CHAPTER II

REVIEW OF RELATED LITERATURE

The review of related literature presented in this chapter aims to provide a clear understanding of the research problem and to facilitate the interpretation of the findings of the study. The literature for the present investigation was collected from the libraries of Bharathidasan University, Annamalai University, Annamalai Nagar, Alagappa University, Karaikudi, Dr. Sivanthi Aditanar College of Physical Education, Tiruchendur, and Bharathiar University, Coimbatore. In addition, relevant literature was gathered from the National Informatics Centre, New Delhi, the University of Birmingham, the Sports Documentation Centre, England, microform publications of the University of Oregon, United States of America, and various internet sources.

The review of related literature plays a vital role in gaining a comprehensive understanding of the problem, identifying research gaps, and providing a scientific basis for the present investigation. In this chapter, an attempt has been made to review studies related to the effects of high-intensity interval training, aerobic training, and concurrent training on selected physical, physiological, and skill performance variables among football players**.**

STUDIES ON HIGH-INTENSITY INTERVAL TRAINING

Koç et al. (2024) examined the effects of a structured high-intensity interval training program on selected physical and physiological variables among youth football players. The study reported significant improvements in speed, agility, cardiovascular endurance, and VO_2 max following six weeks of HIIT compared to traditional endurance training. Resting heart rate also showed a significant reduction, indicating enhanced cardiovascular efficiency. The findings confirmed that HIIT is an effective conditioning method for improving football-specific physical performance

Karim Zouhal et al. (2024) conducted a study to determine the effect of high-intensity interval training on aerobic capacity and performance-related variables among football players. The subjects were trained football players and were assigned into

experimental and control groups. The experimental group participated in a structured high-intensity interval training programme, while the control group followed their regular routine training. The training programme was carried out for a specific duration with regular sessions per week. Before and after the training period, the subjects were assessed for VO_2 max, speed, and agility. The findings revealed that the experimental group showed significant improvement in aerobic capacity, speed, and agility compared to the control group. The study concluded that high-intensity interval training significantly enhances aerobic fitness and performance variables among football players.

Fang et al., (2021) studied the effects of moderate-to-moderate-intensity continuous training and cycle-based high-intensity interval training on adolescent football players. 56 teenage soccer players who were split into HIIT and MICT groups were among the participants. The Wingate anaerobic power test, isokinetic knee strength test, graded exercise test for peak oxygen absorption (VO2 peak), and body composition analysis were all carried out. The VO2 peak was improved in both the HIIT and MICT groups, although the HIIT group's anaerobic threshold and heart rate recovery improved more than the other groups. Wingate anaerobic peak power improved only in set 1 in the MICT group, whereas it had increased considerably in sets 1, 2, and 3 in the HIIT group. In both the MICT group at 240°/s and the HIIT group at 60°/s, there was a substantial improvement in the isokinetic strength. It was determined that teenage football players' cardiorespiratory fitness was successfully increased in both the HIIT and MICT groups by short-term HIIT. While MICT significantly enhanced muscular endurance, HIIT raised anaerobic threshold and power. One training method that might be thought of as time-efficient is short-term, intense training.

Borrega et al., (2021) studied the impact of two intervention programmes on stress, anxiety, depression, and resilience during the corona virus disease-caused confinement: (1) high-intensity interval training (HIIT) and (2) moderate-intensity training (MIT). HIIT and MIT groups comprised 67 people who were randomly allocated to participate. While the HIIT group was required to do a home-based intervention focused on HIIT exercises, the MIT group was required to complete an aerobic-based intervention. In healthy people, depression, anxiety, stress, and resilience were measured

both before and after the 2019 COVID-19 intervention. The outcomes demonstrated that HIIT and MIT considerably enhanced resilience and decreased stress, anxiety, and depression ($p < 0.05$). Additionally, the HIIT group's gains in depression appear to be larger than the MIT group's ($p < 0.05$). Conclusion: During the COVID-19confinement, HIIT and MIT were shown to promote resilience and decrease anxiety, tension, and sadness. Furthermore, it appeared that the HIIT intervention was more effective than the MIT intervention at lowering depression.

