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OVERTRAINING AND BURNOUT IN YOUNG TENNIS ATHLETES: IMPLICATION FOR SPORTS COACHES

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ABSTRACT

Tennis is one of the sports that requires a high level of physical requirements, including speed, agility, strength, endurance, power, flexibility, footwork, and hand-eye coordination, just to successfully serve or receive a ball. In Malaysia, a total of 13 different tournaments, organized locally, and internationally, are available for young tennis athletes to participate in, where they are required to attend various scheduled and intensive training sessions prior to their tournament, ranging from 12 to 48 hours per month in different age groups. Given the chronic stressors including high training load, academic demands, and expectations from coaches, family, and the athletes themselves, young tennis athletes are predisposed to overtraining and burnout occurrence. Overtraining is defined as a longer period of negative unintentional consequences of training, resulting in decreased performance, which lasts longer than just a few days. Burnout is defined as a psychophysiological response to exhaustion, involving three components, including psychological, physical, and behavioural components, which manifests in three features including emotional and physical exhaustion, reduced sense of accomplishment and sport devaluation. Hence, this study aims to identify the risk factors of burnout and overtraining in young tennis athletes, to provide actionable recommendations to parents, coaches, and paediatricians, and in supporting young athletes' well-being. A total of five articles which studies the correlation between training load or training volume and occurrence of burnout in young tennis athletes were included in this study. Results yielded were inconclusive to recommend the optimum duration of recommended training hours or training load in young tennis athletes, to avoid the occurrence of burnout, highlighting the need for further research to be conducted to establish the relationship between training load and burnout occurrence in young tennis players in Malaysia.

Keywords: *Tennis athletes, Burnout, Overtraining, Training load, Early specialization*

INTRODUCTION

Tennis is one of the sports which requires a high level of physical requirements, including speed, agility, strength, endurance, power, flexibility, footwork, and hand-eye coordination, just to successfully serve or receive a ball (Mehrban, 2016). Aside from these physical requirements, mental skills such as concentration, troubleshooting, and motivation, are often needed to become a good tennis player (Tennis World North Ryde, 2017). On an average, a tennis match may only last for 45 minutes, when played amongst the amateurs, but it may even last up to five hours in highly-competitive professional players (Chervinski, 2024). The scoring systems in a tennis match also differ based on the age group of the players.

1.1 Tennis Tournaments in Malaysia and in Worldwide

Apart from improving players' access to tennis, other measures were also taken to further develop this sport, which include increasing funding for coaching, the execution of various tennis-related events, as well as, the upgrading of facilities (International Tennis Federation [ITF], 2024). With the ITF's Tennis Play and Stay Campaign, tennis is accessible to every level and age of players, and even children as young as five years of age, are able to play tennis, with the implementation of a new ruling, the "Red, Orange, Green (ROG)" tennis (ITF, 2023a; ITF, 2023b). In Malaysia, Tennis Malaysia organizes the R.O.G tournament which is held at state, regional and national levels, with three different participating categories, including eight and under, nine and under, and 10 and under categories, whereby each category uses a different colored ball, each with varying density, speed, and elasticity, in the game, namely red, orange and green, respectively (USTA Junior Team Tennis of Spartanburg, 2024). Tennis Malaysia also holds other tournaments such as the Tennis Malaysia Junior Tour (TMJT) and Tennis Malaysia Junior Championship (TMJC), which accommodate young tennis players from the age of 8 years to 18 years (Tennis Malaysia [TM], 2024a). Young tennis players in Malaysia join tournaments organized both locally, and internationally (TM, 2024b). The table and graph below displays the various tournaments available to the junior tennis athletes in Malaysia, based on different age groups, alongside the duration of each tournament and the frequency of the respective tournaments held each year. It is shown from the table below that tournament duration in the age group of 10 and under, lasts for three-to-five days, whereas the tournament duration for athletes in the elder age group usually lasts for a longer duration, at a range of four-to-nine days (TM, 2024b). The three tournaments with a high frequency of re-organizing throughout the year are the ITF World Tennis Tour Juniors (WTTJ), ATF 14&U Grade A SEA, and TMJT, where the total duration of these tournaments in a year, makes up to approximately 114 days per year (TM, 2024b). Upon accumulating the duration of all the tournaments in which a 14-year-old tennis athlete is eligible for, it totalled up to about 154 days in a year, which is almost equivalent to a five-month period (TM, 2024b).

Table 1: Junior tennis tournaments participated by young tennis athletes in Malaysia (TM, 2024a).

Tournament	Age group	Organizer	Tournament duration (days)	Frequency per year	Total tournament duration per year (days)
Tennis Malaysia Junior Tour (TMJT)	16U, 14U, 12U	tennis MALAYSIA	5	6	30
Tennis Malaysia Junior Championship (TMJC)	16U, 14U, 12U	tennis MALAYSIA	4	2	8
R.O.G Regional	10U, 9U, 8U	tennis MALAYSIA	3	2	6
R.O.G National	10U, 9U, 8U	tennis MALAYSIA	3	2	6
SUKMA	21U	SUKAN MALAYSIA	7	1	7

MSSM	18U, 15U, 12U		9	1	9
Junior Billie Jean King Cup 16&U	16U		6	2	12
Junior Davis Cup 16&U	16U		6	2	12
ITF World Tennis Tour Juniors (WTTJ)	16U, 14U		6	8	48
ITF World Junior Tennis Championship (WJTC) Asia/Oceania 14&U Boys	14U		8	2	16
ITF World Junior Tennis Championship (WJTC) Asia/Oceania 14&U Girls	14U		8	2	16
ITF 12&U Team Competition - SEA Boys & Girls	12U		6	1	6
ATF 14&U Grade A SEA	14U		6	6	36

