

CHARLES UNIVERSITY
Faculty of Physical Education and Sport

The Factors Influencing Early Termination of Swimming Career in China

Diploma Thesis

Supervisor:

Mgr. Daniel Jurak, Ph.D.

Elaborated by:

Ma. Fangying Li

Prague 2020

I declare that I did the thesis work separately and I only used the literature listed in the list of bibliographic citations.

In Prague

.....

Ma. Fangying Li

I agree to lend my thesis for study purposes. Please keep records of borrowers who have to properly cite the sources of the literature.

Name and Surname: Faculty/Department: Date of loan: Signature:

.....

Acknowledgements

I would like to express my sincere appreciation to everyone who has involved in the writing process of this thesis. Firstly, I would like to thank my supervisor, Mr. Mgr. Daniel Jurak, PhD., who agreed to be my supervisor without hesitation when I started the research in 2017. Secondly, thank you to Mr. Feng Bi, the coach of mine, a great coach of swimming and life.

In addition, I would like to express my gratitude to my best friend Cheng Wang, who helped me corrected my grammar errors. Also, the person who is very special to me, Michal Váňa. Finally, I need to thank my parents for guiding and supporting me to become who I am today.

Abstract

Topic: The Factors Influencing Early Termination of Swimming Career in China

Goals: We studied a number of young Chinese swimmers who experienced early retirement.

Great attention is paid to the reasons why Chinese swimmers ended their careers at a relatively young age. The goal of this thesis is to find out reasons that make Chinese swimmers choose to end their career during their top-performance period and at a much younger age compared with their counterparts worldwide. Meanwhile, finding potential solutions to the situation is also considered as one of the goals of the thesis.

Methods: On the basis of literature review, in this study, we collect the characteristics of Chinese swimmers who have experienced early intensive specialized training by conducting observation, interviews, and questionnaires.

Results: The number of Chinese swimmers who took early retirement increased incredibly during past twenty years. According to the interviews and the results of the questionnaires, the reasons why Chinese swimmers tend to finish their career at a relatively young age can be classified as follows: 1. Despite the professional training, they lack the spirit while they are training. 2. There are few materials guarantees after they finish their career. 3. Not all swimmers are given what they deserve due to the unbalanced policy. 4. Swimmers drop out of academic classes and other activities at a young age, focusing only on swimming. These reasons affect their future after they finish their career. Despite entering universities, lack of the educational background limits their majors only to those related to sport. Besides, full-time training brings physical injuries and mental fatigue. These factors lead the trend of finishing their career at a relatively young age among Chinese swimmers.

Keywords: Chinese swimming, early retirement, athlete retirement policy, bone age

Contents

1. Introduction	6
2. Theoretical part	9
2.1 The main factors influencing premature termination of a swimming career	9
2.1.1 Common injuries in swimming training	9
2.1.2 The swimming shoulder	10
2.1.3 Swimming knee	15
2.1.4 Swimming ankle	16
2.1.5 Heart function of swimmers	17
2.2 Psychological influence factors	19
2.2.1 Coach	19
2.2.2 Experiences from author's athletic and coaching career	20
2.3 Education and employments	22
2.3.1 Education of athletes in China	23
2.3.2 Employment arrangements	25
2.4 The early specialization	28
2.5 Differences between the calendar and biological age of children	30
2.6 Influences of biological age	32
2.7 Stages of swimming teaching system in China	33
3. Goals, work assignments, research questions, materials and methods	42
3.1 Goals	42
3.1.1 Work assignments	42
3.1.2 Research questions	42
3.2 Materials and Methods	42
3.3 Questionnaires	43
3.4 Interview	43
4. Results	45
5. Discussion	54
6. Conclusion	61
7. References	62
8. Attachments	72

1. Introduction

Swimming is one of the sport activities associated with early sport specialization. There is general agreement that the number of hours spent in deliberate practice and training positively correlates with the level of achievement in both individual and team sports; whether this intense practice must begin during early childhood and to the exclusion of other sports is a matter of debate. There are relatively few data to validate these theories. Professional medical organizations have published position statements on sports specialization and intense training in young people but have limited data upon which to base their recommendations and thus rely on expert opinion (Brenner JS, 2016).

The early retirement of Chinese swimmers not only has a certain level of impact on the overall level of Chinese swimming, but also brings relative difficulties to fundamental coaches on the selection for upper level swimming teams. Having spent 2-4 years in fundamental swimming teams, it is felt that the research on the factor(s) which lead to early retirement is important for the further development of both swimmers and coaches.

There is a debatable point of view among swimming experts that Asian swimmers are different from their European and American counterparts, physically and psychologically. Asian athletes rarely achieve accomplishments which Coventry and Coughlin had after 25 years old. However, the Japanese female backstroker, Teragawa Kawasaki, was 28 years old when she received a bronze medal at the London Olympics 2012.

Before the famous Chinese Olympic swimmers Zetao Ning and Yang Sun, the performance of male swimmers was not as good as that of female swimmers in Chinese swimming team. Chinese female swimmers won medals in competitions at the world level at an average age of 20.5. The average age of these top Chinese female swimmers is 22 years old. In addition to these well-known names, others in China finished their career as professional swimmer is younger (Hong F, 2014).

The slight difference between the Chinese female swimmers and their male counterparts is that the latter did not reach as much top performance worldwide as the former did in the past decades (He JH and Zhao YY, 2006). The famous Chinese male butterfly swimmer, Peng Wu, born 1987, has been competing in the same era as American swimmers Michael Phelps and Ryan Lochte. He finished his career after 2013 Barcelona World Swimming Championships, while Michael Phelps and Ryan Lochte were still in the pool. Another example from Chinese male swimmers is Lin Zhang, who was also born in 1987. In the men's 400-meter freestyle final at the Beijing Olympic Games 2008, Zhang won a silver medal with

a score of 3:42.44 and became the first Chinese male athlete to win a swimming medal at the Olympic Games. He retired in 2013, when failed to qualify for the 200-meter freestyle final at the National Swimming Championships (Gao Y, 2009).

In general, Chinese swimmers from city or provincial teams finish their career even earlier than those top ones. According to the data of swimming teams from three cities in China, respectively, 80 % of the swimmers finish their career at the age of 15-17, when they have reached Level 1 (see appendix). 10 % finish theirs when they are younger than 15. 5 % choose to do other water sports. Only 5 % keep training or upgrade to higher levels. Also, Chinese swimmers' retirement age is remarkably earlier than the world average: age 16-19 for girls and age 18-22 for boys (Zhong Y, 2018).

On average, female swimmers worldwide finish their career around 18-21, while male swimmers at 20-24. The topic is based on interviews, questionnaires from Chinese city's swim teams, literatures and previous researches to demonstration the reasons why Chinese swimmers finish their career in the early age (Chi AG, 2014).

In competitive sports, two main problems are highly concerning by coaches: 1. The age of top performance; and 2. The age of retirement. Compared with athletes doing other competitive sports, swimmers are more likely to peak young but can hardly maintain their peak performance (Tan ZD and Liu P, 2003).

Generally, people think girls peak in swimming around 14-16, while boys at 18-19. And the period of remain high performance (considering with time and place of the competition) typically are 5 or 6 years (Tan ZD and Liu P, 2003).

The overall retirement age of Chinese swimmers, compared with their counterparts worldwide, shows a significant trend. For example, Yong Zhuang, the 90s' world class swimmer, was born in 1972. At the Barcelona Olympic Games in 1992, she won the 100-meter freestyle gold medal. After the 1993 National Games, 21-year-old Zhuang chose to finish her career in swimming. Similarly, the famous Chinese female swimmer Hong Qian, born in 1971, won a gold medal in the 100-meter butterfly at Barcelona Olympic Games. Due to the injuries, she finished her career in the early 1990s when she was 23.

Judging from the overall retirement age of the world's swimmers, among a generation, Chinese swimmers tend to retire relatively earlier than their counterparts worldwide (He JH and Zhao YY, 2006). As the same age as Chinese female swimmers Hui Qi and Xuejuan Luo, Kirsty Coventry, the famous female Olympic swimmer from Zimbabwe, was born in 1983. At the age of 25, she still won 3 medals and 1 silver at the 2008 Beijing Olympics. Famous American swimmer Natalie Coughlin participated in the 2012 London Olympics when she

was 30 and got a bronze medal in 4*100-meter freestyle relay competition. In 2017, the Budapest World Aquatics championships saw a number of veteran swimmers compete in pool, including Federica Pellegrini (29), Holly Barratt (29), and Katie Meili (26) (Yang SS, 2014).

This thesis, starting from looking into the swimmers' age range worldwide, aims to find out what reason(s) make Chinese swimmers terminate their career at a young age compared with swimmers worldwide via personal experiences and the results of a series of interviews and questionnaires.

2. Theoretical part

2.1 The main factors influencing premature termination of a swimming career

2.1.1 Common injuries in swimming training

Most of the athletes who terminated their sport career reported that the injury caused them mild or moderate permanent disability. It is found that sports injuries play a significant role in terminating a career in sport, and in some sports events, injuries may commonly be the main reason for sport career termination. Injury prevention and adequate treatment and rehabilitation of injuries are thus essential to avoid the long-term consequences of severe sport injuries. Injuries are common among athletes, and sometimes so severe that they affect an athlete's career in sport (Ristolainen L, et al., 2012).

Swimmers have considerable expertise in early morning practices, team workouts, and living healthy lifestyles. What many may not know is that swimming with poor stroke mechanics or decreased flexibility and strength may cause an overuse injury. Swimmers who experience pain or soreness for more than 48 hours should seek medical attention. This will allow the experts to evaluate and treat most common swimming injuries in time to help prevent more serious long-term effects.

Causes of swimming injuries (Kammer CS, Young CC and Niedfeldt MW, 1999):

- Overtraining
- Not enough rest periods
- Poor stroke mechanics
- Poor breathing technique
- Poor flexibility or range of motion
- Decreased rotator cuff or shoulder blade (scapular muscle) strength
- Poor core strength or stability
- Decreased hip muscle strength

Variations on this general theme exist, with disagreement on what volume of training constitutes “intense” and whether year-round participation or exclusion of all other sports is essential for classifying an athlete as specialized. Some advocate that a minimum volume of training is required to meet the definition (Ericsson KA, et al., 1993), while others define

specialization as merely limiting participation to a single sport on a year-round basis, regardless of training volume (Russell WD and Limle AN, 2013).

Higher training volumes may increase the risk for injury in a variety of sports (Grahame R, Bird HA and Child A, 2000). There was a linear relationship between exposure and risk of injury (odds ratio, 8.28) (Clinch J, et al., 1992), showing significantly elevated risk once training volume exceeded 16 hours per week. Cumulative match (or competition) exposure also carries a significant risk: medical withdrawals increased in national tennis players after playing > 5 games per year in supranational tournaments (Beach ML, et al., 1992). Players who specialized only in tennis were 1.5 times more likely to report an injury (Bulbena A, et al., 2016). A 10-year prospective analysis of 481 youth baseball pitchers (9-14 years old) found that those who pitched more than 100 innings per year were 3.5 times more likely to be injured. Others have found a significantly increased risk (odds ratio, 5.05) for shoulder or elbow surgery if pitching more than eight months per year (Krabak BJ and Zaremeski JL, 2012).

2.1.2 The swimming shoulder

Movements in water are performed in different positions and in different ways. The ratio of propulsive forces of the upper and lower limbs is different in connection with swimming technique. For example, freestyle is the stroke practiced/trained most in swimming (Vorontsov AR and Rumyantsev VA, 2000). The training of freestyle mainly focuses on improving swimmers' strength and endurance in the pool.

Freestyle is a whole-body movement, but with the upper extremities producing 90 % of the propulsive power (Heinlein SA and Cosgarea AJ, 2010), requiring shoulder strength, endurance, and stability. Biomechanical challenges of the shoulder for the freestyle stroke may occur during the recovery phase, which demands an extensive Range of Motion (ROM). A large ROM is anticipated to be advantageous by allowing the swimmer to achieve a body position that permits a more substantial stroke length, positively associated with swimming speed (Wanivenhaus F, et al., 2012). Consequently, the shoulder is repetitively forced into extension, horizontal abduction and internal rotation. Thus, swimming induces a significant amount of stress on the anterior capsule and ligaments of the glenohumeral joint, which may lead to local shoulder laxity or an increased shoulder ROM (Wanivenhaus F, et al., 2012).

Increased shoulder ROM may be a genetic predisposition or an adaptation to the repetitive and excessive overhead movements in swimming. A condition in individuals with

hereditary increased ROM is Generalized Joint Hypermobility (GJH), in which the ligaments and capsules are laxer compared with the average population (Beighton P, Solomon L and Soskolne CL, 1973). GJH is frequently present in swimmers since as many as 20 % of male and female adult swimmers are classified with GJH (Pink MM and Tibone JE, 2000). Also, a higher prevalence of GJH is founded in young, competitive swimmers compared with non-competitive swimmers (Scheper M, et al., 2014). Increased shoulder ROM alone and GJH including shoulder hypermobility may play an essential role in the development of shoulder pain and injuries, and the extent of both conditions must be described as part of an injury sequence prevention strategy, focusing on underlying mechanisms (Van Mechelen W, Hlobil H and Kemper HC, 1992).

Table 1 shows the Beighton score (1973), which is a simple system to quantify joint laxity and hypermobility. It uses a simple 9-point system, where the higher the score the higher the laxity. The threshold for joint laxity in a young adult is ranges from 4-6. Thus, a score above 6 indicates hypermobility, but not necessarily true BHJS (Benign Hypermobility Joint Syndrome).

Table 1. Beighton score (1973)

Joint	Finding	Points
left little (fifth) finger	passive dorsiflexion beyond 90°	1
	passive dorsiflexion ≤ 90°	0
right little (fifth) finger	passive dorsiflexion beyond 90°	1
	passive dorsiflexion ≤ 90°	0
left thumb	passive dorsiflexion to the flexor aspect of the forearm	1
	cannot passively dorsiflex thumb to flexor aspect of the forearm	0
right thumb	passive dorsiflexion to the flexor aspect of the forearm	1
	cannot passively dorsiflex thumb to flexor aspect of the forearm	0
left elbow	hyperextends beyonds 10°	1
	extends ≤ 10	0
right elbow	hyperextends beyonds 10°	1
	extends ≤ 10	0
left knee	hyperextends beyonds 10°	1
	extends ≤ 10	0
right knee	hyperextends beyonds 10°	1
	extends ≤ 10	0
forward flexion of trunk with knees full extended	palms and hands can rest flat on the floor	1
	palms and hands cannot rest flat on the floor	0

GJH is most often assessed by the Beighton Tests (BT), involving a score from 0 to 9, with a suggested cut off point for classification of GJH of $\geq 4/9$ in adults (Grahame R, Bird HA and Child A, 2000). A cut off point for classifying children or adolescents with GJH has not been established, which is why the cut-off end for GJH varies between studies (Junge T, et al., 2016). The BT for hypermobility includes the 1st and 5th fingers, the elbows, the knees and forward bending, but there is no test for shoulder hypermobility (Beighton P, Solomon L and Soskolne CL, 1973). The Active horizontal Shoulder Abduction test (AHSA) could be a relevant shoulder mobility test for swimmers, simulating a swim-related stressful situation like the recovery phase of the freestyle stroke. Since the BT score is closely related to the general mobility of all joints (Beighton P, Solomon L and Soskolne CL, 1973), the AHSA as the supplemental test may provide a more comprehensive profile of the single swimmer's shoulder joint mobility.

When comparing AHSA between different populations, normative data is required for young, competitive swimmers, taking into account age and sex. Such data exists for 15–21-year old (Beach ML, Whitney SL and Dickoff-Hoffman S, 1992).

The risks of intense training in elite young swimmers in the United Kingdom was relatively low (rates of injury < 1/1000 hours of training) with few serious consequences; training volumes were often < 16 hours per week 7.34; lower than for other intensely trained athletes. A 10-year follow-up suggests that injury incidence is significantly higher for athletes competing at an international level (87.5 %) and a regional/country level (64.0 %) compared with those competing at a national level (16.7 %) or recreational level (47.1 %) (Juul-Kristensen B, et al., 2009).

Shoulder injury is a common injury in swimming training and has an enormous impact on training and competition, which can lead to the termination of a swimmer's career (Ristolainen L, et al., 2012). Many athletes ended their swim career at their peak because of the shoulder injuries. Swim shoulder was first proposed in 1967, initially referred to as a swimmer shoulder pain syndrome, especially after swimming, caused by sub-acromial cervical syndrome and frozen shoulder. And related shoulder disorders are one of the essential reasons of why swimmers finished their career.