Mila et al., (2021) studied the effects of high-intensity interval training combined with handball training (HIIT group) vs small-sided handball games (SSG group) on the physical performance of young female handball players during the pre- competitive era. 24 young female handball players who compete in the national league and have 6.17 ± 1.54 years of training experience were involved in this study. body mass 61.27 ± 3.68 kg, body height 1.64 ± 4.7 m, body mass index 22.7 kg/m2) and body mass index 16.20±1.28 years for the SSGgroup (n=12;age16.06±0.80years) and body mass 62.46±7.86kg, body height 1.68±6.8m, bodymassindex22kg/m2). For eight weeks, both groups followed twice-weekly exercise regimens. Physical performances, including tossing medicine balls, squat jumps, counter movement jumps (CMJ), sprints on 0–10 m, sprints on 0–20 m, and sprints on 0–30 m, were evaluated both before and after the training programmes. After eight weeks, the CMJ, SJ, 0–20 m sprint, 0–30 m sprint, medicine ball throwing, and Yo-YoIRT1 substantially improved in the SSG and HIIT groups ($p<0.05$). HIIT group obtained a substantially higher improvement in Yo Yo IRT1(m) at 28.40% compared to17.63% in SSG group. According to these findings, young female handball players in the pre-competitive phase showed comparable improvements in their physical performances (sprint, leap, and upper explosive strength) across the SSG and HIIT groups.

Selmietal.,(2021) studied that‘s mall-sided games have been found to be more entertaining than high-intensity interval training with comparable workout intensities for football introduction. Small-sided games(SSG) and high-intensity interval training (HIIT) have be ensued and tested with athletes to improve their football performance. Because of this, the purpose of this experimental study was to assess how SSGs and HIIT affected reported enjoyment, power, and physiological reactions. Materials and Procedures One session of HIIT and SSG was performed by sixteen young football

players (mean standard deviation: 17.50.6 years; height: 178.26.4 cm; body mass: 70.45.4 kg; body fat: 10.60.8%) on different days, with a week elapsed between each session. A quarter of an hour was spent working during each session, followed by three minutes of passive recuperation. SSGs were played on a 25 x 35 m pitch between four players, and HIIT was made up of sporadic 15-second sprints at 110% maximum aerobic speed interspersed with 15seconds of passive recovery. The Physical Activity Enjoyment Scale (PACES) was utilised to evaluate the psychological reactions subsequent to each programme. Heart rate (HR) was monitored constantly, and following each training session, measurements of lactate concentration [La] and ratings of perceived effort (RPE) were made. Before and after each training session, lower body muscular power was measured using the 5-jump test relative to leg length (5JT-relative), where a larger average distance per stride over five consecutive jumping steps indicated stronger muscular power. As a result, responses from HR, RPE, and [La] did not significantly differ between HIIT and SSG ($p=0.70$, ES=0.11; $p=0.61$, ES=0.08 and $p=0.38$, ES=0.21, each). In all cases, 5JT-relative dramatically dropped ($p<0.05$, ES=0.50 for SSG and $p<0.05$, ES=0.40 for HIIT). In comparison to HIIT, SSG had a higher PACES score (ES=5.35, $p<0.001$). The researchers came to the conclusion that while HIIT and SSG sessions had comparable physiological effects, SSGs produced greater levels of satisfaction. Based on the goal of the training session and the benefits of SSG connected to pleasure, coaches might use any of these training methods.

Tian et al. (2021) investigated the impact of High-Intensity Interval Exercise (HIIE) and Moderate-Intensity Continuous Exercise (MICE) on cognitive flexibility in young adults. The study involved one-minute treadmill runs targeting 90% heart rate reserve (HRR) interspersed with self-paced walking at 50% HRR for the HIIE session (n=56). For the MICE session, participants completed 20-minute treadmill runs at an intensity targeting 40-59% HRR. A control session involved 24 minutes of rest. These sessions were performed on different days in a counterbalanced order. Cognitive flexibility was assessed at three points: before the intervention (t0), immediately after the session (t1), and 30 minutes post-session (t2), using a more-or-less shifting task. The results showed that the switching cost of reaction time (RT) after HIIE was significantly lower than before the session, suggesting positive effects on cognitive flexibility. These effects were still evident 30 minutes after the session. In contrast, improvements in

cognitive flexibility after MICE were not observed until 30 minutes post-exercise. These findings suggest that a quick and efficient way to enhance cognitive flexibility could be through High-Intensity Interval Exercise (HIIE).