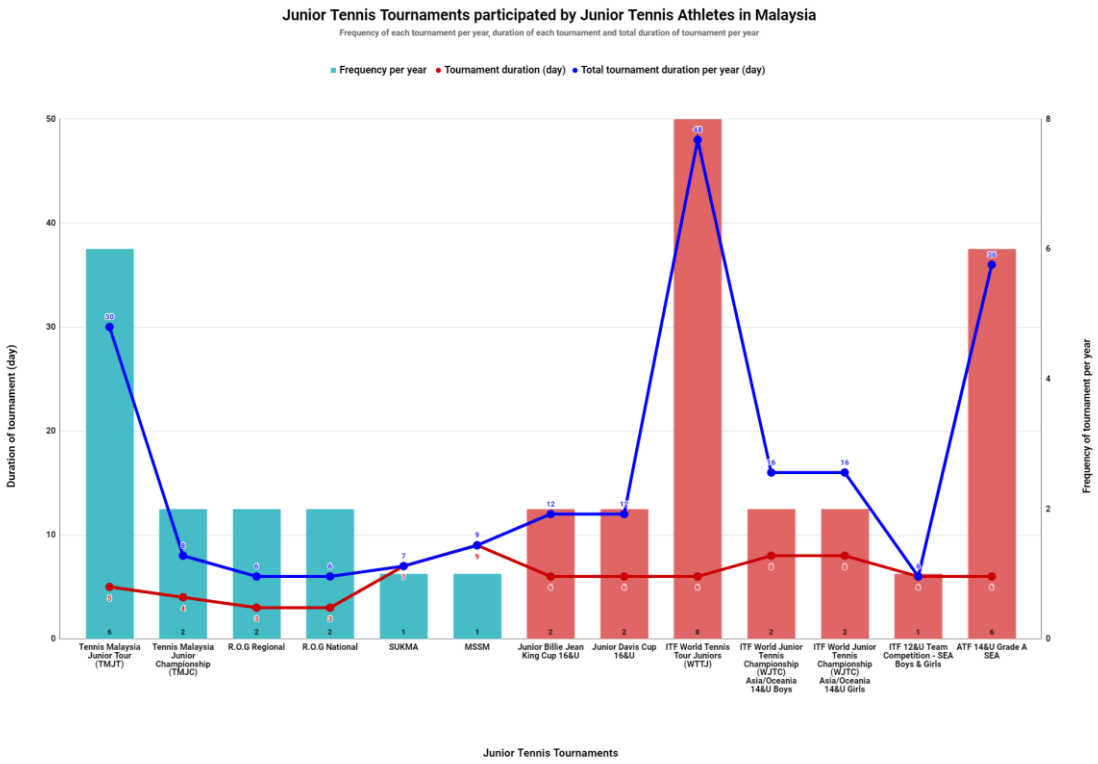

Figure 1: Line and bar chart graph representing the frequency of junior tennis tournaments organized in a year and the accumulated number of tournament days in a year, based on the number of tournament days in each tournament (TM, 2024b).

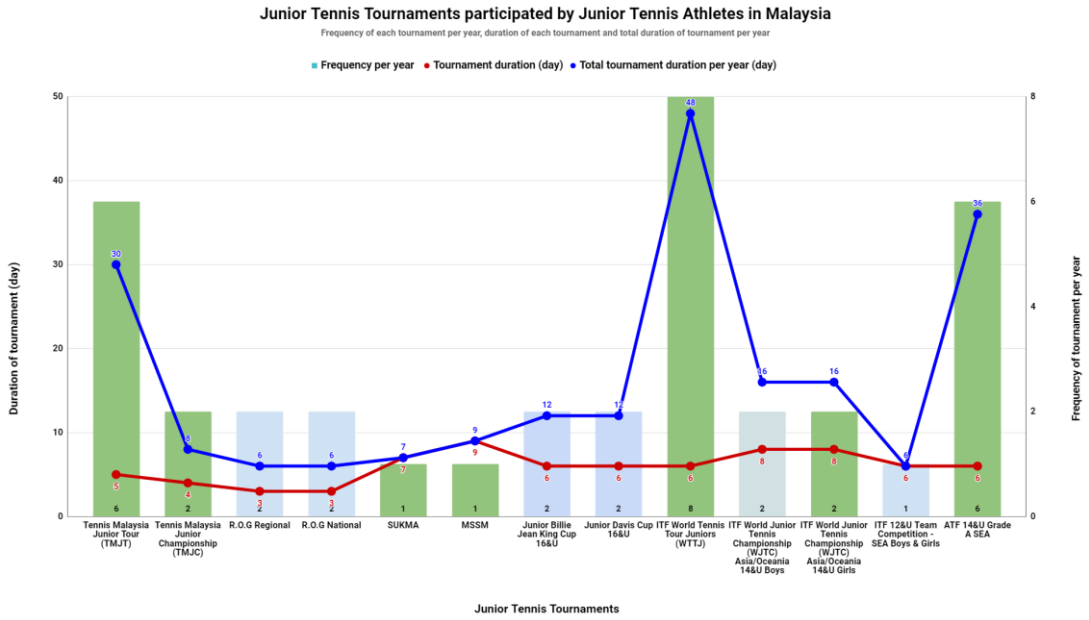

Figure 2: It is seen that the cumulative duration of all the tournaments in which a 14-year-old tennis athlete is eligible for (green bars) totalled up to about 154 days in a year, which is almost equivalent to a five-month period (TM, 2024b).

In general, from the Asian population perspective, the Hong Kong, China Tennis Association (HKCTA), Singapore Lawn Tennis Association (STA), Indonesian Tennis Association (PNP), Lawn Tennis Association of Thailand (LTAT), and All India Tennis Association (AITA), have also upheld the new practice, where players as young as four years of age in Hong Kong, have started joining tennis competitions (HKCTA, 2024; STA, 2024; PNP, 2024; LTAT, 2024; AITA, 2024). Other national tennis associations including the Lawn Tennis Association (LTA) Tennis for Britain, the United States Tennis Association (USTA), and Tennis Australia have also added on the '10 and under' category in the junior tennis competitions held, with the youngest player eligible, only the age of six (LTA, 2024; USTA, 2016; Tennis Australia, 2024).