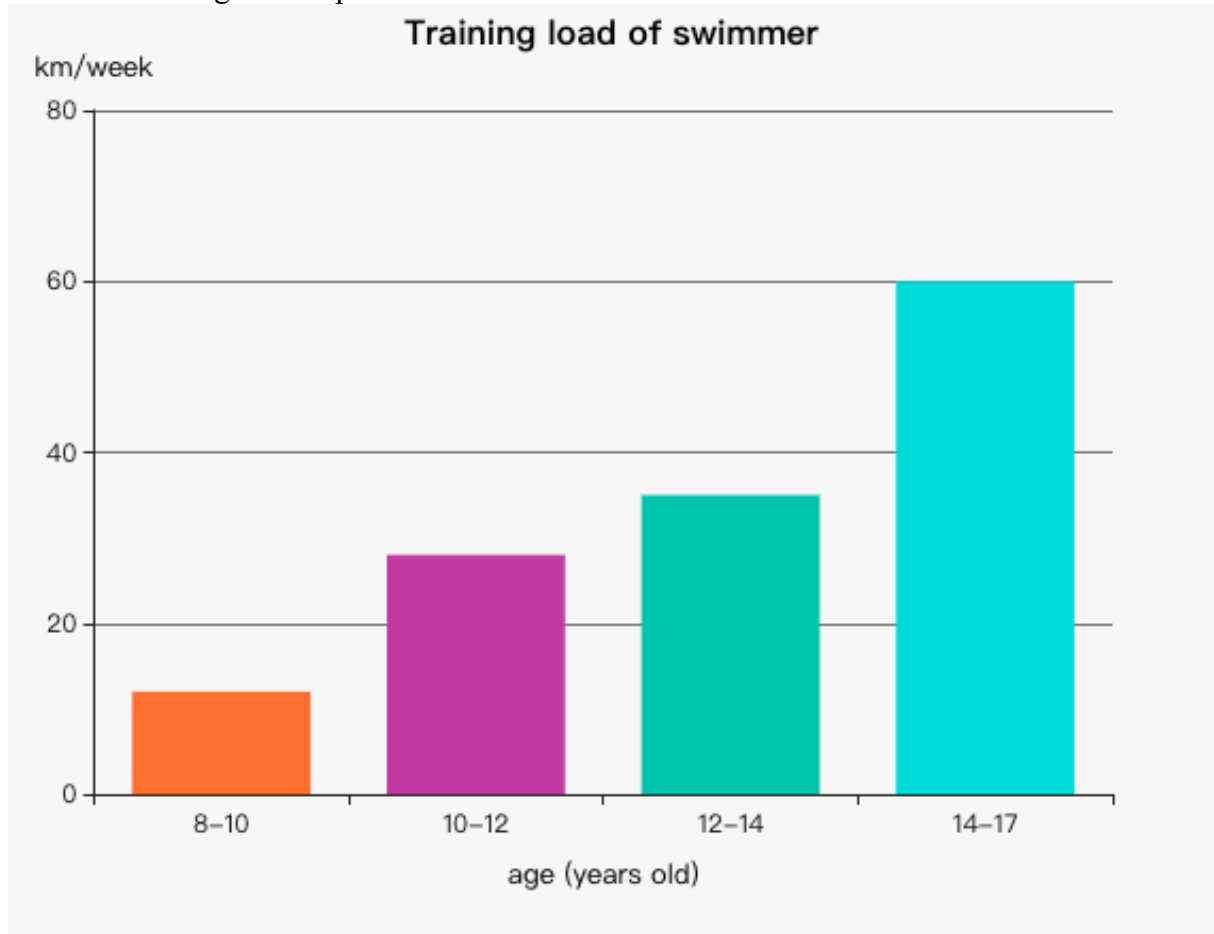
Compared with young swimmers around the world, increasingly more professional Chinese swimmers are suffering from shoulder injury and myocarditis. This could be attributed to their higher than average training volumes that may increase the risk for injury. In general, a competitive swimmer swims 9-110 km a week, depending on age, physical level and training requirements (Gaunt T and Maffulli N, 2012). In China, swimmers start full-time swimming from 12-14 years old, with the training time around 5-7 hours per day (see Chart 1) and at least six days per week.

In the stage of the advanced endurance training, the daily schedule (from author herself) below is for 14-year-old Chinese swimmer:

1. Warm up 800 meters
2. 20*400 meters freestyle
3. 100 meters cooling down
4. 4*25 meters freestyle
5. 100 meters cooling down

Total: 9100 meters

Chart 1. Training load of professional Chinese swimmers



*Data (2004-2014) collected from coaches based in three different cities

The arm movements needed by a professional swimmer during 100-meter freestyle are 80 to 100 times, with an average at 90. According to this, every 1000 meters requires 9000 strokes. The weekly minimum training load of swimmers at the age of 14 to 17 is 60 kilometers. Thus, the shoulder needs to endure the movement for over 540,000 times (60×9000) in one week.

This amount of shoulder movements leads to a significant amount of repetitive movements, which may result in overuse injuries of the shoulder (Wanivenhaus F, et al., 2012). Although competitive swimming attracts a large number of children and adolescents, there are almost no epidemiological studies on adolescent shoulder injuries for children or adolescents within this sport (Kocher MS, Waters PM and Micheli LJ, 2000). The prevalence of shoulder injuries in adult competitive swimmers varies from 40 to 91 %, partly due to inconsistency in the definition of trauma, study design and data collection methods (Wanivenhaus F, et al., 2012).

As the improvement in the world's swimming performance, the intense competition between swimmers is continually increasing. To reach the higher level, swimmers in China would adopt high-intensity, high-volume training methods. Besides, Chinese swimmers devote themselves to all-day training at a young age and have rare holidays. Under this overloaded training, many excellent and talented swimmers cannot complete the required practice. According to the situation of Chinese swimmers, shoulder injuries not only hold back their future and the improvement in their performance but also shorten or end their careers.

A comprehensive and systematic survey on sports injuries was conducted with 120 swimmers who were on national level or above and from 18 different provincial and municipal teams that participated in the 1999 national championships competition (Li MH, et al., 2001).

The results of the survey (see Table 2) show that, except for shoulder, the injury parts of Chinese swimmers include waist and knee as well.

Table 2. Survey on injuries in 1999, National championship

Injury part(s)	Number of people	Injury rate
Shoulder, Waist, Knee	78	65 %
Shoulder	52	43.3 %

2.1.3 Swimming knee

Several factors are related to an increasing risk of knee pain in swimmers. A condition called breast stroker's knee may result from the whip kicking motion used in breaststroke swimming. Risk factors for developing breast stroker's knee include overtraining, poor technique, inadequate warmups and limited flexibility of the hip, among others. Competitive swimmers with good breaststroke technique, on the other hand, are at lower risk for developing knee pain.

The incidence rate of knee injuries in swimming appears to be between 12.9 % (Chase KI, et al., 2013) and 27 % (Kennedy JC and Hakwins RJ, 1980), though it's difficult to be certain, as many of the reported studies are retrospective case series with small participant numbers. Medial knee pain does seem to be most common in breaststroke swimmers. This is most likely due to the specific kicking mechanics used in breaststroke swimming, which result in high valgus loads as the knee goes rapidly from flexion into extension with external

rotation of the lower leg. In one study, 75 % of the 36 surveyed breaststroke swimmers reported at least three episodes of knee pain per season and 47 % of these swimmers reported weekly episodes of knee pain (Rovere GD and Nichols AW, 1985). There were equal numbers of unilateral and bilateral knee complaints in the injured cohort (Rovere GD and Nichols AW, 1985).

The knee, especially the patellofemoral joint, can also be susceptible to injury due to weight training, particularly with exercises such as high-loaded squats and lunges commonly performed by swimmers. Therefore, freestyle, butterfly, and backstroke swimmers may also experience patellofemoral joint overload and anterior knee pain. The repetitive extension moments in the flutter kicks used in butterfly, as well as the repetitive action of pushing off the wall with the knees in a high degree of flexion while turning, may create patellofemoral joint overload, resulting in anterior knee pain (Rodeo SA, 1999).

2.1.4 Swimming ankle

Two common areas of pain generation for swimmers are the flexor and extensor muscle groups and their associated tendons. These groups provide for movement of the foot and ankle in up and down planes - the motion required for kicking in the freestyle swim stroke. In the foot and ankle, raising the foot off the floor is called dorsiflexion, and is predominantly accomplished by contraction of the tibialis anterior muscle. Pressing the foot and ankle down into the floor is called plantar flexion and is predominantly accomplished through the contraction of the gastrocnemius soleus complex of muscles. Accomplishing dorsiflexion of the toes is through contraction of the extensor hallucis longus and extensor digitorum longus. Plantar flexion of the toes is through contraction of the flexor hallucis longus and flexor digitorum longus (McLeod IA, 2009).

Overuse of a muscle is known as a muscle strain and is caused by damage to the muscle. The amount of damage is on a continuum. Small amounts of micro trauma cause a mild healing response, promoting muscle growth. This is the process capitalized on by athletes through progressive adaptive exercise to become stronger. Overuse injury at a further level can be associated with macro trauma, or muscle tearing on a larger level, resulting in a permanently damaged muscle that can become scarred and less functional (Wilder RP and Sethi S, 2004).

2.1.5 Heart function of swimmers

Swimming is a unique form of exercise, differing from land-based exercises such as running in many aspects including medium, position, breathing pattern, and the muscle groups used. Water immersion places compressive forces on the body with resulting physiologic effects. We reviewed the physiologic effects and cardiovascular responses to swimming, the cardiac adaptations to swim training, swimming as a cardiac disease risk factor modifier, and the effects of swimming in those with cardiac disease conditions such as coronary artery disease, congestive heart failure and the long-QT syndrome (Gussak I and Gussak HM, 2007).

The heart and lungs allow the body to use oxygen more efficiently during swimming, which is generally reflected in the decline of the heart rate and breathing rate. This improves muscle strength and flexibility. The heart wall is also formed above average in swimmers. The heart can beat more powerfully and economically, with less beats it is able to pump more blood through our veins than a non-athlete's heart ever could. Water also plays a special role for swimmers, since it puts more pressure on the body than air. Thus, the blood vessels are more compressed, and the blood is pushed towards the chest. As a result, the heart has to work more with each beat and is therefore better trained (Sammut EC, et al., 2018).

Knowledge regarding the adaptations of the human body following long hours of exhaustive swimming is limited (Drygas W et al., 2014). Grünig and co-authors reported 38 cases of swimming-induced pulmonary edema (SIPE) selected from 17 works (Grünig H et al., 2017). The literature also describes dozens of sudden deaths and cardiac arrests of triathletes while participating in the swimming part of competitions (Marouli E, et al., 2017).

Premature beats (extra-systole) refer to heartbeats that occur earlier than expected (Xiao S, 2008). It may be asymptomatic or cause palpitations. Frequent premature beats (due to reduced cardiac output) may cause fatigue, dizziness or other symptoms, patients with a heart disorder may, therefore, induce or aggravate angina or heart failure. By auscultation, it can be found that patients present with arrhythmia and the premature beat is followed by a longer compensatory pause. The first heart sound in a premature beat tends to be louder, while the second heart sound is softer or disappears. When a premature heartbeat occurs after a normal one (bigeminy) or in a three-beat pattern (trigeminy), a long pause can be heard every two or three heartbeats. A premature beat may be interpolated between two normal heartbeats and form three consecutive beats. In such case, intermittent pulse can be detected in pulse palpation.

In 2010, the university of Rochester Medical Centre presents that myocarditis has a spectrum of symptoms ranging from mild dyspnea or chest pain that spontaneously resolves without treatment to cardiogenic shock and sudden death. The major long-term consequence is dilated cardiomyopathy (DCM) with chronic heart failure. Common viral infections are the most frequent cause of myocarditis, but other pathogens, hypersensitivity reactions, and systemic and autoimmune diseases have also been implicated. The diagnosis can usually be made based on clinical presentation and noninvasive imaging findings, but endomyocardial biopsy (EMB) may be indicated in select cases (Blauwet LA and Cooper LT, 2010).

Clinical symptoms in adult

The clinical presentation of acute myocarditis in adults is highly variable, ranging from subclinical disease to fulminant heart failure. A viral prodrome including fever, rash, myalgias, arthralgias, fatigue, and respiratory or gastrointestinal symptoms frequently, but not always, precedes the onset of myocarditis by several days to a few weeks. Patients may present with chest pain, dyspnea, palpitations, fatigue, decreased exercise tolerance, or syncope. Chest pain in acute myocarditis may mimic typical angina and be associated with electrocardiographic changes, including ST-segment elevation. Rarely, chest pain associated with coronary artery vasospasm may occur in patients with myocarditis (McCully RB, Cooper LT and Schreiter S, 2005). Alternatively, chest pain may be more typical for pericarditis, suggesting pericardial involvement. Cardiac rhythm disturbances are not uncommon and may include new-onset atrial or ventricular arrhythmias or high-grade atrioventricular (AV) block. Of the 3055 adult patients with suspected acute or chronic myocarditis who were screened in the European Study of the Epidemiology and Treatment of inflammatory Heart Disease (Hufnagel G, et al., 2000), 72 % had dyspnea, 32 % had chest pain, and 18 % had arrhythmias. Patients with fulminant myocarditis typically present with severe heart failure symptoms that may rapidly lead to cardiogenic shock, whereas patients with GCM commonly present with heart failure symptoms that relentlessly progress to probable early death despite the optimal treatment.

Well-known Olympic Chinese swimmer champion Xuejuan Luo retired due to heart problems. According to an interview (China youth daily. 16. 04. 2007) of Yi Fan, the leader of Chinese swimming research team, in 2002, Xuejuan Luo presented with tachycardia and premature beats, which belong to functional heart problems. The reason is unknown. After the Athens Olympics, in 2005, Xuejuan Luo could no longer adapt to the high-intensity training in the national team, so went back to Zhejiang swimming team for recovery training. The symptoms of her heart problems changed during the period of recovery training. After a

minimally invasive surgery in 2006, she began to present with heartbeat pulsation. Because of organic heart problems, she was unable to keep swimming anymore.

Clinical symptoms in children

The clinical presentation in children varies according to age. Infants may have nonspecific symptoms including anxiousness, malaise, fever, poor appetite, tachypnea, tachycardia, and cyanosis. Symptoms in children greater than 2 years of age may also include chest pain, abdominal pain, myalgias, fatigue, cough, and edema. The severity of symptoms is dependent on the age of the child, as newborns or infants are often more severely affected. In a study of 31 children found to have definite myocarditis (n = 16) or probable myocarditis (n = 15), the most common findings during initial presentation to the emergency department were respiratory distress 68 %; tachycardia 58 %; lethargy 39 %; hepatomegaly 36 %; abnormal heart sounds, including murmur 32 %; and fever 30 % (Freedman SB, et al., 2007). Children, particularly infants, often have a more fulminant presentation than adults and may require advanced circulatory and respiratory support in early stages of their disease (Amabile N, et al., 2006).

2.2 Psychological influence factors

2.2.1 Coach

Coaches have long been known to influence youths' sport experiences (Smoll R.E and Smith F.L, 2002). Typically, coaches who provide poor social support (i.e., pressure, unrealistic expectations, lack of empathy, lack of confidence in athlete) and lead with an autocratic style have been associated with negative outcomes such as negative attitudes towards coaches, decreased motivation, dropout, and burnout (Gustafsson H, DeFreese JD and Madigan DJ 2017). Intervention studies (Barnett NP, et al., 1992) suggest that coach behaviors can be modified to enhance athlete outcomes.

The concept of organizational change has been widely researched. When an organization experiences a change in leadership, employees may undergo feelings of loss of control, a sense of job insecurity, and decreased individual self-esteem and well-being. When a major change occurs in an organization, “new norms and rules are often adopted, causing old norms and rules to be less important” (Kim J, et al., 2013). The corporate world and the world of intercollegiate athletics are similar in many ways, including the concept of employers (coaches) and employees (student-athletes). When a head coaching change takes place, the student athletes, much like corporate employees, may feel the stress of the unknown as the

organization (athletic program) experiences a change in possible leadership style, routine, environment, and self-efficacy. Part of the stress experienced by the student-athletes is a result of the relationship, good or bad, with the coach who recruited them to the program (Kevin W, et al., 2007), stated that employees who have a high-quality relationship with a leader who leaves the organization often experience feelings of psychological loss and withdraw.

Interested in the impact of a coaching change as it related to organizational change, in 1972, Eitzen and Yetman conducted a study of 417 National Collegiate Athletic Association (NCAA) member institutions to examine the overall winning percentage and number of coaching changes from 1930 to 1970. The data indicated, “Coaching change tends to improve team performance” (Eitzen DS and Yetman NR, 1972). The researchers explained that coaching changes appeared to have little effect on team performance; however, when such a change occurred, the new coach provided the possibility of long-term performance and success. Future studies were recommended to investigate the reason for the head coaching change. Similarly, in a qualitative study regarding head coaching changes conducted by Molnar C, (2002), five major themes emerged: change, bonding, expectations, acclimation (or alienation), and growth. Three notable sub-themes also were present: shock/no surprise, relief/sadness, and frustration of the unknown. In a similar study, Beck U (2002) examined the perceived effect of a returning head coach versus a new head coach on the evaluation of anxiety levels of student-athletes. Beck found that student athletes returning to the same coach experienced feelings of concern regarding playing time, change in position/rank, and the relationship with the head coach. Student-athletes experiencing a head coaching change were more concerned with coaching philosophy, relationship with the head coach, and their scholarship expectations.

A survey of elite young athletes (Training of Young Athletes Study) found that Coach was the most substantial influence on the initiation of a sport (gymnastics, tennis, swimming, soccer) while coaches were the most active influence on their decision to perform intense training. Similarly, a survey (Baxter AD and Maffulli N, 2003) of 153 high school athletic directors suggested that coaches were the most potent influence to specialize in a single sport (Hill G and Simons J, 1989).

2.2.2 Experiences from author’s athletic and coaching career

In China, a professional swimmer who has reached the national level or above has at least two long-term coaches.

Take a national level swimmer as an example. The first coach of the swimmer starts to guide him/her when he/she is at beginner level and will oversee the following process from formal training and movement correction to technique modification and performance improvement. For the second coach, the swimmer will follow him/her from the stage of participating in large-scale high-level competitions until the final retirement.

The first coach has a great chance to determine the length of a swimmer's career. From a psychological point of view, for adolescents, it is highly likely to follow the example of adults who live with them for a relatively long time in terms of the development of personality. In China, most athletes live in their teams. Few live at home and commute for participating in the training session.

