, K., Tatsumi, M., Nakai, K., Nishida, Y., Yoshimi, S., & Aoyama, T. (2018). Relationship between agility and lower limb muscle strength, targeting university badminton players. *Journal of physical therapy science*, *30*(2), 320–323. https://doi.org/10.1589/jpts.30.320

Vaeyens, R., Güllich, A., Warr, C. R., & Philippaerts, R. (2009). Talent identification and promotion programmes of Olympic athletes. *Journal of sports sciences*, *27*(13), 1367–1380. https://doi.org/10.1080/02640410903110974

Valovich McLeod, T. C., Decoster, L. C., Loud, K. J., Micheli, L. J., Parker, J. T., Sandrey, M. A., & White, C. (2011). National Athletic Trainers' Association position statement: prevention of pediatric overuse injuries. *Journal of athletic training*, *46*(2), 206–220. https://doi.org/10.4085/1062-6050-46.2.206

Veijalainen, A., Haapala, E. A., Väistö, J., Leppänen, M. H., Lintu, N., Tompuri, T., Seppälä, S., Ekelund, U., Tarvainen, M. P., Westgate, K., Brage, S., & Lakka, T. A. (2019). Associations of physical activity, sedentary time, and cardiorespiratory fitness with heart rate variability in 6- to 9-year-old children: the PANIC study. *European journal of applied physiology*, *119*(11-12), 2487–2498. https://doi.org/10.1007/s00421-019-04231-5

Zeng B, Wang L, & Xing W. Japanese editorial supervisor, Sekioka Y. (1992). Scientific selection for sport talent. *DOWA-SHOIN.*

Zhao, K., Hohmann, A., Chang, Y., Zhang, B., Pion, J., & Gao, B. (2019). Physiological, Anthropometric, and Motor Characteristics of Elite Chinese Youth Athletes From Six Different Sports. *Frontiers in physiology*, *10*, 405. https://doi.org/10.3389/fphys.2019.00405