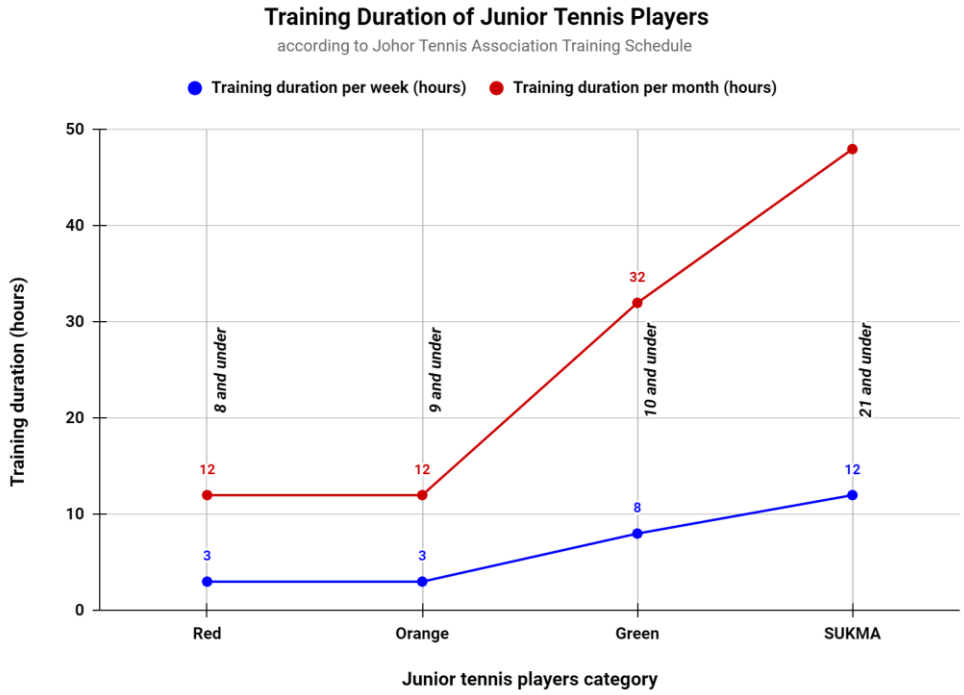

Figure 3: A line graph illustrating the training duration of junior tennis players in Malaysia according to Johor Tennis Association Training Schedule (Johor Tennis Association [JTA], 2024).

Table 2: Training schedule of junior tennis players in Johor Tennis Association in Malaysia (JTA, 2024).

Age group	Tennis Players Category	Training duration per week (hours)	Training duration per month (hours)
8 and under	Red	3	12
9 and under	Orange	3	12
10 and under	Green	8	32
21 and under	SUKMA	12	48

The table and graph above display the training duration of junior tennis players in Malaysia according to the training schedule of the Johor Tennis Association. It is shown that different age groups have different training duration per week, and the training duration increases as the age group increases.[18] Young tennis athletes who are 21 years and under have the longest training duration, up to 36 hours per month, whilst tennis players in the red category have the shortest training duration, which only takes up to 12 hours per month (JTA, 2024). Although there were not any changes in the training duration between tennis players aged eight and nine, the transition from aged nine to 10, has a substantial increase in the training duration per week, from three hours to eight hours, which is just four hours less than that of a 21-year-old athlete.

The introduction of sports to children at a young age has shown to be beneficial to children and their families, both in the short and long run, as it enhances children's physical, mental, and social health in various perspectives, where they have better growth, emotional and psychological development (University of San Diego - Professional & Continuing Education [PCESanDiego], 2023). Nevertheless, studies have shown that young tennis athletes are exposed to chronic stressors such as increased training loads in preparation for competition, high risk of injuries during training or competition, where they are required to return to training without sufficient rest, financial challenges, and expectations on sports achievements by themselves, their family and the society (PCESanDiego, 2023; US Department of Health and Human

Services, 2018). Stress, at an optimum level, has a role in optimizing athletic performance. However, overloaded stress may result in negative consequences such as overtraining syndrome and burnout in these young tennis athletes (Lee, 2024). Yet, most of the previous studies have only focused on the effect of training load in improving athletic performance, from the perspective of physical fitness and technical skills (Ericsson, 1996; Ericsson, 1993; Ford et al., 2015).

OBJECTIVE

This study aims to determine the risk factors of burnout and overtraining in young tennis athletes, to provide guidance to parents, coaches, and pediatricians, on the optimum amount of training load in young tennis athletes, to recommend correctional alternatives for coaches, as well as to uphold safe and healthy sports practices.

METHODOLOGY

Several databases including Ovid MEDLINE, Google Scholar, PubMed, Scopus, and CINAHL Complete database were utilized to search for articles published between 1995 and 2024, reporting on tennis players' training load and the occurrence of overtraining and burnout among tennis players. Keywords and terms such as "tennis", "tennis players", "training", "training intensity", "training hours", "training load", "burnout", and "overtraining" were used for the search, and these keywords were combined using operator "AND" and "OR" where relevant.

Articles reporting on young tennis players' or young athletes' training duration and burnout or overtraining occurrence were included, and articles reporting on the similar topic as above but does not include the term, "junior" or "young" athletes above 21 years old as their study population were excluded.

A total of 5 articles were yielded from the search.