Young swimmers in sports school form a community, spending time together not only on professional training but in daily life and study. Young Chinese swimmers enter sports schools at an average age of 11-13. The first coach, therefore, takes care of them in both professional training and life. Before upgrading to a higher-level team, a young swimmer is usually under the supervision of one coach for 2-3 years. Chinese coaches assess the further development of swimmers on the basis of their foundation, which is developed and completed from their childhood to adolescence. The foundation of a swimmer, consisting of the cardiorespiratory ability, the flexibility of movement, streaming-line height and body development and muscle type, plays an essential role in becoming a professional swimmer, and its quality will directly affect the swimmer's career. The process of cultivating swimmers' foundations is often overseen by the first coach.

The second coach has a relatively higher-grade requirement for swimmers. In the past ten years, athletes entered provincial training teams should be the top three in essential provincial competitions. Or some talented swimmers trained in groups below the provincial level got selected by provincial-level team's coaches. He or she would adapt to the practice in the provincial team.

The length of the athlete's career is affected by the coach's replacement frequency and length of the term, and the athlete's own level of competition is the main reason that affects his or her own value.

2.2.3 Parents

Typically, studies examining associations between parents' behaviors and youth sport outcomes have found that high perceived amounts of parent support, encouragement,

involvement, and satisfaction have been associated with more enjoyment, intrinsic motivation, and preference for challenge (Scanlan TK and Lewthwaite R, 1986).

Parents need to be able to differentiate the needs of their children from their own. If social comparisons and negative criticism drive the parent-athlete relationship, confidence levels can quickly plummet. Excessive parent “coaching” can result in undue stress for the athlete, which quickly leads to performance anxiety, fatigue, burnout, and loss of enthusiasm and drive for the sport.

Parents, in their many different ways, play a vital role in supporting the involvement of their children and young people in competitive sports (Jean C, 1999). According to Fraser-Thomas and associates (2008), parents are responsible for introducing their children to practice sport and provide the necessary means and resources so that the children remain active in it (Myrian N and Mauricio O, 2013).

Although the involvement and support of parents in sports, to a large extent, are associated as being positive, Karen and Vidmar (2000) warn that many parents who are overly enthusiastic in their support of their children (Karen D and Vidmar P, 2000), can damage the careers of their young athletes. Some parents have difficulty perceiving that their degree of involvement in sports can be understood by the children, in some cases, as a source of stress (Kanters MA, Bocarro J and Casper J, 2008).

For example, it has been suggested that parents often pressure their children by encouraging them on the path to early specialization by funding their involvement in camps, clinics, and lessons, and by providing sport-specific facilities in the home (Fraser-Thomas JL Côté J and Deakin J 2005). Further, it has been suggested that youth often experience pressure because they feel obligated to continue training and competing to fulfill parental expectations (Coakley J, 1992).

2.3 Education and employments

In general, the educational level of professional Chinese swimmers is between primary school and secondary school (grade 5-8) due to the full-day training (see Chart 2). The lack of academic knowledge affects swimmers’ choices for university and further career. Even if the swimmers who have reached the high level and therefore attained job offers and subsidies after retirement have limited choices in career development.

2.3.1 Education of athletes in China

Swimming is an early-specialized sport (Baker J, Cobley S and Fraser-Thomas J, 2009). Chinese swimmers start full-time training at an average age of 12-14 years old, when most of them are in secondary school. After several years of training, if a swimmer's performance is competitive and has reached a certain level, it is highly likely that this swimmer will start full-time training to prepare for upper level competition (see Chart 4).

In most of the cases, the overwhelming majority of swimmers would choose to finish their career and participate in university studies when they are around 17 years old. In 2011, adjustments were made in the preferential policy of bonus points for students with special talent in sports in China. Specifically, three kinds of students in senior high school are eligible to enjoy the bonus points: 1. those who have participated in individual competitions or group competitions of major international sports competitions and made the first six; 2. those who have participated in individual competitions of national sports competitions and made the first six; and 3. those who have attained the certificate of national second-level athletes (or above) and met the corresponding standards in the test organized by provincial admissions authority. Besides, the eligible students should be fresh graduates of the year and the admissions committee of the province that the students belong to will decide whether they can get up to 20-point bonus in addition to their exam scores.

In 2015, the General Office of the State General Administration of Sport released the Notice on Granting the Elite Athletes the Exemption from the National Higher Education Entrance Examination 2016 (Beijing Daily, 2015). Meanwhile, details were given to important sports administrative centers and local sports departments.

According to the Notice (Beijing Daily, 2015), athletes must meet three conditions to enjoy the exemption. First of all, meets the 2016 college entrance examination registration requirements and obtains the local college entrance examination registration number. Second, has formal formalities for enrollment and the salary, consisting of basic allowance and performance allowance for athletes, is paid by the sports team in sports system (professional athletes are not subject to this condition). The most important point is that the athletic performance is outstanding and satisfies any one of the following: participated in designated competitions and won top three on the national level, top six in Asia and top eight in the world; obtained the title of Master of Sports in football, basketball, volleyball, track and field, and martial arts; obtained the title of International Master of Sports (Beijing daily news, 2015). In China, students generally enter universities at the age of eighteen. We now take professional swimmers as an example. A swimmer starts to learn swimming from the age of

eight then takes full-time training at age twelve for five years. With no injuries, the swimmer may reach a certain level, which will allow him or her to be admitted to a relatively good domestic university. If the swimmer wants to start college life at the age of eighteen and attend academic courses a year earlier, then the swimmer's best retirement age is 17 years old.

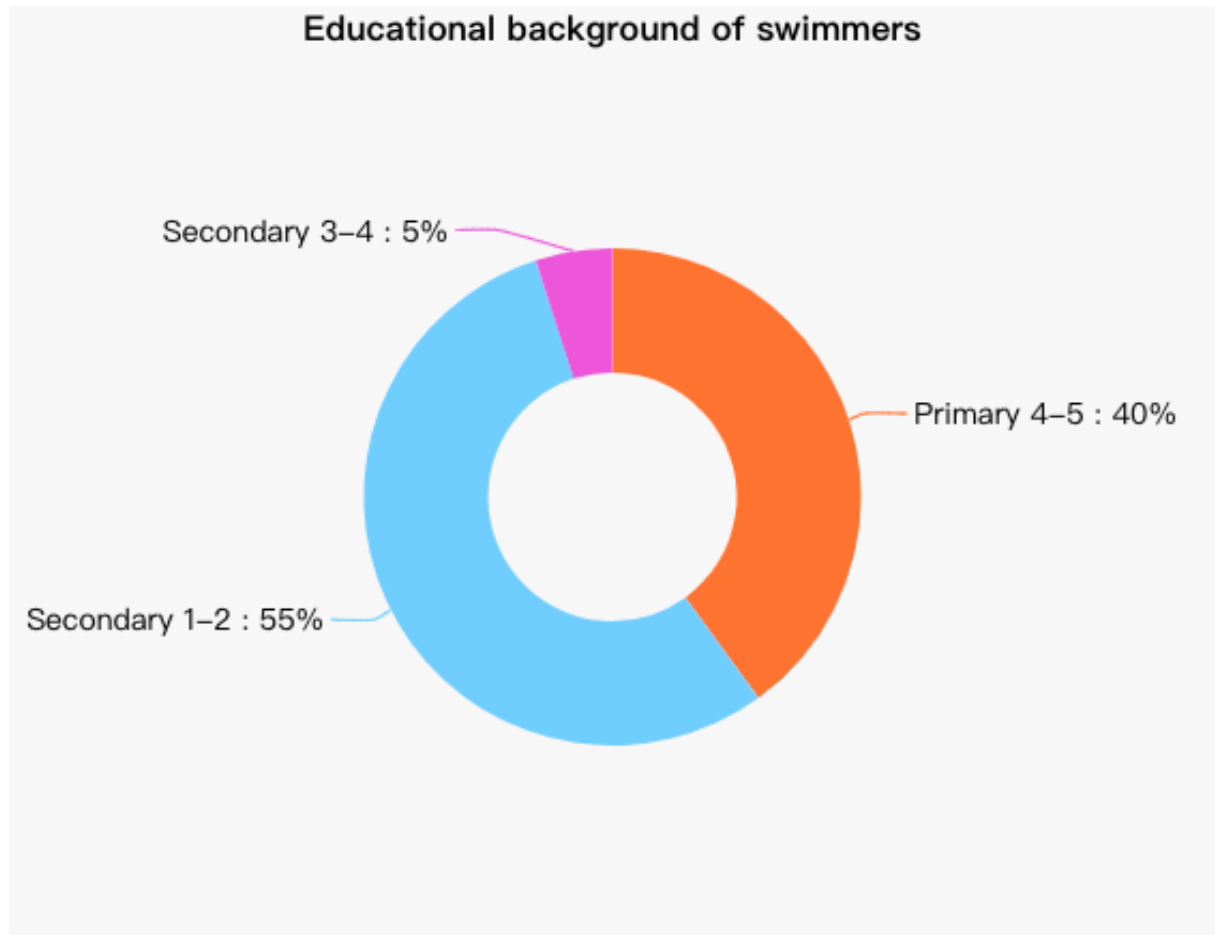
Due to the intensive training in adolescence, professional athletes in China usually spend little time on academic learning, which limits their college major choices (see Chat 2). In Chinese universities, more than 98 % of the retired athletes chose to enter the faculty of sports training or physical education. The majority of students from the sport and physical education faculty come from various sports activities. With the lack of educational background in sports teams, they would gain much knowledge in universities. Furthermore, students in sport faculties in China are on a relatively lower academic level compared with those in faculties not related to sport.

In China, there are Project 985 universities and Project 211 universities (Ministry of Education of the People's Republic of China, 2003). Project 985 is a higher education construction project implemented by China for the construction of several world-level universities. The list of Project 985 consists of a group of internationally renowned high-level research universities. Project 211 is a project of National Key universities and colleges initiated in 1995 by the Ministry of Education of the People's Republic of China, with the intent of raising the research standards of high-level universities and cultivating strategies for socio-economic development. During the first phase of the project, from 1996 to 2000, approximately US\$2.2 billion was distributed. In China, diplomas issued by these universities are regarded as "prestigious" and represent a steppingstone to employment.

Sport-related faculties in China, either in Project 985 or Project 211 universities, have limited placements. In universities that provide programs related to sports, the majors mainly focus on sports management, sports training, and sports therapy. After the retirement of Chinese professional swimmers, more than 90 % of them study in sports training (See the questionnaire). This is because the other two main majors, sports management and sports therapy, require not only a background in sports but academic knowledge as well. Considering the fact that the retired athletes do not have much strong educational background, therefore, these two majors' students mainly are sports enthusiasts of a certain sport training program. Unlike professional athletes, they are on a relatively better academic level; meanwhile, they have certain sports foundation compared with common students in junior and senior high school. They can choose management and treatment courses related to sport,

while those ex-professional athletes usually find that the courses of these two majors are beyond their academic ability.

Chart 2. Educational background of Chinese swimmers



2.3.2 Employment arrangements

Prior to the end of the 1990s, according to the resettlement policy announced by the General Administrations of Sport of China in 1996, high-performance athletes (provincial champion or above), when retired, would have their jobs arranged by the human resources and other departments in a unified way. The elite athletes who had had certain achievements (such as the top 6 in a national competition) would have their jobs arranged by the human resources department of the province. Other retired athletes' jobs would be arranged by human resources department of city or county (Dai HX, 2015).

Later, the reform of public institutions and the reform of the personnel system of enterprises and public institutions led to great difficulties in policy-oriented resettlement (Dai

HX, 2015). It was difficult to continue the implementation in a wide range. Different from the national resettlement of the retired athletes in the planned economy, in a city, only a few retired athletes with outstanding sports achievements on the national or provincial level would receive special attention, be retained as coaches or enter state organs, public institutions or state-owned enterprises enjoy more benefits. Other athletes could only choose the one-off economic compensation. Although athletes who choose their own jobs can get financial compensation, this can only be realized in rich provinces (Dai HX, 2015).

Take Zibo, a city in Shandong Province, as an example. The resettlement policy for retired athletes after the 21th Provincial Games in 2006 was: provincial champions (must have high school diploma) would have the chance to be allocated to public institutions of the city they belong to. Athletes who officially represented the provincial team and got the top eight in national competitions would have the same arrangement.

Table 3. Age groups of swimmers in 2006 Shandong 21th Provincial Games

	Group A	Group B	Group C
Age	Born between 1991-1992	Born between 1993-1994	Born after 1995

According to the age groups of the 21st Shandong Provincial Games (see Table 3 above), swimmers who won medals in this competition would be 15-14, 13-12 and 11 years old. In total, over 500 swimmers participated in the 21st provincial swimming competition, while only 10 % of them could get the guarantee of employment at that time. According to the employment and resettlement policy of a city in Shandong Province in 2005, the champions of the Provincial Games with diplomas from secondary school or above would be placed by the government. On this premise, the athletes who won the championship were up to 15 years old. Without related diplomas, the employment offer could not be obtained. Even under this circumstance, this policy was changed in the following years.

2.3.3 Changes of policy

Later, since 2010 (officially announced in 2013), with the reform of institutions, the General Administration of Sport of China, and the personnel systems of enterprises and institutions, the policy-based placement has been facing tremendous difficulties and it is difficult to continue its implementation on a large scale (Yi S, Qin Z and Li Q, 2015).

A few years ago, in 2003, six ministries and commissions in China, namely the General Administration of Sport, Office of the Central Commission for Public Sector Reform, Ministry of Education, Ministry of Finance, Ministry of Personnel, and Ministry of Labor

and Social Security announced: Only athletes achieved extraordinary performance or honors for the country and province, such as champions of National Games or Asian competitions, or the top eight places of world competitions, can get employ arrangement from relevant department in the government. Then, it is possible for these athletes to be retained as a coach or arranged to work in organs, public institutions and state-owned enterprises that are comparable in the good economic situation. Other former athletes can only choose to obtain one-off compensation and find employment by themselves (Yi S, Qin Z and Li Q, 2015).

According to the “Opinions on Further Improving the Placement of Retired Athletes” issued by the six ministries and commissions including the General Administration of Sport of China, Office of the Central Commission for Public Sector Reform, Ministry of Education, Ministry of Finance, Ministry of Personnel, and Ministry of Labor and Social Security, athletes are encouraged to choose their own jobs through the market and the economic compensation is proposed for athletes chose to find employment by themselves (Huiying X, 2016).

Policy on retired athletes who find jobs by themselves in China:

1. Scope of implementation

If the retired athletes, who have gone through formal recruitment procedures, have their personnel relations at sport teams within the sport system, and enjoy basic allowances plus performance allowances, voluntarily decline the official replacement and choose their own jobs, upon the approval of the authority, can enjoy the one-off economic compensation as long as they complete relevant personnel relation procedure within the prescribed time frame.

2. Retirement compensation standard

For retired athletes who choose their own jobs, reform the existing retirement subsidy policy by granting a one-off economic compensation instead. The compensation is calculated on the basis of several factors, including the years the athletes have spent in the sports team, their achievements and their salaries before retirement. It is determined by local authorities of personnel matters, finance and sports administration according to the local circumstances, and granted by the local sports’ administrative authority as a lump sum. The economic compensation consists of three parts: the basic placement fee, the age compensation, and the performance reward. The basic placement fee compensates for the dissolution of the personnel relation between the retired athlete and the sports team, assisting the retired athlete in basic settlement expense and costs of learning and training in basic professional skills required by the new job. It can be determined directly by provinces, autonomous regions, or

municipalities with reference to the average annual salary of urban employees in the previous year, with a minimum amount of 10,000 yuan. (Approximately not less than 1200 euro).

3. Athletic age compensation

This is a kind of compensation received by retired athletes for the physical injuries caused by challenges for physiological limit during training. The compensation is linked to the years of training and the basic sports allowance before retirement. Its calculation is according to the relevant provisions of the state.

4. The performance rewards

Generally, the retired athletes will be rewarded for their achievements in the Olympic Games, World Championships, World Cup, Asian Games, Asian Championships, Asian Cup, National Games and national competitions during the training period, which will encourage athletes to make more achievements and contributions. The specific criteria for the performance reward will be determined by local authorities according to the local conditions. Retired athletes who have achieved certain places in national competitions (top eight for Olympic sports and top six for non-Olympic sports) can receive a performance reward with a minimum amount of 5,000 yuan (Equivalent to about 650 euros).

In addition, after the retired athletes who choose their own jobs enjoy the economic compensation, they will no longer be eligible to the one-time retirement fee policy stipulated in the Circular on Printing and Issuing the Implementation Opinions on Following the Plan for the Reform of the Salary Policy of Staff in Public Institutions with Athletes and Coaches.

All provinces, autonomous regions and municipalities may, in accordance with the present measures, taking the local economic development and living standards into account, formulate specific implementation opinions on the economic compensation for retired athletes who choose their own jobs and report the implementation opinions to related authorities for the record.

2.4 The early specialization

Sport specialization is operationally defined as the age or point in time in an athlete's development when sports training and competition is restricted to and focused upon a single sport in the pursuit of elite performance (Capranica L and Millard-Standford ML, 2011). In principle, sports can be classified as either 'Early specialization' or 'Late specialization' (Balyi I and Hamilton A, 1999). Each early specialization sport needs to develop a sport-specific model; a generic model would lead to serious oversimplifications. The challenge for early specialization sports is either to combine the "Fundamental" and "Training to Train"

stages or to amalgamate them into a single stage, such as Training to Train stage (Balyi I and Way R, 2011).

Swimming, as an individual technical sport, typically requires early specialization and high intense training volumes in prepubescent stage (Myer GD, et al., 2015). In the youth sport, particularly in the sport of swimming, age group swimmers follow the training programs like they are college swimmers. Very young kids are being shown absolutely every tool, every possible modality (Sheard M and Golby J, 2006).