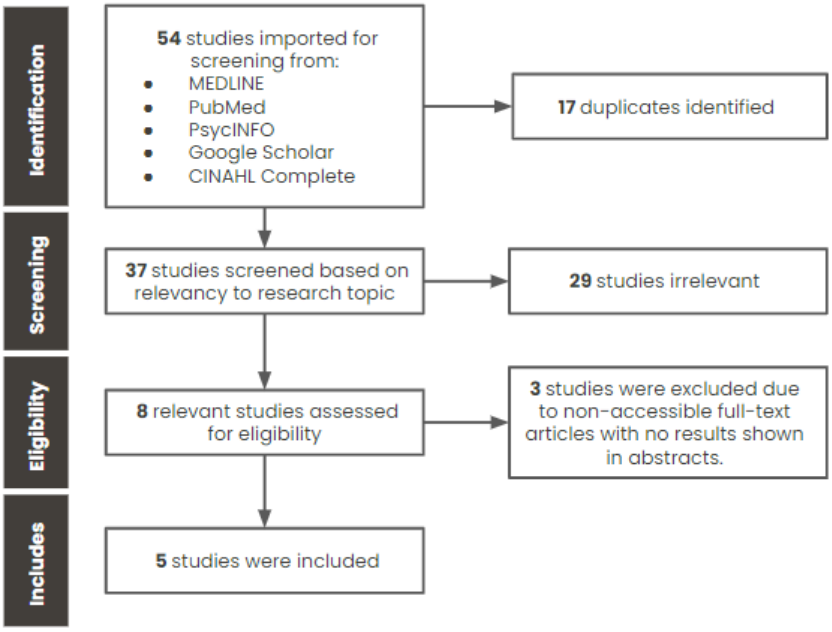

Figure 4: PRISMA chart illustrating the process of choosing relevant articles for review.

1.2 Training in Tennis Players

1.2.1 Periodization

Periodization training is a training method where it involves a stepwise oscillation between an overloaded work phase, involving training intensity and volume which exceeds the athlete's usual maximal training

load, and recovery phase, where athletes are allowed to rest for a certain duration of time for recovery, to improve long-term athletic performances, decrease injury risks, and other overtraining features, by establishing a new and higher starting point of ability for the next course of training, given the physiological adaptation of the body to the higher training load (Kovacs et al., 2024; Ochi et al, 2016). Often, coaches and athletes train adequately during the overloaded work phase or loading phase of periodization, but lacks in the recovery phase, leading to higher risk of injuries and overtraining syndrome, due to insufficient period of rest (Kovacs et al., 2024).

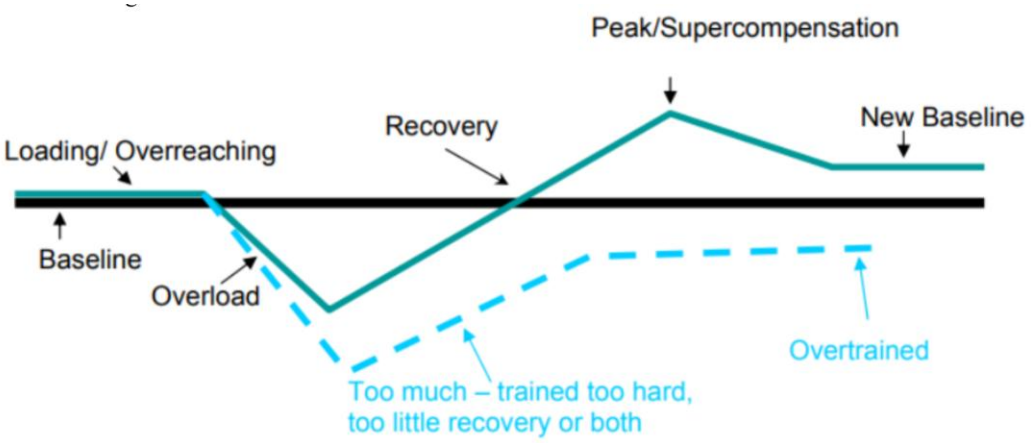

Figure 5: Graph illustrating the relationship between training load and overtraining, showing that an excessive training load and insufficient rest period for recovery results in overtraining in athletes (Ochi et al., 2016).

The periodization training cycle encompasses macrocycles, mesocycles and microcycles (Ochi et al., 2016). Macrocycle basically refers to the entire training cycle, where there may be one-to-two macrocycles in a year. In each macrocycles, there will be at least two mesocycles, in which each may last from weeks to months, and it reflects the various sport seasons including preseason and postseason (Ochi et al., 2016). Similarly, in each mesocycle, there are at least two microcycles, each lasting up to 14 days, which represents specific training calendar weeks, with various training goals (Ochi et al., 2016).

The contemporary periodization model consists of four phases, where each phase has varying training goals (Ochi et al., 2016). The first phase is the preparatory phase, where athletes are subjected to some light intensity training, in moderate-to-high volume, with minimal training on tennis skills (Ochi et al., 2016). Athletes in this phase usually have just returned to training from a long resting period (Ochi et al., 2016). The next phase is the pre-competition phase, where athletes train more on specific tennis skills such as footwork, strength, power, agility and speed, by undergoing lower-volume, but higher-intensity training (Ochi et al., 2016). Following this, athletes now enter the competitive phase, which is further subdivided into a maintenance and peaking phase (Ochi et al., 2016). The maintenance phase mainly prioritizes training on-court skills at a moderate intensity and volume, whilst the peaking phase, training volume is significantly tuned down but the high intensity is still maintained, mainly to ensure adequate rest and recovery, in preparation for the major tournaments (Ochi et al., 2016). The active rest period is the last phase, where tournaments have ended and will only proceed to the preparatory phase in the next macrocycle. During this period, athletes are to prioritize healing their injuries acquired during the tournaments, and should have zero to minimal involvement in any on-court training (Ochi et al., 2016).

Periodization in young tennis athletes differs from that of adult tennis athletes because young tennis athletes are constantly evolving, growing and developing each day, and the periodization training design should be altered based on the young athletes' developmental stage, including the prepubertal, pubertal, and postpubertal stage (Ochi et al., 2016). Hence, the macrocycle and mesocycle representation in periodization of young tennis athletes also differs from that of adult, where the athlete's entire youth phase, prior to becoming an adult, is perceived as the macrocycle of periodization (Ochi et al., 2016). In usual circumstances, the physiological changes during puberty may cause a transient decline in certain previously

acquired tennis skills (Ochi et al., 2016). Nevertheless, with continuous progression of periodization training, the pubertal stage may instead become a window of opportunity for the young tennis athlete to improve their performance in the postpubertal phase (Ochi et al., 2016).

1.2.2 Overreaching and Overtraining

Overreaching is defined as a transient, purposeful training stress experienced by an athlete, after undergoing a training session whose training load exceeds the athlete's usually-tolerated capacity, to ultimately enhance athletic performance (Ochi et al., 2016). Overreaching resulting from the overloading of training stress may either result in functional overreaching or non-functional overreaching (Ochi et al., 2016). Functional overreaching is where athletes experience a temporary decline in physiological status for about a period of three days, but eventually results in improved fitness and performance with sufficient rest (Ochi et al., 2016). Non-functional overreaching is the opposite of the former, where it causes an extended period of deteriorating performance in athletes, which may lead to overtraining, if the athletes continue to train, without resting adequately (Ochi et al., 2016).

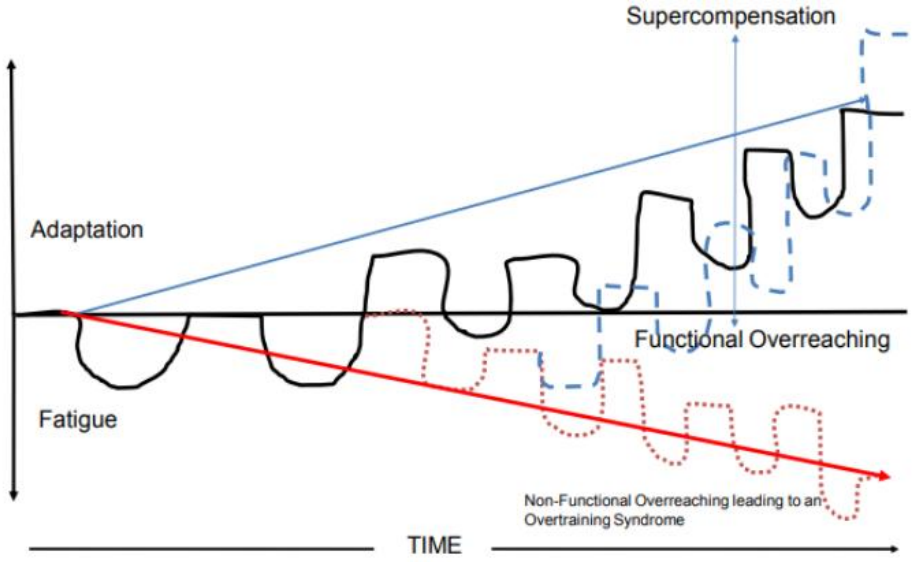

Figure 6: This is a graph illustrating the changes of the body's physiology in response to fatigue (black solid line), functional overreaching (blue dashed line) and non-functional overreaching (red dotted line) (Ochi et al., 2016).

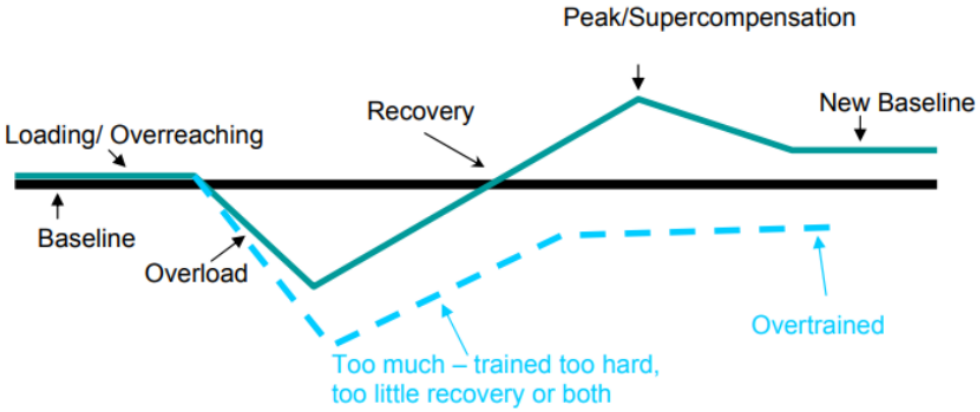

Figure 7: This graph demonstrates that a poorly performed periodization training with an excessive training load and insufficient rest period for recovery results in overtraining in athletes (Ochi et al., 2016).

Overtraining is a prolonged period, of unintended training outcome, which may be ranging from days to months, where athletes may feel fatigue and experience muscle soreness, leading to performance decline, as a result of an excessive training load and inadequate recovery from injuries and muscles fatigue (Ochi et al., 2016). Apart from deteriorating performance, overtraining in athletes may manifest both physically

and psychologically, including insomnia, tachycardia upon awakening, increased risk of injury, appetite changes, emotional and mental instability, which may present with depression, anger, irritability, and a low self-confidence, as displayed in the table below.

Table 3: Signs and symptoms of overtraining (Ochi et al., 2016).