In general, children involved in sport academies start competing around 8 years old. Through the investigation of the success and competitive behavior of adolescent sports, it is found that the detection, selection and monitoring of sports development are crucial (Robert M, et al., 2004). Logically at novice level, youth competitions should be based on a progression, where demands are sequentially linked to meet physiological and psychological characteristics of young athletes, to facilitate the development of technical-tactical skills, and to prevent injuries during physical growth and biological maturation when athletic skills are not fully developed (Ford P, et al., 2018). Unfortunately, youth competitions are organized according to the gender and chronological age of the athlete, not considering biological maturation and behavioral development. Thus, the selection of young talented athletes is often biased in favor of those with an early maturity status who likely receive greater opportunities for expert coaching and training throughout childhood and adolescence (Capranica L and Millard-Stafford ML, 2011).

Compared with athletes who play multi-sports, the injury rate of early specialized athletes is much higher. Moreover, only less than 1 % early specialized athletes reached peak level in their professional athletic life (Wiersma L, 2000). Severe sports injuries, especially injuries caused by over-training, are even more common today than decades ago. The American College of Sports Medicine issued a position statement on adolescent sports overuse injury and tiredness in 2013, stating that "early sports specialization may not bring long-term success to sports career and may increase overuse injury and burnout risks."

Early sports specialization may contribute to the success of early athletic performance, but it is almost impossible to lead to longer-term, higher-level success. Conversely, it is more beneficial for young athletes to play multiple sports in their teens, making them more likely to achieve greater success in their future careers (Mayer GD, 2015). On the practical level, problems such as "premature specialization" for youth athletes (Ling-ling DING, 2016) "adultification" of youth training, and excessive training load have long existed. On the theoretical level, although the research on youth training theory has been beneficially

explored, the research is not systematic and in-depth. It needs to be further optimized. The above problems lead athletes to finish their career at a relatively young age (Schwartz RG, 2011).

2.5 Differences between the calendar and biological age of children

Biological age is an abbreviation of skeletal maturity and needs to be determined by the specific image of the bone in the X-ray imaging. Biological age identification methods are more widely used in judicial decisions and play a critical role (Engebretsen L, et al., 2010). At the end of 19th century, the concept of growth rate was proposed for the first time. Since the application of X-ray radiography, experts in the field of axiology have been applying this concept and technique to studies in bone development and carrying out long-term exploration and continuous improvement in the methods of measuring bone age.

Biological age was first applied to medical research and measurement of children's growth and development. It was then widely used to determine the athlete's actual age to qualify for entry. Based on a single X-ray of the left hand, the sport doctor determines the biological age by observing the degree of development of the ossification centers of the phalanges, wrist, and ulnar bones of the left palm (Kassab HA, 2013).

Changes in human bone development are fundamentally similar, and the development of each bone is continuous and phasic. Different growth stages of bones have different morphological characteristics. Therefore, bone age assessment can accurately reflect the individual's growth and development level and maturity. It can not only determine the biological age of children but also give an early understanding of children's growth potential and sexual maturation trends: through bone age, experts can even predict a child's adult height (Lewis ME, 2007).

Since the 1980s, Chinese swimmers have been divided into different groups to participate in competitions by biological age rather than calendar age. The competition policy using the bone age grouping has continued until recently when calendar age grouping policy was adopted. (Swimming competition policy in China, according to the conversation with Feng Bi, City Swimming Center Head-director, on May 8, 2018).

In general, three to five months before a competition, swimmers from different teams gather together at the Sports Research Institute to measure their biological age by X-ray. The biological age determines how many swimmers can participate in the competition and who they will compete with. It even specifies whether a swimmer is qualified to compete.

Particularly for those swimmers whose body grows faster than the actual age, when the bone age is older than their actual age, the swimmers must compete in the corresponding group of bone age.

How does this policy impact swimmers? For example, the age restrictions of one of the provincial competitions in 2008 were: the oldest age group was for those born in 1996, and the youngest was for those born in 2002. Swimmers whose biological age was above or under such restriction would not be qualified to participate in the competition even if their calendar age met the restriction. There were three different groups by biological age. The first group was for swimmers whose biological age was 10-12. The second group was for swimmers whose biological age was 8-9. The third group was for swimmers whose biological age was 6-7 (2008 Provincial swimming competition policy, according to the conversation with Feng Bi, City Swimming Center Head-director, on Mar 8, 2018).

This policy would create the following scenarios that might be favorable to a swimmer or opposite:

1. Swimmer A was actual born in 2000 and 8 years old in 2008 but his bone age was 10. Swimmer A must compete in group for 10-12.
2. B is an athlete born in 1996. His bone age was 10 in 2008. Therefore, B could not only be eligible to participate in the competition, but in the group where swimmers are younger than him. Obviously, B has a good chance to win. Meanwhile, A, four years younger than B in reality, must compete with B.
3. C was born in 2002 but his bone age was 5 in 2008. Then C was not eligible to participate in this competition.

In China, the upper level competition, i.e. national games or provincial game is held every four years. In her athletic and coaching career, the author has seen the age policy changing, which sometimes affects a swimmer's career permanently. Apart from restricting participators' age, this bone age policy could create another scenario: the change of age group occurs once every four years, therefore, a swimmer like C, if he is not eligible to join the first competition, then after four years, he may still fail to participate in the competition because the competition's policy might be changed and causes his bone age exceeding the restriction of the oldest age group. In such case, all swimmers like C would not have any chance to participate in any competition in their careers. This happens frequently to swimmers.

2.6 Influences of biological age

There is a strong correlation between young swimmers' bone age and height. Young swimmers' height at various ages is highly correlated with their adult height (2018 National Youth swimming competition regulation. CSA. May 11, 2018).

According to the standards of young talented swimmer selection, the method of biological age is: The X-ray result reflects the biological age of the person. Then, the biological age reflects the level of physical development and exercise ability of adolescents and can also reflect the sexual maturity and tooth development of adolescents (Hu XF, 2006). Finally, it possibly determines a swimmer's career.

Nevertheless, there are many factors affect the height of swimmers. Still, no matter which type of prediction method is, it is impossible to take into account all the factors in the prediction formula. Moreover, after each prediction, the unpredictable factors, such as nutrition, disease, and environment, could change the final result. Although these prediction methods are based on science, still, the prediction of height has its own error, and it is unavoidable that teenager swimmers' height could be affected by many factors in the future (Kassab HA, 2013).

Another part from the restriction, in the early selection process of swimming talents, biological age is used to predict their future professional development (Rose N, 2005). In China, the biological age, especially the height, is crucial to the future of a professional swimmer. Whether a swimmer can get further professional training is determined by his or her parents' height, the biological age, and the prediction of his or her future height and the assessment of physical condition.

For swimmers, height growth means longer arms with a wider range of motion and greater power. From the point of reduce the resistance in the water, the slender streamlined body has more advantage than other types of body shape. It allows swimmers to move faster with less force (Videler JJ and Weihs D, 1982). These factors would be advantages for a swimmer to reach higher level in his or her future career.

On the contrary, when the height prediction is not satisfactory, it often means a swimmer may not have a great chance to reach the peak of his or her career. When assessing the growth and development of adolescents, it is often necessary to use the bone age to judge the puberty growth sport. The biological age test is important for predicting the potential ability of young athletes, especially 12-13 years old female, and 15-year-olds (Beunen G, et al., 1981). At the age of 16, the combination of biological age and observation is more important for the choice

of athletes' growth intervention time. It provides meaningful standards for coaches to develop scientific training plans according to the athletes' own developmental level (Durand-Bush N and Salmela JH, 2002).

Under this circumstance, the prediction leads to the termination of a minority of young swimmers' career. Due to lack of more scientific evidence and advanced techniques, the biological age and its predication of physical condition were one of the main reasons made swimmers to finish their career at a relatively young age.

2.7 Stages of swimming teaching system in China

Athletes usually need 6 to 10 years of systematic training before they can become international level players. The entire process of training for outstanding athletes can reach 15 to 20 years (Swimming age group, 2006). Like all the other competitive sports, Chinese swimmers, from the beginner to professional level, experience mainly three stages:

1. Beginner (4 – 6 years old)
2. Intermediate and pre-professional (7 – 11 years old)
3. Professional training (from 12 years old)

Beginner

When it comes to learning swimming, children in China usually start with attending the summer swimming camp. The period of the camp normally only lasts 10 to 15 days. During these days, children will learn how to breathe properly, keep body afloat, and swim one stroke properly.

Normally the first stroke they learn is breaststroke. Different cultures and countries have vastly different approaches to the question of which swim stroke is the “best” one to introduce first. In most countries, for example as Japan, the strong preference is teaching breaststroke first. Interestingly, in North America and in Australia, learn-to-swim programs primarily teach Freestyle (front crawl) and Backstroke first (Sanders RH, 2007). The rationale is that for beginners, breaststroke can be done with the head out of the water which allows a simple forward breathing pattern and also a symmetrical arm and leg action. Critics of Breaststroke, of course, point out how challenging the Breaststroke kick (i.e. whip kick) is for beginners to learn along with the “pull, breathe, kick, glide” stroke coordination timing pattern. It is commonly believed that breaststroke is the easiest style of swimming to learn first. For this reason, it is often the first that is taught at sessions, to give children water confidence and an ability of enjoyment and water safety. Breaststroke allows beginners to keep their head above

the water level, which makes people more willing to try this stroke; they feel more at ease with breathing and visibility is clearer (Kapus J, Moravec T and Lomax M, 2018).

The teaching method of breaststroke for the beginner swimmer in Chinese swimming camp (12days) mainly uses these steps:

1. Learn how to breathe in and out in the water.
2. Learn how to keep body afloat and standing in the water.
3. Learn the basics of the breaststroke kick.
4. Learn the arm movement of the breaststroke, combined with the imitation practice in the land.
5. Learn the coordination of the whole body.

After the summer swimming camp, the child who learnt at least one stroke would have the chance to be selected by the coach from upper level.

Intermediate and pre-professional

The primary purpose of the selection stage (7-10 years old) is to select and send those children who are qualified as pre-professional swimmers and have the prospect of training to the city or district sports school. The selection should be made not only among children sent by parents, but also those recommended by primary school physical education teachers. The primary school selection is the responsibility of the coach of the city or district sports school.

In China, sports school is the main form of amateur sports training and the main source of high-level sports players. Sports school training is still a government action in China. In order to cultivate reserve talents for competitive sports, China's sport training has two organizational systems that belong to the sports and education departments. According to statistics, 61 % of the outstanding athletes in China come from various types of sports schools. In the four years from 1992 to 1996, there were 361 world champions in China, and more than 90 % of them came from sports schools. At the 26th Olympic Games, all 16 of China's gold medallists came from sports schools. It can be seen that the school system still plays a major role in training reserve talents for competitive sports (Ling P and Wang ZG, 1997).

Also, before the end of each swimming camp, most of the children would have an "exam". The exam means they would be tested to swim 10 – 15 meters non-stop with the stroke they learnt. The "test" takes place on the last day of the camp, to exam the children's knowledge of swimming. Meanwhile, coaches from the upper level (before Chinese swimming changed to the club-system), namely coaches from city or district sports team/school, will come as well, mainly selecting those who meet the requirements of

swimmers and have the prospect of training to sports schools for training (Stager JM and Babington JP, 1997).

In China, the first goal of talent young swimmer selection is not children's feel for the water. For many coaches, the first goal of selection is age and biological age. When it comes to a swimmer whose age matches the preparatory competition and who has at least one year to prepare for the training, it usually means the swimmer belongs to the age group that meets the city or provincial games (once every four years).

The indicators of the primary selection must meet the basic requirements of swimming events. The indicators used are relatively small and simple, but the key points should be highlighted. Those with high heritability will be chosen (Swimming, 1999). The emphasis is on water sports ability, technical mastery, flexibility, the feel for the water, body shape and other indicators. The selection has been comprehensively evaluated, with an emphasis on identifying children with special skills. In the selection process, the indicators required for swimming athletes should be included as much as possible. Comprehensiveness is not only the principle of basic training, but also an important principle for assessing the talented children and the talents of athletes (Markel DL, 2013).

In addition to the actual age of the swimmers, the age at which swimmer started systematic training, the biological age, the number of years of training, and the progress of the competition results have a significant impact on athletic performance. On the other hand, the coach also conducts an investigation of the genetic and training background of the athlete as a selection material (Morgan TK and Giacobbi TR, 2006). The training background check includes the age when the swimmer started to swim, the number of years of exercise, the ability to bear the amount of exercise, the training level, the performance growth rate and stability, the performance of the competition level, and the attitude of parents and themselves to training (Kanigsberg JS and Levant RF, 1988).

Different than professional training, swimmers in this stage are preparing for the full-time training. In general, they are training 5 - 8 times per day, 1.5 - 2 hours per time. Compared with America, Europe and other countries, China's swimming training is mainly on weekends and holidays, especially during the summer holiday. Meanwhile, swimmers carry on taking their academic classes in normal schools instead of sports schools, considering their age, level of swimming and further development.

Professional training (from 13 years old)

Swimming is a sport to start at a very young age, because the high-performance often comes early. The age of athletes taking professional training in swimming is earlier than those doing other sports, such as basketball and football (Wylleman P and Lavallee D, 2004). In China, 80 % and above swimmers officially start professional training before 15 years old, specifically, 13-15 years old for boys and 12-14 years old for girls. Some swimmers are even younger (Wylleman P and Lavallee D, 2004). The primary reason is that the schoolwork at primary school is not as heavy as that at secondary school, therefore, they could cope with swimming training after class.

After 2 to 4 years of basic training, children of 10 to 14 years old can be specially selected. The conditions and physical fitness of athletes are different in different places. On the basis of the local situation and a large amount of research materials, it can be proved that the fastest growth of athletic ability occurs at around the age of 13, a key age for professional selection (Musch J and Grondin S, 2001).

Besides the performance of swimmers in competitions, the focus of professional selection is not only on body shape. In China, coaches are more concerned about swimmers' bone age and the feel for the water. At present, people understand the definition of the feel for the water. There are divergences and differences. Light and floating are concrete manifestation of a good feel for the water. This is just one summary of the subjective experience of coaches. To the level of theoretical analysis, the research points out: The accurate and comprehensive meaning of the feel for the water should be a special grasp of the characteristics of water that swimmers have and use to observe and objectively reflect some certain physical properties of water. It contains the swimmer's perception of the characteristics of the water, comprehensive physical and psychological response force (Jürimäe J, et al., 2007), including some physical characteristics of the human body under water (Water pressure, buoyancy, resistance), and appearance of external characteristics (Kim MK and Lee SA, 2017).

Except for the physical structure of swimmers in this stage, it is important to understand their skeletal development. During the growth and development of an athlete, due to genetic, nutritional and other environmental influences, people's age and development process are not consistent (Rogol AD, Clark PA and Roemmich JN, 2000). If the coach chooses professional swimmers only on the basis of their physical age, clearly, in the opinion of Chinese swimming coaches, it is impossible to truly reflect and evaluate a swimmer's performance, physical shape, physical function, and physical fitness.

Different than intermediate/pre- professional swimmers studying in sports schools, it is more difficult for those in ordinary secondary schools to participate in the after-school training, because of the extended school hours and more homework. Usually, before swimmers entering secondary schools, coaches would communicate with their parents, attempting to let the swimmers enter sports schools to participate in full-time or part-time training.

A sports team is a professional organization that aims at competitive sports (Relvas L, et al., 2010). The purpose of training is to get good results in competitions. A local sports team refers to a provincial team. Besides training of various sports, sports gymnasiums and sport facilities to ensure all athlete daily training, sports schools also provide normal academic classes from elementary school or even kindergarten, to secondary school and high school. The focus is to ensure that athletes can conduct comprehensive training while studying cultural lessons. The majority of athletes who enter sports schools are provided with training guarantee in all aspects. There are two types of athletes in sports teams. One is formal member who has salary and insurance, and the other is informal member who needs to pay for training in the sports team.

In China, competitions above the provincial level follow the four-year cycle, taking place in the second year after the Olympics. The national competition is also held every four years, in the first year after the Olympic Games. This cycle is to select qualified athletes for high-level competitions. The National Swimming Championships is hosted by the Swimming Management Center of the General Administration of Sport of China, and co-organized by the provincial, municipal, and local sports bureaus in turn. Since 2000, the National Swimming Championships has become one of the highest-level swimming competitions in China (Guang M, 2002).

The National Swimming Championships contains 34 events. Through this competition, swimming teams in various regions allow athletes to accumulate experience and promote the growth of athletes. At the same time, talents are selected to participate in international competitions. For Chinese swimming competitions, a swimmer who wants to participate in a national competition needs to be qualified in the annual competition. Normally, there are at least two qualifying matches in a year, divided into North and South. As the name implies, athletes from different regions will be divided into North and South to meet the standards of the championship.

Every year, the China Swimming Association would hold two high level competitions, championship for example. According to the regulation, athlete who meets the standard (see

from Table 4) could be exempt from training, meals and accommodation expenses. Athletes who have participated in the championship and have achieved the top 16 results could officially join the provincial sports team and be paid according to the results. In each provincial swimming team, the athletes are guaranteed at least 6 hours per day, at least 6 days per week for full-day training, no holiday and weekend. Not only swimming training, but also land-training. Even some of swimmers went to the plateau or aboard for training before the competition.

Once the swimmer did not reach the standard of the national championship for two years, it might happen that the swimmer would choose to finish his or her career. Also, the great chance for them is they would change another water sport, triathlon and modern pentathlon for examples. Swimmers under this circumstance would face the fact either they would finish their career, which means no more sport and waiting the time to go to university or employment opportunity, or change the sport seeking for chance to be medallists.

Even for the swimmer who qualified to the national championship, still, the chance of reaching the top one is not easy, and the competitors are from all around China. The consuming of time, expense, physical fatigue, psychological exhausted make the way of top swimmer of China, and also make swimmers drop out from professional athletic life.