Physical	Psychological
Decreased performance Muscle weakness Muscle soreness Chronic fatigue Sleep disturbance Increased waking heart rate Increased injury Increased upper respiratory infections Disturbed sleep Changes in appetite	Increased anger Increased irritability Increased depression Reduced motivation Mental exhaustion Emotional exhaustion Decreased self-esteem Sadness

The terms, 'overtraining' and 'burnout' are often used interchangeably by many, where these terms are often thought to mean the same, when they actually differ. Burnout is a consequence of overtraining, but overtraining may or may not result in burnout (Ochi et al., 2016; Gustafsson, 2007). Overtrained athletes may end up in two outcomes, where they either attain recovery and achieve performance improvement, or they remain in a prolonged state of under-recovery, leading to staleness or overtraining syndrome (Ochi et al., 2016; Gustafsson, 2007). An extended period of staleness will subsequently lead to burnout, as the athletes developed a sense of demotivation (Gustafsson, 2007).

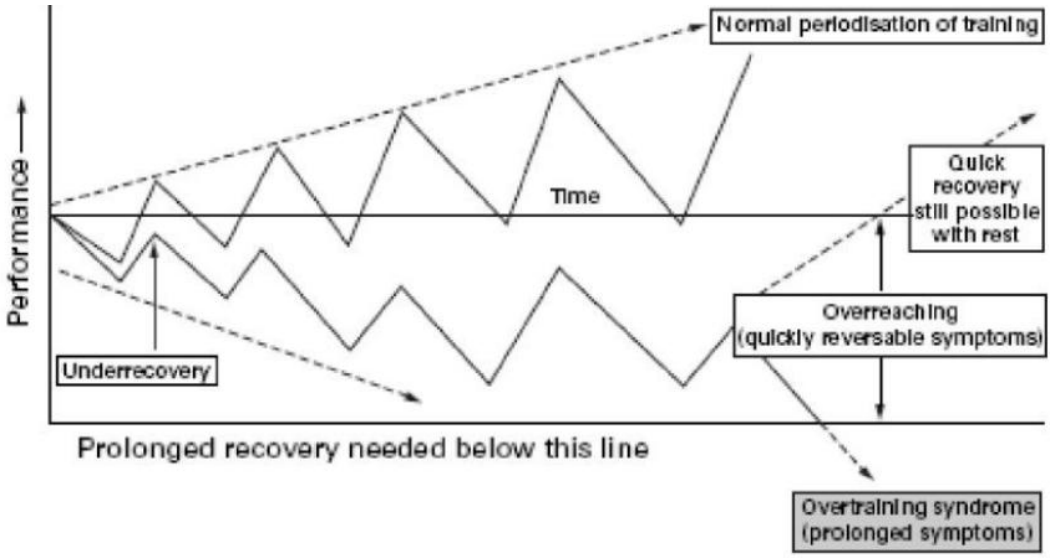

Figure 8: This graph illustrates the progression of an athlete from a non-functional overreaching to overtraining, and eventually overtraining syndrome when the athlete experiences a prolonged period of under-recovery symptoms (Ochi et al., 2016).

1.2.3 Training Load

There are various training terms used by coaches and athletes, which includes, training volume, training intensity, and training load (Coutts et al., 2010). Training volume refers to the duration of time spent in training, which may be in the form of minutes, hours, or days (Coutts et al., 2010). Training intensity reflects on the degree of difficulty of a training session, which may be indicated by changes in the athlete's biochemical parameters, including oxygen consumption, heart rate, and lactate concentration in blood, or by using the rate of perceived exertion (RPE) method (Coutts et al., 2010). Training load, which equates to

the multiplication of training volume and intensity, is essential to determine the efficiency of a training program because an optimum amount of training load improves athlete performances, but an exceedingly high training load is likely to result in overtraining and burnout (Coutts et al., 2010; Genevois et al., 2020). Numerous techniques were previously used to quantify training load in sports, including measuring changes in heart rate, and the accumulated weight lifted in a training session (Coutts et al., 2010). However, none of these methods considered both the training volume and intensity simultaneously, which resulted in a non-reliable method of assessing training load (Coutts et al., 2010).

The session-RPE method is a commonly used, non-invasive, and simple alternative, developed to quantify the training load of a training session, where it takes into account the training volume, in the form of training duration, and training intensity, in the form of RPE (Coutts et al., 2010; Genevois, 2020; Haddad, 2017). To assess the athletes' RPE, a simple question, "How was your workout?" was asked within 30 minutes post-training session, and the athletes will have to respond by reporting a number from a scale of zero (at rest) to 10 (at maximal exertion), to indicate their perceived training intensity, which will then be classified into at rest, easy, moderate, hard or maximal, based on the modified Borg CR-10 scale, in the figure shown below (Coutts et al., 2010; Genevois, 2020; Haddad, 2017). Training load is then calculated with the formula of RPE multiplied by training duration in minutes, presented in arbitrary units (AU) (Coutts et al., 2010; Genevois et al., 2020; Haddad, 2017).

Rating	Descriptor
0	Rest
1	Very easy
2	Easy
3	Moderate
4	Somewhat hard
5	Hard
6	
7	Very hard
8	
9	
10	Maximal

Figure 9: Modified Borg CR-10 scale used for classification of athlete's perceived training intensity (Foster, 1998).

In a research conducted by Foster (1998), it is found that maintaining an ongoing variation in training load such as periodization, instead of practising the training design of an unremittingly high or low training load, is crucial to improve athlete's performance. Training load should be closely monitored to optimize periodization training, especially prior and during a tournament, to prevent fatigue and allow for adequate recovery, to promote enhancement of the athlete's performance (Coutts et al., 2010). Although the session-RPE is a relatively user-friendly and affordable tool for training load assessment, it is still necessary for further studies to be conducted to provide concrete validation for its application in tennis (Coutts et al., 2010).

1.3 Burnout

1.3.1 Definition

Athlete burnout, is defined as a psychophysiological response, which involves the physical, psychological and behavioral components, to exhaustion, due to excessive training and competition, often manifested in features of emotional and physical exhaustion (EPE), sport devaluation (SD), and a reduced sense of accomplishments (RSA) (Andrade et al., 2019; Mouelhi-Guizani et al., 2021). EPE arises as the sensation of mental and physical fatigue emerges, given the excessive demands for accomplishments in sports training and tournaments. As negative feelings towards a sport grows, leading to an eventual loss of interest in the sport, alongside an impulse of abandoning the sport, SD has developed. RSA happens when the athlete becomes increasingly dissatisfied with his or her performance, and when these three features of

EPE, SD and RSA are present, it may cause deteriorating athletic performance (Andrade et al., 2019; Mouelhi-Guizani et al., 2021).

1.3.2 Risk factors

The occurrence of burnout in young athletes are often influenced by their environmental factors such as exceedingly high training volumes and demands, and personal characteristics including a perfectionism personality and low self-esteem (Andrade et al., 2019; Mouelhi-Guizani et al., 2021; DiFiori et al., 2014). Poor performance such as sequential defeats in tournaments, is one of the main predisposing factors of a burnout occurrence in young tennis athletes, as this exaggerates the athlete's RSA (Andrade et al., 2019). It is also found that young tennis athletes who have managed to accomplish their goals at an early stage of their athletic career, are more likely to develop burnout in future, due to the exceedingly high expectations and demands for good performance and results by the young tennis athlete's coaches, family, friends and even the society, since young, which negatively affects the athletes (Andrade et al., 2019). Other risk factors for burnout in young tennis athletes are the duration of competitive play, and the training load of the athletes, involving the days of training per week, number of training sessions per day. number of training hours per session and the aggregated weekly training hours and intensity (Andrade et al., 2019).

1.3.3 Sports Specialization

Athletes have undergone sports specialization if they are involved in at least eight months of training each year, focusing only on one sport, with the neglect of all other sports (Myer et al., 2015). There are two sports specialization models, early and late, whereby both involve the introduction of tennis sports to athletes at a young age. However, it is found that the tennis athletes who had early specialization are at higher risk of burnout, overuse injury, dropout and earlier retirement from sports (Myer et al., 2015). The table below highlights the differences between an early and late specialization model.

Table 4: Early and late sports specialization (Myer et al., 2015).

Early specialization model	Differences	Late specialization model
Early: Focuses only on tennis since young	Specialization	Late: Still joins a variety of sports during younger days
Exposed to high training load since young (middle adolescent phase)	Increasing training intensity and volume since	Exposed to high training load at the later phase of life (adolescence to adult phase)
Higher risk of burnout, dropout, overuse injuries, fear of reinjuries	Impact on athlete	

RESULTS

A total of 5 articles were reviewed to establish the association between training load and burnout occurrence in young tennis athletes. Upon comparing the outcomes of these articles, studies by Mouelhi-Guizani et al. (2022) and Andrade et al. (2019) have found a significant correlation between increased training volume for at least 10 to 12 training hours per week and the occurrence of burnout in young tennis athletes. However, another study by Casagrande et al. (2014), have found that burnout incidence was higher in athletes with lower training volume (10 training hours per week or lesser), compared to those with higher training volume (11 to 20 training hours per week), which is contradicting to the findings in the first two articles. Another study by Casagrande et al. (2018), found that there were no significant correlations between burnout scores of the Athlete Burnout Questionnaire (ABQ) and training load, supported by Prins' (2011) study. The table below shows the results yielded from the reviewed articles.

Table 5: Results extracted from the reviewed articles to demonstrate the effects of training load or volume on burnout occurrence in young tennis athletes.

Study Title	Author(s) / Year	Burnout measure	Results
Effect of practice hours on elite junior tennis players' burnout: Gender differences	Mouelhi-Guizani et al. (2022)	Athletic Burnout Questionnaire (ABQ)	Tennis players training **more than 12 hours per week (high volume)** has significantly higher scores of the burnout dimensions (EPE, SD, RSA) and the general burnout than the other two groups (moderate and low volume) training less than 12 hours per week. **Females** had higher scores on burnout dimensions and general burnout than males.
Burnout in elite junior tennis players: a multiple case study	Andrade et al. (2019)	Athletic Burnout Questionnaire (ABQ)	Of the 130 participants, 10% had moderate, 3.1% had high risk of burnout and 2.3% showed signs of burnout. Of the 7 players who had high risk of burnout or signs of burnout, 2 players trained **more than 30 hours per week** and the others trained **at least 10 hours per week**.
Burnout in elite tennis players of different junior categories	Casagrande et al. (2018)	Athletic Burnout Questionnaire (ABQ)	Tennis players from **category (CAT) 18** had **higher** scores for Burnout in the three dimensions (EPE, SD, RSA) and global burnout score than CAT 16 and CAT 14. Each category differs in **training load**, competition levels, involvement, and goals. However, there was **no difference between the three categories** regarding training characteristics (initiation and competition) and **weekly training load.**
Burnout in Brazilian junior tennis players	Casagrande et al. (2014)	Athletic Burnout Questionnaire (ABQ)	Young athletes with **lower training volum**e **(10 hours or less per week**) had **higher rates of burnout**, **SD** and **RSA** than those with higher volumes (11 to 20 hours per week)
Indicators of Fatigue in Collegiate Women Tennis Players	Prins (2011)	Athletic Burnout Questionnaire (ABQ)	There were **no significant correlations** between Global Burnout Index (GBI) and training load. **Significant increase** in **GBI score from before training (T1) to 10th week of training (T6)**, indicating psychological deterioration throughout the **fall tennis season**. **Significant increase** in **GBI score from T1 to 2nd week of training (T2),** GBI at T2 was the **highest.**

DISCUSSION

This narrative review aims to determine the relationship between training load and burnout occurrence in young tennis athletes. However, there was limited evidence available for review, and results yielded from these articles were inconclusive given the inconsistency of the results of each study. Studies by Mouelhi-