Loads and methods of different training stage

Perfect swimming skills and performance improvement of swimming depend on a number of physiological factors (Jürimäe J, et al., 2007). To successfully develop these factors, training program arrangements include both land and water. In particular, early childhood (under 10) enlightenment training appears more complicated (Kennedy RJ, 1989). In China, swimmers of different ages have different training goals, times, and loads. There are differences in muscle fitness and energy utilization among swimmers of different ages. So, the emphasis during training in different stage varies.

The training stage as Beginner is divided into two stages, the first is the basic teaching stage. At this stage, swimming is mostly for enlightenment. Cultivating children's interest in water is the focus of most Chinese swimming instructors. Children's nervous system has strong excitement and strong imitation, so the training focuses on learning backstroke, breaststroke and freestyle (Warner F, 1906). In addition, mastering water safety knowledge and related skills is also one of the training priorities of Chinese swimming coaches. The second phase is training for the reserve team. The swimming team here is not a professional team but the one training children before they are entering a regional sports school, a team

from the summer swimming camp for example. Different from provincial and municipal sports schools, the management of regional sports schools is children coming to swimming pool after school. As the name implies, it refers to the preparatory swimming team that students voluntarily participate, generally after school or on weekends and holidays. This stage mainly cultivates children's interest in swimming and training habits. Through repeated practice, the children will master all four basic swimming strokes and learn techniques, such as starting and turning.

During Beginner stage, depending on the number of children attending the training, at least two coaches participate in the training. The training time will not exceed 90 minutes, and there would be two to four training sessions a week. Moreover, each child's own training load varies from 400 to 1000 meters per session.

Intermediate and pre-professional is an important stage for every swimmer to achieve higher development in the future. Before entering this stage, the children have been selected by their coaches to their respective training teams. In China, each coach has his or her own training team, which means that one coach is responsible for all athletes in this team, whether in or out of the swimming pool. On average, a Chinese swimming coach has ten to fifteen athletes. At this stage, in addition to introducing basic strength training, core training, psychological training, and recovery training to athletes, it is also necessary to include land training to prepare for the next level as professional athlete.

At this stage, the athlete would participate in his or her first competition or swimming meet. In the late 20th and early 21st century, swimming meets were essential for every Chinese swimming team. The tests range from kicking, four strokes, medley to some tests in land-training, pull-up, running, sit-ups for examples. The point is to select better swimmers and motivate their better performance.

Compared with beginner stage, swimmers in intermediate and pre-professional stage train more than 5 times per week, over 2 hours per session. It means, each week, swimmers in this stage have to train for over 10 hours.

According to the training program from the coach in the city swimming team, one of the trainings was following the program below:

1. 400 metres warm up
2. 16*25 metres medley
3. 1000 metres free style kicking
4. 100 metres cold down
5. 10*100 metres free style
6. 4*25 metres free style with start

Total: 3000 metres

From the program, the focus of this stage, besides endurance training and competition preparations, is the training of the kicking. In the general view of Chinese swimming coaches, the development of leg muscle strength and the training of flexible joints are the key for athletes to achieve better results in the near future (Lloyd RS and Oliver JL, 2012).

Similar as beginner stage, swimmers in intermediate and pre-professional stage still attend classes in schools. But the difference is, most of them are attending the sports school in their municipal team, which means, they would be studying in the morning, while only swimming after lunch. And the purpose of half-day study is to guarantee the swimmer would have sufficient time for the training in the afternoon.

Professional training for a Chinese swimmer includes many aspects (Wang L, Huddleson S and Lu P, 2003): strength training, explosive power training, endurance training, core muscle group stability training, flexibility training, and coordination training. In addition, the physical functions of human body also belong to the physical fitness category, such as aerobic training, anaerobic training, and cardiopulmonary training. Besides, over the years, Chinese swimming coaches have not only strengthened their emphasis on strength and quality, making the proportion of strength in swimming training increase significantly, but also increasingly recognized the key influence of special strength on athletic performance (Li ZM, 2004).

Once swimmers have been selected by coach from swimming teams on an upper level than municipal team, they are likely to move to the capital city of their province. This means that they live and train in the team's base. In most cases, Chinese swimmers have already started full-time training during this stage. The training is 2.5 to 3 hours each session, at least twice a day, and could be up to three times before competitions, only one day off per week, no exception on holidays. For swimmers, this is tantamount to a full-time job. The weekly training, besides that conducted in the swimming pool, would also have at least two land training in the gym or stadium. In this stage, the training volume of Chinese professional

swimmers would also be changed according to the training goals of different periods. Overall, professional swimmers guarantee 70 – 90 Km training or more per week. According to the program from the coach who answered the questionnaire, one training session during the endurance improvements includes:

1. 800 metres warm up
2. 4*100 metres medley
3. 10*400 metres freestyle pulling
4. 400 metres medley kicking
5. 10*400 metres freestyle
6. 4*100 metres freestyle
7. 400 metres cooling down

Total: 10400 metres

The training plan will also be changed depending on the main items. The coach will also divide his swimmers into different groups for specific training according to the main items. Training cycle and training purpose are changed according to different competitions.

3. Goals, work assignments, research questions, materials and methods

3.1 Goals

Through comparison and analysis of the age cycle of outstanding Chinese and foreign competitive swimmers, it is found that although the overall level of Chinese swimmers has gradually entered the forefront of the world, the professional sport life of Chinese swimmers is far shorter than the world level.

One of the goals of this thesis that had its structure formed in the spring of 2018, is to summarize the reasons that make Chinese professional swimmers choose to finish their career at a relatively young age by combining the literature and the data from both swimmers from China and other countries around the world.

Meanwhile, the thesis also aims to find the reason of early retirement through the questionnaires and interviews with coaches, parents and swimmers.

3.1.1 Work assignments

- Gathering and processing available literature that addresses the issue of premature termination of a swimming career.
- Selecting interviewees, designing questionnaires and conducting interviews.
- Evaluating and interpreting acquired data, taking into account factors related to premature termination of a swimming career.
- Evaluating acquired data, discussing and reaching the conclusion.

3.1.2 Research questions

1. What is the main reason makes Chinese swimmers finish their career at a relatively young age?
2. What is the age range of the retirement?
3. Does the early retirement involve any external reasons? (Parents, outcomes, retirement policies etc)

3.2 Materials and Methods

Ten swimmers (8 boys and 2 girls) participated in the study. Girls were at the age of ± 17 years old and finished their career at ± 16 ; boys were ± 18 years old and finished their career at ± 16 years old. The training experience of the whole group was nearly 7 years, and the average length of training session per week was ± 20 hours. The questions were sent off via

WeChat (a Chinese social app) as a group message. All the answers were collected within 24 hours. Besides answers returned via group chat, three of the participants gave the personal reasons by voice messages.

Ten coaches participated in the study. Among them, three have over ten years' coaching experiences, leading teams to participate in provincial games (once four years) for more than three times and winning over 5 medals each time. Meanwhile, all of the coaches have experienced the scenario that their swimmers finished their career at a relatively young age. They chose the age group among three options of their students who finished their career as professional swimmer in the early age.

Two parents participated in the part of interview of the study. Their children have won at least 2 medals in provincial competitions. They have witnessed their children's early retirement due to the injury, policy changes and biological ages, etc.

3.3 Questionnaires

The questionnaires had general questions and were designed to capture some of the main dimensions of the age and reasons of young swimmers decided to finish their career and what they do after retirement. The questions are organized along three thematic blocks targeting to different groups of swimmers and coach. The first one looks into coaches who have experienced early retirement of their swimmers. The second focuses on the age and reasons of retired swimmers. Questions from the third block cover several aspects related to biological age competition policy.

The questionnaires combined open-ended questions and multiple-choice questions with predefined answers offering respondents the possibility to choose and rank among several options. For these questions, an optional space was provided to elaborate on the answer.

3.4 Interview

The interview method of collecting data involves presentation of oral-verbal stimuli and reply in terms of oral-verbal responses. This method can be used through personal interviews and, through telephone interviews or social-app voice messages. Ask questions (to follow up and to clarify): While an interviewer generally enters each interview with a predetermined, standardized set of questions, it is important that they also ask follow-up questions throughout the process. Such questions might encourage a participant to elaborate upon something poignant that they've shared and are important in acquiring a more comprehensive understanding of the subject matter. Additionally, it is important that an interviewer ask

clarifying questions when they are confused. If the narrative, details, or chronology of a participant's responses become unclear, it is often appropriate for the interviewer to ask them to re-explain these aspects of their story so as to keep their transcriptions accurate (Seidman, I 1998). The interview has been pre-prepared by the author, including an open question on why they decided to finish their swimming career. Originally, all interviews were recorded in Chinese, and then translated to English.

The interview was conducted to three groups: swimmers, coaches and parents. The first group consists of swimmers. The swimmers who participated in this interview were born in 1991-2004. All of the swimmers are level 1 or above swimmer in China, having won more than two provincial competition medals in their professional career. The second group is for two coaches who have experienced early retirement of their swimmers after each competition period. Besides, both of them have been coaching swimmers in different age groups for over ten years under different competition policies. The third group is for parents. Parents who participated in this interview, have both seen their children finish their career as professional swimmer at the age of 15 and 17 years old respectively. They were not willing to write their names, therefore, the name "Parent A" and "Parent B" were written in this thesis.

The interview was initially conducted via voice messages on social apps, originally recorded in Chinese and then translated in English. When the researcher began the interview process, the question of concerning was why the swimmer finished their career at a young age.

Only two interviews were conducted via phone calls. All data were collected from 15th of February to 30th of March in 2018.

4. Results

During the data collecting 10 former professional swimmers, 10 coaches and 2 parents participated in the questionnaire and an interview. Not everyone participated in the interview.

Swimmers' answers to the questionnaire:

1. The first swimmer reported the main reason for ending his career was the bone age. He also said he was not satisfied with the trainer, who was not capable to help him improve his performance to a higher level.
2. The second swimmer ended her career because of the university admission. She mentioned that she got admitted to university because of her level 1 swimmer certificate of China, and she was physically and mentally tired for years of training.
3. The third swimmer was disqualified from competitions because of her bone age. While she was considering whether she would keep training, she got the employment opportunity from her city as a teacher.
4. The fourth swimmer had shoulder injury at the age of 15 years old. He was medallist of the provincial games. After the injury he was not able to keep the intensive training plan.
5. The fifth swimmer had the highest achievement in swimming among these ten swimmers. She used to be the top eighth in China. She retired at the age of 16 because of the injuries and relationship with coach.
6. The sixth swimmer finished her career due to the biological age that is older than her actual age. Also, she did not want to change another water sport. When she obtained the level 1 swimmer certificate she chose to go to university.
7. The seventh swimmer finished his career as swimmer at 12 years old because of myocarditis after the year he won the provincial champion.
8. The eighth swimmer finished her career because of the exhaustion from swimming training. Also, she mentioned she had a new coach when she got in the provincial team, and she was not in a good relationship with the coach.
9. The ninth swimmer decided to finish his career because of the university admission and employment offer he got after he won the champion in the provincial games.

10. The last swimmer retired because of the biological age that is 3 years older than her actual age. She has been competing with swimmers physically and psychologically more mature than her. She finished her career after she won the relay champion together with the other 3 swimmers.

Coaches' answers to the questionnaire:

1. The first trainer experiences swimmer's early retirement almost every year, especially from the year of 2003 to 2010, due to the bone age competition policy and changes in the employment policy applied to champions.
2. The second trainer has over 30 young swimmers finished their career before 16 years old. All of them were level 1 or above level swimmer of China. He had achieved the 8th place in national competition. The reasons for this scenario were from three aspects: injuries, bone age and exhaustion from training. He also mentioned, the exhaustion is not just from swimming training, but from the lack of educational knowledge, which leads to no self-estimation, the lack of peer groups except for teammates in the swim team, and the pressure from parents.
3. The third trainer mentioned he thinks the early retirement is mostly because of the compensation after retirement, which is not guaranteed and unbalanced.
4. The fourth trainer chose the age group of 15-17 years old among the three options as the average age range of early retirement, he mentioned that majority of swimmers finished their carrier because of the biological age competition policy.
5. The fifth trainer has over 20 years' coaching experiences. The early retirement age group he experienced during these years was 15-17 years old, especially for swimmers who were born in 1992-1997.
6. The sixth trainer chose two age groups, 15-17 years old and 17-19 years old. The reason she wrote at the end of the questionnaire is biological age.
7. The seventh trainer is the oldest coach among the 10 trainers. He elaborated on the early retirement age group for different generations. 15-17 years old for swimmers who were born in 1991-1996; 17-19 years old for swimmers who were born in 1987-1990; 20 years old and above for swimmer who were born in 1984-1989. According to the trainer, with the difference of the time and policies change, two main reasons of early retirements are injury and university.

8. The eighth trainer is the youngest who has less experiences comparing with other 9 trainers. She chose the age group of 15-17 years old. And she mentioned that from her experiences, most of her swimmers retired because of university admissions and injuries.

9. The ninth trainer saw swimmers retire early when they were 17-19 years old. He wrote that the changes of competition and the employment opportunities were the main causes.

10. The tenth trainer said the early retired swimmers he had experienced were 15.5 to 18 years old. The main reason of the retirement was injury plus the physical and mental exhaustion.

Interview with swimmers:

Participant 1. (Male, national level swimmer, born in 1991, long-distant freestyle swimmer, won over 5 medals)

“I finished my career in 2007 when I was only 16 years old. In 2006, I was training together with Yang Sun, the world long-distant champion. We went for Plateau training in Yunnan and I saw how talented and fast he is. Meanwhile, I knew deep in my mind that I cannot be faster than him. It is meaningless for me to keep training and challenging my limitation only in order to take the second place. Another reason was our city had a policy in that time: if you won the medal, the city would assign you a job in a good place.

When I was focusing on preparing for the biggest competition in 2006, one day in the afternoon training I was so tired, mentally and physically. Still, I was keeping challenging the limitation of myself. And on that day the ambulance took me from swimming pool to hospital because I lost conscious and collapsed in the pool. The doctor said it was because of the low blood sugar and over-training. In the next year, I felt uncomfortable in my heart, so I went to doctor again, and he told me it was the early stage of the myocarditis and I even had to have heart monitor for a week.

Under this condition, there was no point to keep swimming anymore especially I could be assigned for a job. So, I quit.”

Participant 2. (Male, level 1 swimmer, born in 1994, breaststroke swimmer, won two medals)

I finished swimming when I was 16, in the year of 2010. You know in competitions in city, I mean before you reach the national level, you have to compete with others in an age group that depends on your bone age not your real age. My bone age is older than my real age. That means I must compete with people older than me, stronger than me, faster than me. I

could not compete with people at my own age. Of course, I was not able to win. So, I thought it was the time for me to go to university. Actually, I am not very keen to be a professional swimmer.”

Participant 3. (Level 1 swimmer, male, born in 2004, long-distant freestyle and medley swimmer, won freestyle all-round medal in 2014)

“I stopped swimming last year when I was 13 years old. And it should be the good age for swimmer. After I won the all-round freestyle medal, I was selected by the famous coach who coaches Zetao Ning, the famous short-distant freestyle swimmer. I started full-time training in Shanghai.

But one day I started vomiting in the morning, and my stomach was extremely painful. In the beginning they all thought that it was just gastroenteritis and not that serious. But it became worse. I was sent to the emergency room and my mum drove 800 km from home to Shanghai. The doctor told her that I got myocarditis and could not keep training anymore. It would even cause more danger situations to my body.”

Participant 3. (Female, level 1 swimmer, female, born in 1994, freestyle swimmer, won two medals)

“It was too exhausted for me to keep training. I did not wish to keep swimming anymore. I started training when I was 10 in 2004 and then continued day after day until 2010, when I won the medal in the biggest competition in the city. I stopped swimming in the year of 2011. For me, it was good to get into university as soon as possible, and to get work right after graduated.”

Participant 4. (Female, national level swimmer, female, born in 1995, butterfly swimmer, won more than 3 medals, reached the 8th place in National competition)

“After I got into the Provincial team, I was not in a good relationship with my coach there. He pushed me to train more than I was willing to. I started training very early, when I was only 8 years old. I went to the city team, training every day. From 8 years old until 18 years old, in 10 years, there was nothing else in my life but only swimming. I got lots of injuries in my shoulder and waist disc. Even now I still suffer in rainy days.”

Participant 5. (Female, born in 1992, medley swimmer, won medals in 2016) “I finished my career in 2009, when I was 17 years old. There were two reasons. Firstly, after I went to the

provincial team, the coach of mine did not give me as much attention as my coach in the city team. Sometimes he even did not appear in the swim pool and just gave us program of the day. Also, he did not know and was not even willing to discover what my specificity was. The only thing he did was pushing me to the swimming pool. The years I spent in the provincial team, from my prospective, is quite important for a swimmer. Especially after I won the medal, I reached my top performances.

Secondly, I had an opportunity to join another team to keep swimming after the coach was no longer capable for training me. But still, because of some policies among cities, my department did not want me to join another team even if they had already given me up. I was not into swimming anymore and even felt it disgusting.”

Interview with coaches:

Participant coach 1. (Male, coach of Asian champion, national champions, over 20 years’ coaching experiences in city team, vice-director of city team)

“Under the unreasonable system, the coaching methods, I mean the attitude of the coach, the way of how they trained, are far from high-level.

Besides, the utilitarian competition system causes the swimmer to have no lofty goal. They cannot feel the spiritual pleasure of sports at the same time. They did not have anything, ordinary school life, hobbies, and activities except for swimming. This is the main reason why some athletes retire prematurely. Then the financial support and guarantee for their future life are far from what they deserve. It is not enough.

All these make swimmers cannot feel the equal “payback” after they had high performance and good results. Additionally, they do not have solid educational background because they started training at a very young age. In reality, most of them only have had systematic education in primary school. The swimmer's spiritual world is relatively scarce, lacking awareness of the cognition and having no self-estimation compared with other same-age swimmers in US or Europe.”

Participant coach 2. (Female, Coach of City sports school, over ten years coaching experiences, former national level swimmer)

“All the swimmers I am coaching, they are on the level of beginning to become professional swimmers. In the past five years, I have sent more than 100 young swimmers to higher-level teams. Amount this number of swimmers, only one or two were chosen by the national team. I mean they had high performance in the country. But the average retirement

age of them was 14.5-17 years old, and the majority of them finished swimming because of the age to enter university. For all of them, the lowest level they reached was Level-2 swimmer in China.

I heard lots of feedbacks from their parents, basically on the policy of the athletic retirement. The previous policy that swimmers who won provincial medals could be arranged for jobs has been abolished, so there is no motivation for them to keep training. Some of them felt mentally break-down either because of the full-time training or not winning a good place in the competition.

Parents also have a great influence on them. They do not want to continue trying to take the professional athletic life like gambling. So, they decided to let their children go back to the "normal" school life.

Interview with parents:

Parent A:

“My daughter won the champion in the provincial competition, so she was assigned to work as a coach in our city’s team.

During the time she was training, she was on the level above national athlete. Besides, her coach was definitely qualified enough among the coaches in the provincial team. Still, from my point of view, I think he is not as good as her previous coach in the city team. I am not a professional swimmer, but I could see from her performances and her psychological changes. I believe the role of a coach is very important for athlete. In addition, the cost in the provincial team was not cheap. We are just ordinary family with average income. The cost in provincial team was even a burden to us.

After my daughter had trained for so many years, she did not want to keep training anymore. Of course, we did not want to push her. Luckily enough, the placement policy was still existing. When both her age and educational background met the minimum requirement of the policy, she finished her career immediately.

Even now, sometimes she regrets about stopping swimming so early. Often when she talks about her career, she says she loves swimming, but the coach was not able to bring her to another level.”

Parent B

“I and my husband's heights are not very tall. At the beginning of the full-time training we only wanted him to have a try. After he won a few medals, we were convinced that he might be talented, and we let him keep training. Especially, the policy of work arrangement for swimmers who won champions was inspirational for all the parents.

Later on, the policy was changed. Naturally, as a parent, I am also worried about my son's future development. Although swimming coaches have a certain place in the society, without educational background it could neither last long nor be stable. Actually, we have the family relationship that could send him aboard. But the fact is that he has not learned English at all, not mention other subjects that the university aboard requires. Unexpectedly, during the time of his professional career, he got myocarditis. It was a shock to us. Even after he got recovery from it, but still, it is impossible to take risk to keep being a professional swimmer anymore.”

Chart 3. Reasons impacted swimmers finished their career

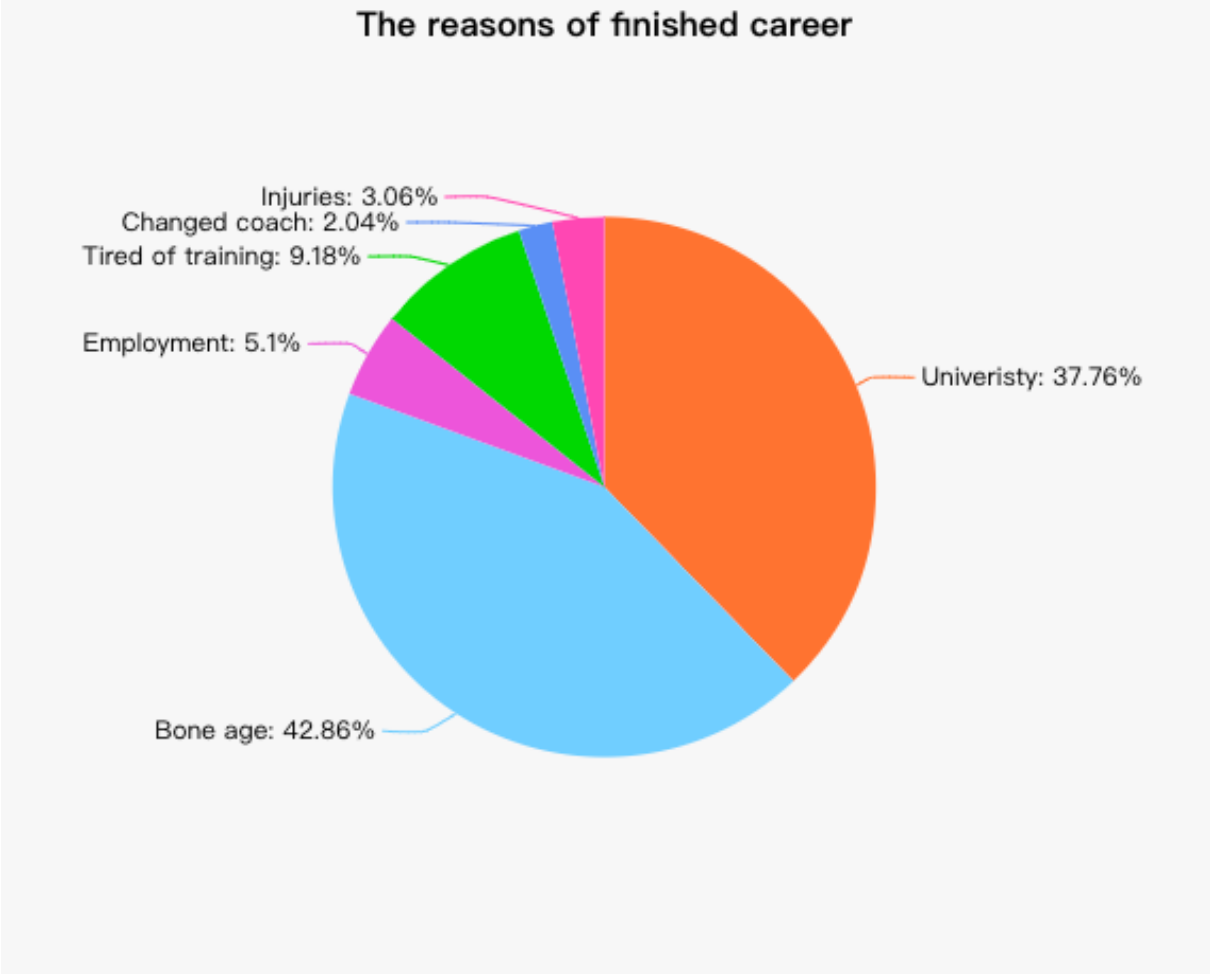
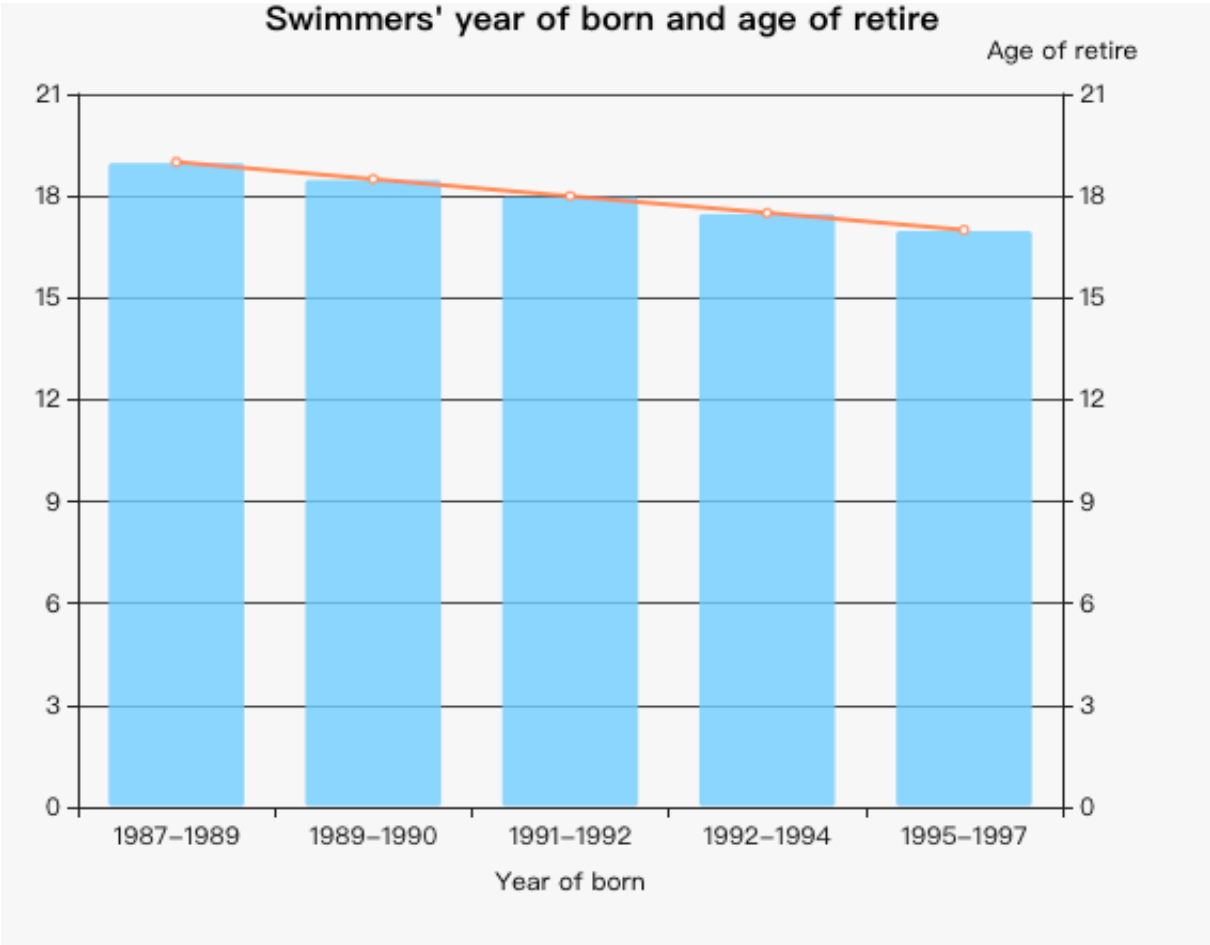


Chart 4. The age range of swimmers' retirement



5. Discussion

The reason why Chinese swimmers terminate their career at a relatively young age is not solely because of the physical and psychological exhaustion of the full-time swimming caused by early specialization and single training, we think that more reasons come from the lack of personal and social life.

The answers to the research questions settled in the beginning of the thesis are collected from various channels, including swimmers, parents and coaches, which show that the reasons why Chinese swimmers tend to finish their career at a relatively young age come from many sides.

Based on the answers to the first question (**“What is the reason (factor) made him/her finished his/her career?”**), it could be found from the majority of swimmers who participated in the questionnaire and interview that in recent years, bone age was one of the main reasons that caused swimmers to finish their career (see Chart 3). Whether a swimmer can participate in provincial-level competitions or not determines how long his/her career goes. Swimmers who are not able to participate in provincial competitions are divided into two different types. The first type changes to another water sport related to swimming, for example, sailing, triathlon, modern pentathlon and water polo. These are popular sports for swimmers who are not qualified for swimming competitions because of the bone age. These water sports also have bone age competition policy. Normally, the age groups (by bone age) are not as young as those of swimming. Compared to swimming competitions in recent years, the oldest age group of these water sports were 3-4 years (in bone age) older than that of swimming competitions.

The second reason is young swimmers directly stopped their career as professional athlete and returned back to school to keep attending their academic classes. Among these swimmers, over 90 % (observed subjects) were at the age of studying in secondary schools. They chose to study in one or two grades lower than they should have been in. Some of them could afford a private teacher at home. At the same time, for preparing the admission test of university, these swimmers still attend training in the team. However, they would not train as much as when they were professional swimmers. The training would be continuing until they reach the Level 2 or above in China (see the Appendix).

In the years of being a coach, and as a former professional swimmer, I have only seen less than 1 % in total of these swimmers reach high level, national champion or above. They were selected to Chinese national team or military team, preparing for the national, Asian and

Olympic games (national level or above does not have bone age policy). Besides the restriction of competitions, from the result of the third questionnaire, it is also showed that the bone age prediction is not absolute. Later development, nutrition, and other factors are bringing possibilities to height changing. The misjudgments of bone age prematurely ended some young swimmers' professional career.

The second question (**How old was the swimmer when he/she finished his/her career?**) pointed that in the different age's group, most of the swimmers who were born in 1987-1989 retired at around 19.5 years old (see from Chart 4). The figure slightly changed among the swimmers born in 1989 and 1990. The age of retirement was around 18.5 years old. A few years later, swimmers born in 1995, 1996 and 1997 finished their career at around 16.5 years old.

In China, staffing of public institutions means relatively higher wages, insurance, medical care and pension guarantees compared to other industries and companies in the country. Each year, enormous graduates are preparing for the examination of public institutions. In 2015, the acceptance rate of the exam is 13:1 (Qu M, 2002). The gold medal athlete and the provincial official athlete would be entitled to be arranged to one of the national institution departments. This is a guarantee, or in other words, a compensation for medalist athletes and their parents. For some athletes who are not only swimmers, this arrangement is their motivation of training.

With great population in China, there could be hundreds to thousands young swimmers in one city or one province. In one provincial swimming competition, more than 500 swimmers will participate (2006 provincial competition in Shandong). Among all of the professional swimmers in China, only less than 1 % could finally reach the world level. The rest of them, after years of training, when they face the fact that they are unlikely to reach the upper level, almost all of them would finish their career as a swimmer. Moreover, without the guarantee of employment, athletes need to seek opportunities in the whole society.

In a decade, employment policies have been constantly changing. From guaranteed distribution to national institutions, to distribution to national institution according to swimmers' achievement to the city, and distribution to local organizations and institutions. Formal athletes on provincial level or above may choose to find their own jobs and enjoy the retirement compensation related to their years of training and achievements during their career.

When a swimmer does not reach the provincial level or above, chances are that swimmer could choose to finish his/her career as a professional swimmer. Some of them are already at

the age to enter university, otherwise they study for one or two years at home and then go to university.

It is not easy for a retired swimmer, in any possible way, to go back to study after years of training. Under this circumstance, the lack of educational background makes the “normal” life in society even harder.

The last question (**What was the best/highest performance he/she reached?**) also brings the fact that most European and American swimmers who have won championships in the Olympic Games or world's championships also have another role in their daily life and university. Katie Ledecky, the well-known American swimmer, is the world record holder of women 400 meters, 800 meters, and 1500 meters freestyle swimming. Except for her popularity in the world of swimming, she is a bachelor student studying at Stanford University. Also, Cameron McEvoy, who has won the champion in the Olympic Games, is studying at Griffith University as an undergraduate in Australia, majoring in physics and mathematics. Examples like Katie Ledecky and Cameron McEvoy are common in Europe and the United States, but barely happens in China (<https://en.wikipedia.org/>, 2020).

Swimmers in Europe and the United States are training for more than one sport, and studies and other activities are part of their lives as well (Guo Y, 2009). From my point of view, swimming should not be the only thing that a professional swimmer does in the life. Friendship, education, peers outside of swimming team are also taking important parts of the life.

The fact is that, for Chinese swimmers, the interaction with the same generation is difficult, except the teammates or athletes who are training in other sport activities, because they do not have time and chance to meet other peers. Differently, in Europe and the United States, there are more opportunities for athletes to fulfill their sporting and personal life. They are studying in normal schools with classmates who may not be professional athletes or may even not like sports. Besides, parents and neighbors are part of their daily life too (You X, 2018). This is impossible for Chinese professional swimmers who live with teammates.

It could not be missed that Chinese athletes lack comprehensiveness in sports career. Material rewards, such as a bonus behind the gold medal, reward of employment opportunity, and university interviews and admission policies for athletes who have reached certain levels, replace the most important thing from sports, the self-worth.

For Chinese retired professional swimmer, the university is not a place for the acquisition of knowledge. It is more like a symbol of an unrestrained life. During the professional athletic life, they have had in the team, swimmers were controlled by sports

teams and coaches. Those entertainment activities prohibited before can completely be done at the university. For example, they were not allowed to drink sodas, which is not good for x-ray result, or they were not allowed to go out of the team bases, etc. Once the certain limit has been reached, the change in the opposite direction is inevitable. Having been living in the system with strict restrictions, they are unable to devote themselves fully to learning even though they have entered the best universities in the country. They would try every possibility to make up the time that they lost in sports teams. Plus, the fact that athletes lack educational background due to full-time training predicts that it would be more difficult for them in study comparing to their own peers. Under the unconstraint environment, the retired swimmers probably would not be willing to study.

In China, swimming coaches tend to adopt training methods inherited from predecessors who had also inherited them. Specifically, it means a coach passes the training methods down to swimmers. Once the swimmers retire and some of them become coaches, then they will train their swimmers with the same methods. As such, the methods would be passed down in generations. Within this circle, there are few significant breakthroughs in training programs and methods, which makes the high achievement even harder, because swimmers, at different age and of different gender, should be trained differently. Especially, different generations of swimmers have different physical condition, the same training methods and programs therefore would not be suitable to all of them. Most Chinese swimming coaches used to be full-time swimmers. Similarly, they lack educational knowledge like the professional Chinese swimmer do. This leads to a problem that when coaches are learning a new coaching technique, they might understand the method but not the concept behind it and may not be able to apply lessons learned from one instance to other cases. For example, the training method from other countries like Australia and America, these swimmers from different countries, they have different physical condition, for some of the Chinese swimmers, whose physical condition may not compare to other swimmers, which would not improve from these novel, foreign training methods.