Guizani et al. (2021) and Andrade et al. (2019) have shown similar results where training hours of at least 10 hours each week is associated with a higher risk of burnout, and this correlation is thought to be due to the role of training and competition requirements as stressors to athletes, where it brings EPE and RSA to athletes. Nonetheless, both studies by Casagrande et al. (2014; 2018) yielded contradictory results, where one of them found that tennis athletes with lower training volumes of 10 hours or less per week, had higher rates of burnout than those training up to 20 hours per week, whilst the other yielded no significant correlation between training load and burnout occurrence, which is consistent with the findings of the study by Prins (2011), which shows no significant relationship between training load and burnout occurrence as well. The last three studies found that the burnout occurrence in tennis athletes were influenced more by the athletes' tournament demands, climate changes including increasing heat and humidity, as well as the increased commitments faced by athletes as the transition from a junior athlete into an adult athlete (Casagrande et al., 2014; Casagrande et al., 2018; Prins, 2011). Furthermore, it is also difficult to ascertain the results validity of these studies given the disparity of training parameters measured in each of these studies, where some measured training volumes while others measured training load. Besides, measuring training volume instead of training load is not an accurate measure as the training volume does not account for the training intensity of the session. For instance, in athletes practising the same sports, although one athlete trains longer than the other each week, both athletes developed burnout, but it is unsafe to conclude that training hours exceeding the shorter duration is sufficient to predispose one to burnout because their training intensity may be different. Hence, training load is the best measure to determine the training effects on athletic burnouts.

All of the reviewed articles have utilized the ABQ as their burnout measure in young tennis athletes. It is a 15-item, self-reported questionnaire, which covers the three features of burnout, including the EPE, SD and RSA, developed to overcome the shortcomings of another burnout measure, the Eades Burnout Inventory (EABI) (Gerber et al., 2018). Nevertheless, the ABQ has its setbacks, where there is still no reliable score system established to categorized athletes based on the severity of their burnout features (Gerber et al., 2018). With several studies suggesting the validity and reliability of this tool, it is now the most popular form of burnout measures in athletes, where it has been translated to multiple languages including Chinese, Spanish and Portuguese, to be used in other countries (Gerber et al., 2018).

		MOI	Almost Never	Rarely	Sometimes	Frequently	Almost Always
1	I am accomplishing many worthwhile things in my sport	RA	1	2	3	4	5
2	I feel so tired from my training that I have trouble finding energy to do other things	E	1	2	3	4	5
3	The effort I spend in my sport would be better spent doing other things	SD	1	2	3	4	5
4	I am not achieving much in my sport	RA	1	2	3	4	5
5	I feel overly tired from my sport participation	E	1	2	3	4	5
6	I don't care about my sport performance as much as I used to	SD	1	2	3	4	5
7	I am not performing up to my ability in my sport	RA	1	2	3	4	5
8	I feel "wiped out" from my sport	E	1	2	3	4	5
9	I am not into my sport like I used to be	SD	1	2	3	4	5
10	I feel physically worn out from my sport	E	1	2	3	4	5
11	I feel less concerned about being successful in my sport than I used to	SD	1	2	3	4	5
12	I am exhausted by the mental and physical demands on my sport	E	1	2	3	4	5
13	It seems that no matter what I do, I don't perform as well as I should	RA	1	2	3	4	5
14	I feel successful at my sport	RA	1	2	3	4	5
15	I have negative feelings toward my sport	SD	1	2	3	4	5

Note: Items 1 and 14 are reverse scored, MOI = measure of interest, RA = reduced accomplishment, SD = sport devaluation, E = exhaustion

Figure 10: 15 items of the self-reported Athlete Burnout Questionnaire (Nick et al., 2022).

CONCLUSION

Overtraining and burnout in tennis players cause detrimental effects to their athletic career, such as increased dropout rates, fatigue, and decreased performance. From the research findings, it shows the importance of monitoring for risk factors and features of burnout in young tennis athletes to prevent further deterioration of athletes' condition. The consequences of not understanding the early specialization model in tennis and poorly designed periodization training with neglect in the recovery phase resulted in a higher risk of overtraining and burnout, overuse injuries, and earlier retirement from the sport. Interviews with Malaysian tennis coaches reveal that the primary issue in tennis sport development in Malaysia is early specialization in the sport, driven by parents who expect immediate success, which is unrealistic. Introducing children to tennis at age four with proper fundamentals of movement is crucial, but parents often misinterpret initial struggles of serving balls as a lack of learning. Additionally, many former state and national players become coaches without proper education, ignoring the necessity of ITF certification and supervision, often leading to athlete burnout and dropout. With only eight coaches who truly understand ITF guidelines in Malaysia and developmental officers limited in their reach of educating tennis coaches, the shortage of well-educated coaches in Malaysia hampers the sport's growth. Further exploration of potential interventions or preventive strategies could enhance the practical implications of the study, and benefit the athletes.

SUGGESTION

Given the limited number of literatures available for review, and the non-conclusive results from the reviewed articles on the correlation between training load or training hours and burnout in tennis, the presence of information gap clearly highlights the need for further researches in this topic given the negative consequences of overtraining and burnout in young tennis athletes. Future research should include training load, quantified using the session-RPE method, instead of training volume, as the independent variable, and burnout assessment using the ABQ, as the dependent variable, to establish the recommended training load to avoid burnout occurrence in young tennis players.

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CONFLICT OF INTEREST

There is no conflict of interest among the authors of this article.

AUTHORS CONTRIBUTIONS

Dr Wong Carmen prepared the literature review and wrote the research methodology. She also did the data entries and conducted the write-up of the article. Dr. Rosdara Masayuni and Mr. Luqman Nul Hakeem supervised the writeup of the article and gave input on the relevant background information about tennis tournaments and training in young tennis athletes in Malaysia, besides advising on the interpretation of results. Dr Sor contributed to the literature review and scoping of relevant articles to be included in this narrative review.

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