Meanwhile, how opinions and suggestions from parents affect swimmers have an important place in this discussion. Most parenting from typical Chinese parents for children is based on spoiling and over-protection. The majority of professional swimmers have injuries because of years of full-time training. Once those who had good results in competitions and reached certain achievements and levels have guarantee for a study place at university or an employment opportunity, without doubt, nearly all of their parents would suggest their children to finish their career. On the contrary, for those ordinary swimmers, they have to face

high cost on training and risks of injuries if keep training. Therefore, it is highly likely that they will finish their career earlier than those who have had certain achievements.

The reason why Chinese swimmers finish their career at a relatively young age, from my own opinion, it is not only because of the fact that Chinese swimmers are over-trained at a young age and early specialized. Also, the system in China has enormous impact on it.

Firstly, the training system was only focusing on the physical development. During the puberty of swimmers, the physiological changes should be concerned as well. In my coaching experiences for over five years, I have experienced many swimmers who finished his or her career because of the reasons above. But there is another factor which has not been considered, namely the swimmers retired due to the early “adultization”, this means they were thinking about material life because of the income difference in the sports team. Also, they started entering places of entertainment, such as bars, clubs and others. These influences and the lack of educational knowledge make young swimmers have no self-estimation and judgement. The mentality greatly increases the uncertainty of their athletic career and the possibility of quitting swimming in the early stage.

Secondly, not only swimmers, the lack of education and social cares, employment difficulties, injuries, are troubling all other retired athletes in China. In my opinion, this situation has a direct relationship with China’s current professional training system that lacks corresponding supporting policies. Competitive sports are like a pyramid. After all, only few people could stand on the top of it. Most people paid a lot for building it, struggling for climbing up to the peak. Also, according to China’s existing professional sports school training system, athletes enter local sports schools and start training at a very young age. During this period, training is generally conducted alongside with academic classes, and some are even full-time training. Having been training in the sports school for a period of time, athletes are selected to the provincial professional team for “closed” training, which means no academic classes and leisure time but only training, in order to win the gold medal. Meanwhile, even if there are still a few classes, the exhaustion after training would prevent them mentally from involving to the study.

Based on my own experience as a professional swimmer, I have been training full-time for nearly five years after 13 years old. During my professional training career, there were hundreds of people at the same age training together, but only one of them has participated in the Olympic Games. At that time, all of these athletes participated in full-time training and gave up academic classes at the age of 12-13. In addition, except for the athletes who could be

assigned to employment, the rest of them would face the situation that they have no guarantees after retirement and the years spent in the team turns to be a waste.

In recent years, the Chinese sports system has changed. In the past, the athletes represented respective provinces or cities, now clubs. The sports system in China has become a club system. The previous bone age competitions have become competitions subject to actual age on ID card. Not only to swimmers, is this a big change to all athletes. It means that athletes would have more opportunities to compete in a fairer environment. Moreover, the education level of athletes has also attracted the attention of China's sports and education departments. Unlike the previous practice, namely providing special academic classes in sports schools, athletes will take the same academic exams as regular school students. Those who fail to pass the exam would be disqualified from the competition regardless of their swimming performance. The impact of this policy on athletes comes from two aspects. The advantage is that apart from fair competition in terms of age during competitions, athletes can guarantee their education level, which means they will find there is no huge gap between them and their classmates in terms of academy when they enter ordinary schools after retirement.

Again, this is a great challenge to athletes' energy. After a day of high-intensity training, the physical and mental exhaustion will prevent athletes from staying focused on study. In this case, it is likely that the athletes could fail the qualifying line of the exam. As a result, even if they are extremely talented in swimming, still, they would not be able to participate in the competition and miss the great opportunity to reach a higher level. Besides, the swimming club system means that athletes have to pay clubs for their own training. Some clubs' charges could be expensive for some families. As it is known, Chinese families have large income deviations. When a family cannot afford the expensive training fees, etc., their children would not be able to continue training.

We believe, the situation of early retirement of Chinese swimmers has been improved in the past decade, but compared with the United States, Europe and other countries, it is far from enough. To completely change this phenomenon requires not only time, but also improvement of the sports system and attention from the whole society.

Question 1. What is the reason (factor) made him/her finished his/her career?

A: Mainly due to the changes under the bone age policy, which effected the age and further study as student.

Question 2. How old was the swimmer when he/she finished his/her career?

A: Swimmers who were born during the years of 1987-1989 retired at around 19.5 years old (see Table 4). The figure is slightly changed among swimmers who were born in 1989 and 1990: the age of retirement was 19 years old. A few years later, swimmers who were born in 1995, 1996 and 1997 finished their career at around 16.5 years old.

Question 3. What was the best/highest performance he/she reached?

A: By summarizing the interviews with swimmers who retired at a relatively young age (see the interviews), all of them were level 1 swimmer in China or above (See appendix).

6. Conclusion

The number of Chinese swimmers who took early retirement increased incredibly during past twenty years. According to the interviews and the results of the questionnaires, the reasons why Chinese swimmers tend to finish their career at a relatively young age can be classified as follows: 1. Despite the professional training, they lack the spirit while they are training. 2. There are few materials guarantees after they finish their career, employment opportunities, award-bonus for examples. 3. Not all swimmers are given what they deserve due to the unbalanced policy. 4. Swimmers drop out of academic classes and other activities at a young age, focusing only on swimming. These reasons affect their future after they finish their career. Despite entering universities, lack of the educational background limits their majors only to those related to sport. Besides, full-time training brings physical injuries and mental fatigue. These factors lead the trend of finishing their career at a relatively young age among Chinese swimmers.

In summary, to change the situation of the early retirement of Chinese swimmers requires not only the change in training methods. It is also necessary to help Chinese swimmers under the system increase their educational background to a certain extent. More importantly, it is needed to change the understanding of the meaning of being a medalist. Over the last three years, the Chinese swimming system has been gradually changing. The educational requirements to athletes are more stringent than ever. However, this change cannot be accomplished in a short time of period. To change the situation of the relatively premature retirement of Chinese swimmers in the world of swimming, it is requiring the knowledge from both swimmers and parents, the adjustment and innovation from coaches' training methods, the affirmation of athletes in the system, the logistics to a certain extent, and the retirement guarantee.

7. References

1. Coltheart, M., Curtis, B., Atkins, P. & Haller, M. (1993). Models of reading aloud: Dual-route and parallel-distributed-processing approaches. *Psychological review*, 100(4), 589.
2. Brenner, J. S. (2016). Sports specialization and intensive training in young athletes. *Pediatrics*, 138(3), e20162148.
3. He, J.H. & Zhao, Y. Y. (2006). Research and analysis of the phenomenon of "premature retirement" of Chinese swimmers. *Journal of Guangzhou Physical Education Institute* (06), 50-52.
4. Gao, Y. (2009). *Analysis and countermeasures of factors influencing the sports life span of excellent swimmers in China*. (Doctoral dissertation).
5. Hong, F. (2004). Innocence lost child athletes in China. *Sport in society*, 7(3), 338-354.
6. Zhong, Y. (2018). A Brief Analysis of the Current Status of the Development of Teenage Swimming Reserve Talents in Guizhou Province. *Sports Time and Space*.2018; 25-29.
7. Chi, A.G. (2014). Zhu Lavlev said that how to make athletes reach the pinnacle of the competitive state in the grandest competition is the main problem we must solve. *Swimming Quarterly*. 000 (004), P.29-29.
8. Tan, Z.D. & Liu, P. (2003). From the results of the five Olympic Games to see the success and inadequacy of the development of Chinese competitive swimming. *Journal of Guangzhou Institute of Physical Education* (01), 86-88 + 92.
9. Yang, S. S. (2014). Analysis of the causes of the assistance phenomenon of Chinese swimmers after retirement. *Sports World (Academic Edition)* (11), 31-33.
10. Ristolainen, L., Kettunen, J. A., Kujala, U. M., & Heinonen, A. (2012). Sport injuries as the main cause of sport career termination among Finnish top-level athletes. *European Journal of Sport Science*, 12(3), 274-282.
11. Guang, M. (2002). Chinese swimming steadily steps up. *Chinese Sports: Chinese and English version*, 000 (006), 56-57.
12. Kammer, C. S., Young, C. C., & Niedfeldt, M. W. (1999). Swimming injuries and illnesses. *The Physician and sportsmedicine*, 27(4), 51-60.

13. Ericsson K. A., Krampe R. T., Tesch-Römer C. (1993). The role of deliberate practice in the acquisition of expert performance. *Psychol. Rev.* 100 363–406. 10.1037/0033-295X.87.3.215.
14. Hill, Grant M. & Hansen, Gary F. (1988). "Specialization in High School Sports: The Pros and Cons." *JOPERD*, 59 (4):76-79.
15. Russell, W. D., & Limle, A. N. (2013). The relationship between youth sport specialization and involvement in sport and physical activity in young adulthood. *The Journal of Sport Behavior*, 36, 82-98.
16. Grahame, R., Bird, H. A., & Child, A. (2000). The British society for Rheumatology special interest group on heritable disorders of connective tissue criteria for the benign joint hypermobility syndrome. The revised (Brighton 1998) criteria for the diagnosis of the BJHS. *J Rheumatol*, 27, 1777-1779.
17. Clinch, J. P. (1992). *U.S. Patent No. 5,108,239*. Washington, DC: U.S. Patent and Trademark Office.
18. Beach, M. L., Whitney, S. L., & Dickoff-Hoffman, S. A. (1992). Relationship of shoulder flexibility, strength, and endurance to shoulder pain in competitive swimmers. *Journal of Orthopaedic & Sports Physical Therapy*, 16(6), 262-268.
19. Mallorquí-Bagué, N., Bulbena, A., Pailhez, G., Garfinkel, S. N., & Critchley, H. D. (2016). Mind-body interactions in anxiety and somatic symptoms. *Harvard Review of Psychiatry*, 24(1), 53-60.
20. Zaremski, J. L., & Krabak, B. J. (2012). Shoulder injuries in the skeletally immature baseball pitcher and recommendations for the prevention of injury. *PM&R*, 4(7), 509-516.
21. Vorontsov, A. R., & Rummyantsev, V. A. (2000). Propulsive forces in swimming. *Biomechanics in sport—Performance, enhancement and injury prevention*, 205-231.
22. Heinlein, S. A., & Cosgarea, A. J. (2010). Biomechanical considerations in the competitive swimmer's shoulder. *Sports health*, 2(6), 519-525.
23. Liu, M.H., Lei X.S., Huang, L.S., Yuan, J. W., Chen, Y.H., & Luo, X. P. (2001). Characteristics of sports injuries of high-level swimmers in China. *Chinese Journal of Sports Medicine*, 020 (002), 210-212.

24. Wanivenhaus, F., Fox, A. J., Chaudhury, S., & Rodeo, S. A. (2012). Epidemiology of injuries and prevention strategies in competitive swimmers. *Sports health*, 4(3), 246-251.
25. Beighton, P. H., Solomon, L., & Soskolne, C. L. (1973). Articular mobility in an African population. *Annals of the rheumatic diseases*, 32(5), 413.
26. Pink, M. M., & Tibone, J. E. (2000). The painful shoulder in the swimming athlete. *Orthopedic clinics of North America*, 31(2), 247-261.
27. Scheper, M., de Vries, J., Beelen, A., de Vos, R., Nollet, F., & Engelbert, R. (2014). Generalized joint hypermobility, muscle strength and physical function in healthy adolescents and young adults. *Current rheumatology reviews*, 10(2), 117-125.
28. Van Mechelen, W., Hlobil, H., & Kemper, H. C. (1992). Incidence, severity, etiology and prevention of sports injuries: a 1-year prospective study in young Adults. *Medicine and Science in Sports and Exercise*, 1171-1179.
29. Grahame, R., Bird, H. A., & Child, A. (2000). The British society for Rheumatology special interest group on heritable disorders of connective tissue criteria for the benign joint hypermobility syndrome. The revised (Brighton 1998) criteria for the diagnosis of the BJHS. *J Rheumatol*, 27, 1777-1779.
30. Junge, T., Henriksen, P., Andersen, H. L., Byskov, L. D., Knudsen, H. K., & Juul-Kristensen, B. (2016). The association between generalized joint hypermobility and active horizontal shoulder abduction in 10–15-year-old competitive swimmers. *BMC Sports Science, Medicine and Rehabilitation*, 8(1), 19.
31. Beighton, P. H., Solomon, L., & Soskolne, C. L. (1973). Articular mobility in an African population. *Annals of the rheumatic diseases*, 32(5), 413.
32. Beighton, P., Solomon, L., Soskolne, C. L., & Sweet, B. (1973). Serum uric acid concentrations in a rural Tswana community in Southern Africa. *Annals of the rheumatic diseases*, 32(4), 346.
33. Beach, M. L., Whitney, S. L., & Dickoff-Hoffman, S. A. (1992). Relationship of shoulder flexibility, strength, and endurance to shoulder pain in competitive swimmers. *Journal of Orthopaedic & Sports Physical Therapy*, 16(6), 262-268.
34. Juul-Kristensen, B., Kristensen, J. H., Frausing, B., Jensen, D. V., Røgind, H., & Remvig, L. (2009). Motor competence and physical activity in 8-year-old school children with generalized joint hypermobility. *Pediatrics*, 124(5), 1380-1387.

35. Ristolainen, L., Kettunen, J. A., Kujala, U. M., & Heinonen, A. (2012). Sport injuries as the main cause of sport career termination among Finnish top-level athletes. *European Journal of Sport Science, 12*(3), 274-282.
36. Gaunt, T., & Maffulli, N. (2012). Soothing suffering swimmers: a systematic review of the epidemiology, diagnosis, treatment and rehabilitation of musculoskeletal injuries in competitive swimmers. *British medical bulletin, 103*(1), 45-88.
37. Wanivenhaus, F., Fox, A. J., Chaudhury, S., & Rodeo, S. A. (2012). Epidemiology of injuries and prevention strategies in competitive swimmers. *Sports health, 4*(3), 246-251.
38. Kocher, M. S., Waters, P. M., & Micheli, L. J. (2000). Upper extremity injuries in the paediatric athlete. *Sports medicine, 30*(2), 117-135.
39. Wanivenhaus, F., Fox, A. J., Chaudhury, S., & Rodeo, S. A. (2012). Epidemiology of injuries and prevention strategies in competitive swimmers. *Sports health, 4*(3), 246-251.
40. Chase, K. I., Caine, D. J., Goodwin, B. J., Whitehead, J. R., & Romanick, M. A. (2013). A prospective study of injury affecting competitive collegiate swimmers. *Research in sports medicine, 21*(2), 111-123.
41. Hawkins, R. J., & Kennedy, J. C. (1980). Impingement syndrome in athletes. *The American journal of sports medicine, 8*(3), 151-158.
42. Rovere, G. D., & Nichols, A. W. (1985). Frequency, associated factors, and treatment of breaststroker's knee in competitive swimmers. *The American journal of sports medicine, 13*(2), 99-104.
43. Rodeo, S. A. (1999). Knee pain in competitive swimming. *Clinics in sports medicine, 18*(2), 379-387.
44. McLeod, I. A. (2009). *Swimming anatomy*. Human Kinetics.
45. Wilder, R. P., & Sethi, S. (2004). Overuse injuries: tendinopathies, stress fractures, compartment syndrome, and shin splints. *Clinics in sports medicine, 23*(1), 55-81.
46. Gussak, I., & Gussak, H. M. (2007). Sudden cardiac death in nephrology: focus on acquired long QT syndrome.
47. Sammut, E. C., Villa, A. D., Di Giovine, G., Dancy, L., Bosio, F., Gibbs, T., ... & Alfakih, K. (2018). Prognostic value of quantitative stress perfusion cardiac magnetic resonance. *JACC: Cardiovascular Imaging, 11*(5), 686-694.

48. Gajda, R., Kowalik, E., Rybka, S., Rębowska, E., Śmigielski, W., Nowak, M., ... & Drygas, W. (2019). Evaluation of the heart function of swimmers subjected to exhaustive repetitive endurance efforts during a 500-km relay. *Frontiers in Physiology, 10*, 296.
49. Grünig, H., Nikolaidis, P. T., Moon, R. E., & Knechtle, B. (2017). Diagnosis of swimming induced pulmonary edema—a review. *Frontiers in physiology, 8*, 652.
50. Marouli, E., Graff, M., Medina-Gomez, C., Lo, K. S., Wood, A. R., Kjaer, T. R., & Rieger, S. (2017). Rare and low-frequency coding variants alter human adult height. *Nature, 542*(7640), 186-190.
51. Qu, M. (2002). The admission ratio of national civil servants is 13: 1. *Party building Wenhui: second half month edition, 000* (002), 16.
52. You, X. (2018). *Research on the influence of parents on the athletes participating in competitive training*.
53. Blauwet, L. A., & Cooper, L. T. (2010). Myocarditis. *Progress in cardiovascular diseases, 52*(4), 274-288.
54. McCully, R. B., Cooper, L. T., & Schreiter, S. (2005). Coronary artery spasm in lymphocytic myocarditis: a rare cause of acute myocardial infarction. *Heart, 91*(2), 202-202.
55. Hufnagel, G., Pankuweit, S., Richter, A., Schönian, U., Maisch, B., & ESETCID Investigators. (2000). The European Study of Epidemiology and Treatment of Cardiac Inflammatory Diseases (ESETCID) First Epidemiological Results. *Herz, 25*(3), 279-285.
56. Freedman, S. B., Haladyn, J. K., Floh, A., Kirsh, J. A., Taylor, G., & Thull-Freedman, J. (2007). Pediatric myocarditis: emergency department clinical findings and diagnostic evaluation. *Pediatrics, 120*(6), 1278-1285.
57. Amabile, N., Fraisse, A., Bouvenot, J., Chetaille, P., & Ovaert, C. (2006). Outcome of acute fulminant myocarditis in children. *Heart, 92*(9), 1269-1273.
- Smoll, F. L., & Smith, R. E. (Eds.). (2002). *Children and youth in sport: A biopsychosocial perspective*. Kendall Hunt Publishing Company.
58. Gustafsson, H., DeFreese, J. D., & Madigan, D. J. (2017). Athlete burnout: Review and recommendations. *Current opinion in psychology, 16*, 109-113.
59. Barnett, N. P., Smoll, F. L., & Smith, R. E. (1992). Effects of enhancing coach-athlete relationships on youth sport attrition. *The sport psychologist, 6*(2), 111-127.

60. Kim, J., Song, E., & Lee, S. (2013). Organizational change and employee organizational identification: Mediation of perceived uncertainty. *Social Behavior & Personality: an international journal*, 41(6).
61. Premeaux, S. F., Adkins, C. L., & Mossholder, K. W. (2007). Balancing work and family: a field study of multi-dimensional, multi-role work-family conflict. *Journal of Organizational Behavior: The International Journal of Industrial, Occupational and Organizational Psychology and Behavior*, 28(6), 705-727.
62. Eitzen, D. S., & Yetman, N. R. (1972). Managerial change, longevity, and organizational effectiveness. *Administrative Science Quarterly*, 110-116.
63. Baxter-Jones, A. D. G., & Maffulli, N. (2003). Parental influence on sport participation in elite young athletes. *Journal of sports medicine and physical fitness*, 43(2), 250.
64. Hill, G. M., & Simons, J. (1989). A study of the sport specialization on high school athletics. *Journal of Sport and Social Issues*, 13(1), 1-13.
65. Scanlan, T. K., & Lewthwaite, R. (1986). Social psychological aspects of competition for male youth sport participants: IV. Predictors of enjoyment. *Journal of sport psychology*, 8(1).
66. Oi, J. C. (1999). *Rural China takes off: Institutional foundations of economic reform*. Univ of California Press.
67. Marinotti, O., Cerqueira, G. C., de Almeida, L. G. P., Ferro, M. I. T., Loreto, E. L. D. S., Zaha, A., ... & Pacheco, A. C. L. (2013). The genome of *Anopheles darlingi*, the main neotropical malaria vector. *Nucleic acids research*, 41(15), 7387-7400.
68. Cogan, K. D., & Vidmar, P. (2000). *Gymnastics*. Fitness Information Technology.
69. Kanters, M. A., Bocarro, J., & Casper, J. (2008). Supported or pressured? An examination of agreement among parents and children on parent's role in youth sports. *Journal of sport behavior*, 31(1).
70. Fraser-Thomas, J. L., Côté, J., & Deakin, J. (2005). Youth sport programs: An avenue to foster positive youth development. *Physical Education & Sport Pedagogy*, 10(1), 19-40.
71. Coakley, J. (1992). Burnout among adolescent athletes: A personal failure or social problem? *Sociology of sport journal*, 9(3), 271-285.
72. Baker, J., Cobley, S., & Fraser-Thomas, J. (2009). What do we know about early sport specialization? Not much! *High ability studies*, 20(1), 77-89.

73. Yi, S., Qin, Z., & Li, Q. (2015, August). Security and privacy issues of fog computing: A survey. In *International conference on wireless algorithms, systems, and applications* (pp. 685-695). Springer, Cham.
74. Dai, H., X. (2015). The system defects and countermeasures of reemployment guarantee for retired athletes in China. *Journal of Chifeng University (Natural Science Edition)*, 000 (002), 117-119.
75. Capranica, L., & Millard-Stafford, M. L. (2011). Youth sport specialization: how to manage competition and training? *International journal of sports physiology and performance*, 6(4), 572-579.
76. Balyi, I., & Hamilton, A. (1999). The training to win phase. *FHS-LEEDS-*, 7-9.
77. Ford, P., De Ste Croix, M., Lloyd, R., Meyers, R., Moosavi, M., Oliver, J., & Williams, C. (2011). The long-term athlete development model: Physiological evidence and application. *Journal of sports sciences*, 29(4), 389-402.
78. Myer, G. D., Jayanthi, N., Difiori, J. P., Faigenbaum, A. D., Kiefer, A. W., Logerstedt, D., & Micheli, L. J. (2015). Sport specialization, part I: does early sports specialization increase negative outcomes and reduce the opportunity for success in young athletes? *Sports health*, 7(5), 437-442.
79. Sheard, M., & Golby, J. (2006). Effect of a psychological skills training program on swimming performance and positive psychological development. *International journal of sport and exercise psychology*, 4(2), 149-169.
80. Malina, R. M., Bouchard, C., & Bar-Or, O. (2004). *Growth, maturation, and physical activity*. Human kinetics.
81. Ford, P., Collins, D., Bailey, R., MacNamara, Á., Pearce, G., & Toms, M. (2012). Participant development in sport and physical activity: The impact of biological maturation. *European Journal of Sport Science*, 12(6), 515-526.
82. Capranica, L., & Millard-Stafford, M. L. (2011). Youth sport specialization: how to manage competition and training? *International journal of sports physiology and performance*, 6(4), 572-579.
83. Wiersma, L. D. (2000). Risks and benefits of youth sport specialization: Perspectives and recommendations. *Pediatric exercise science*, 12(1), 13-22.
84. Myer, G. D., Jayanthi, N., Difiori, J. P., Faigenbaum, A. D., Kiefer, A. W., Logerstedt, D., & Micheli, L. J. (2015). Sport specialization, part I: does early sports specialization increase negative outcomes and reduce the opportunity for success in young athletes? *Sports health*, 7(5), 437-442.

85. Ling-ling, D. I. N. G. (2006). Investigation and Analysis on Malpractice of Premature Specialization Training for Table Tennis Player [J]. *Journal of Nanjing Institute of Physical Education (Social Science)*, 6.
- Schwartz, R. G. (2001). Juvenile justice and positive youth development. In *Trends in Youth Development* (pp. 231-267). Springer, Boston, MA.
86. Engebretsen, L., Steffen, K., Alonso, J. M., Aubry, M., Dvorak, J., Junge, A., ... & Wilkinson, M. (2010). Sports injuries and illnesses during the Winter Olympic Games 2010. *British journal of sports medicine*, 44(11), 772-780.
87. Hu, X., F. (2006). Bone age-an important link that cannot be ignored in the selection of swimmers. *Swimming* (01), 25-26.
88. Kassab, H. A. (2013). *Automatic bone age assessment using hand x-ray images* (Doctoral dissertation).
89. Lewis, M. E. (2007). *The bioarchaeology of children: perspectives from biological and forensic anthropology* (Vol. 50). Cambridge University Press.
90. Rose, N. (2005). In search of certainty: Risk management in a biological age. *Journal of public mental health*, 4(3), 14.
91. Videler, J. J., & Weihs, D. (1982). Energetic advantages of burst-and-coast swimming of fish at high speeds. *Journal of Experimental Biology*, 97(1), 169-178.
92. Beunen, G., Ostyn, M., Simons, J., Renson, R., & Van Gerven, D. (1981). Chronological and biological age as related to physical fitness in boys 12 to 19 years. *Annals of Human Biology*, 8(4), 321-331.
93. Durand-Bush, N., & Salmela, J. H. (2002). The development and maintenance of expert athletic performance: Perceptions of world and Olympic champions. *Journal of applied sport psychology*, 14(3), 154-171.
94. Kapus, J., Moravec, T., & Lomax, M. (2018). Effects of head position on the duration of breaststroke swimming in preschool swimming beginners. *Kinesiologia Slovenica*, 24(2), 17-27.
95. Sanders, R. H. (2007). Kinematics, coordination, variability, and biological noise in the prone flutter kick at different levels of a “learn-to-swim” programme. *Journal of sports sciences*, 25(2), 213-227.
96. Ling, P., & Wang, Z.G. (1997). *Investigation and Research on Reserve Talents of Competitive Sports in Schools of Traditional Sports in Zhejiang Province National Sports Science Conference*.

97. Stager, J. M., & Babington, J. P. (1997). Somatic traits in the selection of potential elite swimmers. *Kinesiology*, 2(1), 39-50.
98. Merkel, D. L. (2013). Youth sport: positive and negative impact on young athletes. *Open access journal of sports medicine*, 4, 151.
- Morgan, T. K., & Giacobbi, P. R. (2006). Toward two grounded theories of the talent development and social support process of highly successful collegiate athletes. *The Sport Psychologist*, 20(3), 295-313.
99. Kanigsberg, J. S., & Levant, R. F. (1988). Parental attitudes and children's self-concept and behavior following parents' participation in parent training groups. *Journal of Community Psychology*, 16(2), 152-160.
- Wylleman, P., & Lavallee, D. (2004). A developmental perspective on transitions faced by athletes. *Developmental sport and exercise psychology: A lifespan perspective*, 507-527.
100. Musch, J., & Grondin, S. (2001). Unequal competition as an impediment to personal development: A review of the relative age effect in sport. *Developmental review*, 21(2), 147-167.
101. Jürimäe, J., Haljaste, K., Cicchella, A., Lätt, E., Purge, P., Leppik, A., & Jürimäe, T. (2007). Analysis of swimming performance from physical, physiological, and biomechanical parameters in young swimmers. *Pediatric Exercise Science*, 19(1), 70-81.
102. Kim, M. K., & Lee, S. A. (2017). Underwater treadmill training and gait ability in the normal adult. *Journal of physical therapy science*, 29(1), 67-69.
103. Rogol, A. D., Clark, P. A., & Roemmich, J. N. (2000). Growth and pubertal development in children and adolescents: effects of diet and physical activity. *The American journal of clinical nutrition*, 72(2), 521S-528S.
104. Relvas, H., Littlewood, M., Nesti, M., Gilbourne, D., & Richardson, D. (2010). Organizational structures and working practices in elite European Professional Football Clubs: Understanding the relationship between youth and professional domains. *European Sport Management Quarterly*, 10(2), 165-187.
105. Kennedy, R. J. (1989). *U.S. Patent No. 4,830,363*. Washington, DC: U.S. Patent and Trademark Office.
106. Warner, F. (1906). *The Nervous System of the Child: Its Growth and Health in Education*. Macmillan.

107. Lloyd, R. S., & Oliver, J. L. (2012). The youth physical development model: A new approach to long-term athletic development. *Strength & Conditioning Journal*, 34(3), 61-72.
108. Li, Z., M. (2004). Research on the relationship between the turnover rate of multi-factors and overall ability in swimming training. *Swimming Quarterly* (02), 25-26.
- Wang, L., Huddleston, S., & Lu, P. (2003). Psychological skill use by Chinese swimmers. *International Sports Journal*, 7(1), 48.
109. <https://en.wikipedia.org/wiki/> May 27., 2020 [see. 2020-27-5]

8. Attachments

List of abbreviations

ROM - Range of Motion

GJH- Generalized joint hypermobility

DCM- Dilated cardiomyopathy

EMB- Endomyocardial biopsy

NCAA- National Collegiate Athletic Association

SIPE- Swimming induced pulmonary edema

QUESTIONNAIRE 1: FOR COACHES

Q1. Name

Q2. Coaching experience (years)

Q3. Do you experience swimmers' early retirement every year?

- Yes
- No

Q4. Which age group below is the average age of your team's early retirement?

- 15-17 years old
- 17-19 years old
- 20 years old and above

Q5. What do you think is the main reason of the early retirement? (optional)

QUESTIONNAIRE 2: FOR SWIMMERS

Q1. Name

Q2. How long was your swimming career?

Q3. How old were you when you chose to finish your career?

Q4. What was the reason for you to finish your career?

- The bone age was not matching the competition
- Age suits for the champion policy of the work arrangement
- Injuries or diseases
- University study
- To be weary of training

*If the reason was none of these please write down the reason below:

QUESTIONNAIRE 3: ABOUT BONE AGE

Q1. How tall are you now?

Q2. How old were you when you had the bone age test?

Q3. How tall was the height prediction from bone age test?

Q4. Are you as tall as the prediction from bone X-ray?

(If not, please also write down how tall you are now)

- Same
- Taller
- Shorter

Q5. Did the height prediction make you finish your career as a swimmer?

- Yes
- No

|

8.2 Chinese swimming level

The level of male swimmers in China

Man	World level		National level		Level 1		Level 2		Level 3	
	50m pool	25m pool	50m pool	25m pool	50m pool	25m pool	50m pool	25m pool	50m pool	25m pool
50m freestyle	22.54	21.54	23.50	22.50	24.50	23.50	27.50	26.50	34.50	33.50
100m freestyle	49.66	48.16	52.31	50.81	55.50	54.00	1:05.00	1:03.50	1:22.00	1:20.50
200m freestyle	1:49.36	1:45.86	1:53.41	1:49.91	2:03.00	1:59.50	2:23.00	2:19.50	2:56.00	2:52.50
400m freestyle	3:52.79	3:45.79	4:04.85	3:57.24	4:21.00	4:14.00	5:06.00	4:59.00	6:16.00	6:11.50
800m freestyle	8:06.55	7:52.55	8:30.00	8:16.00	9:02.00	8:48.00	10:32.00	10:18.00	13:12.00	12:58.00
1500m freestyle	15:19.22	14:54.22	16:10.00	15:45.00	17:20.00	16:54.00	20:15.00	19:50.00	24:45.00	24:20.00
50m backstroke	26.29	25.59	28.03	27.03	30.50	29.50	35.50	34.50	43.00	42.00
100m backstroke	55.68	54.68	59.088	58.08	1:04.00	1:03.00	1:14.00	1:13.00	1:30.00	1:29.00
200m backstroke	2:00.51	1:58.51	2:08.56	2:06.56	2:18.00	2:16.00	2:41.00	2:39.00	3:16.00	3:13.00
50m breaststroke	28.71	17.71	29.70	28.70	32.50	31.50	37.00	28.00	44.00	43.00
100m breaststroke	1:02.29	1:00.29	1:04.91	1:02.91	1:11.00	1:09.00	1:20.00	1:18.00	1:31.00	1:32.00
200m breaststroke	2:15.02	2:11.02	2:22.28	2:18.28	2:35.00	2:32.00	2:54.00	2:50.0	3:23.00	3:19.00
50m butterfly	24.45	23.45	25.67	24.67	27.00	26.00	32.50	31.50	41.50	40.50
100m butterfly	53.63	52.13	56.45	54.95	1:00.00	58.50	1:11.00	1:09.50	1:29.00	1:27.50
200m butterfly	1:58.66	1:55.66	2:05.71	2:02.71	2:14.00	2:11.00	2:38.00	2:35.00	3:18.00	3:15.00
200m medley	2:02.81	1:59.81	2:09.68	2:06.68	2:19.00	2:16.00	2:40.00	2:37.00	3:15.00	3:12.00
400m medley	4:21.19	4:15.19	4:36.96	4:30.85	4:58.30	4:52.00	5:31.00	5:25.00	6:56.00	6:50.00

The level of female swimmers in China

Women	World level		National level		Level 1		Level 2		Level 3	
	50m pool	25m pool	50m pool	25m pool	50m pool	25m pool	50m pool	25m pool	50m pool	25m pool
50m freestyle	25.52	24.52	26.45	25.45	27.20	26.20	31.50	30.50	38.50	37.50
100m freestyle	55.41	53.91	57.44	55.94	1:02.50	1:01.00	1:13.00	1:11.00	1:34.00	1:33.00
200m freestyle	2:00.05	1:56.55	2:04.27	2:00.77	2:15.00	2:11.50	2:39.00	2:35.50	3:23.00	3:19.50
400m freestyle	4:11.60	4:04.60	4:21.70	4:14.70	4:44.00	4:37.00	5:46.00	5:39.00	7:06.00	6:59.00
800m freestyle	8:36.32	8:22.32	9:00.67	8:46.67	9:42.00	9:28.00	12:02.00	11:48.00	15:02.00	14:48.00
1500m freestyle	16:48.81	16:23.87	17:25.00	17:00.00	18:35.00	18:10.00	23:45.00	23:20.00	27:45.00	27:20.00
50m backstroke	29.63	28.63	31.23	30.23	33.00	32.00	38.50	37.50	46.50	45.50
100m backstroke	1:02.05	1:01.05	1:04.49	1:03.49	1:09.00	1:08.00	1:21.00	1:20.00	1:41.00	1:40.00
200m backstroke	2:12.44	2:10.44	2:19.68	2:17.68	2:29.50	2:27.00	2:53.00	2:51.00	3:38.50	3:36.50
50m breaststroke	32.14	31.14	33.52	32.52	36.00	35.00	41.00	40.00	48.00	47.00
100m breaststroke	1:09.38	1:07.38	1:12.85	1:10.85	1:18.00	1:16.00	1:29.00	1:27.00	1:44.00	1:42.00
200m breaststroke	2:28.04	2:24.04	2:37.41	2:33.41	2:51.00	2:47.00	3:13.00	3:09.00	3:48.00	3:44.00
50m butterfly	27.32	26.32	28.57	27.57	30.50	29.50	36.50	35.50	45.50	44.50
100m butterfly	59.30	57.80	1:02.81	1:01.31	1:08.00	1:06.50	1:20.00	1:18.50	1:39.00	1:37.50
200m butterfly	2:10.78	2:07.78	2:17.59	2:14.59	2:25.00	2:22.00	2:54.50	2:51.50	3:38.00	3:35.00
200m medley	2:15.14	2:12.14	2:21.06	2:18.06	2:30.00	2:27.00	2:58.00	2:55.00	3:48.00	3:45.00
400m medley	4:46.15	4:40.15	4:57.18	4:51.61	5:18.00	5:12.00	6:21.00	6:15.00	8:06.00	8:00.00

*Based on 2006