Segovia (2020) investigated the impact of a game-based High-Intensity Interval Training (GB-HIIT) curriculum on the body composition of schoolchildren, with a secondary goal of comparing its effectiveness using the Sport Education model versus conventional methodology (TM). The study employed a pre-post quasi-experimental design and involved 154 primary school pupils in grades 5 and 6 (ages 9–13, M=10.66±0.82). The program consisted of 15 sessions, and body fat percentage and waist circumference were measured using bioelectrical impedance. The results showed a significant reduction in body fat percentage and waist circumference in the experimental group compared to the control group ($p < 0.001$). In conclusion, the GB-HIIT curriculum was effective in improving schoolchildren's body composition.

Miguet et al. (2020) explored the effects of High-Intensity Interval Training (HIIT) compared to Moderate-Intensity Continuous Training (MICT) on eating behaviors and body composition in obese adolescents. Over a 16-week period, 43 participants were randomly assigned to either HIIT or MICT. The study found that both groups showed significant reductions in weight, BMI, and body fat percentage (FM%), with the HIIT group showing more significant improvements in body composition. Both groups also experienced increases in 24-hour calorie consumption, but HIIT had a greater effect on fat mass reduction than MICT. Additionally, adolescents with higher baseline cognitive restraints consumed more calories, and those who restricted their eating lost less weight than unconstrained eaters.

Mekari et al. (2020) examined how HIIT, resistance training (RT), and MICT affected executive function in older adults. Ninety-nine participants, aged 68 ± 7 years, completed six weeks of exercise, with HIIT consisting of two 20-minute bouts alternating 15-second intervals of 100% peak power output (PPO) and passive recovery. All groups showed increased cardiorespiratory fitness, but only the HIIT group demonstrated improved executive function, particularly faster reaction times in cognitive flexibility tasks. The findings suggest that HIIT could be particularly beneficial for preventing cognitive decline in older adults.

Lee et al. (2020) assessed the impact of a 12-week HIIT program on glycemic management in overweight or obese individuals with type 1 diabetes. Thirty sedentary participants were randomized to either a usual care control group or the HIIT intervention, which consisted of three weekly 4-minute HIIT sessions. After 12 weeks, the HIIT group showed a significant decrease in HbA1c levels (from 8.63% to 8.10%). However, no statistically significant differences were observed between the two groups regarding other health outcomes, such as insulin dosage or body composition. Notably, participants who completed at least 50% of the HIIT sessions experienced a greater reduction in HbA1c, highlighting the importance of adherence to the exercise regimen.

Da Silva et al. (2020) investigated the effects of high-intensity interval training (HIIT) on endothelial function, lipid profile, body composition, and physical fitness in normal weight and overweight or obese teenagers. Over a 12-week period, 38 physically inactive adolescents (aged 14–17) participated in HIIT combined with sports activities, with assessments before and after the intervention. The results showed that both groups improved physical fitness, including cardiorespiratory endurance, explosive strength, and flexibility. While the overweight group did not see significant changes in body composition, waist and abdominal circumferences decreased. Endothelial function improved in both groups, with significant increases in flow-mediated dilation (FMD). The study concluded that HIIT can enhance physical fitness and endothelial function, potentially reducing the risk of early atherosclerosis in teenagers.

Mondal et al. (2020) investigated the effect of High-Intensity Interval Training (HIIT) and Speed Endurance Training (SET) on the aerobic capacity of football players. Seventy-five male district-level football players, aged 18 to 25, from Birbhum, West Bengal, were randomly selected and divided into three groups: SET (n=25), HIIT (n=25), and an active control group (AC, n=25). Pre-test data on aerobic capacity was collected before the experiment began. Over the course of eight weeks, the HIIT and SET groups underwent their respective training routines three times per week. The data was analyzed using descriptive statistics, ANCOVA, and the LSD post-hoc test to determine the impact of the two training regimens. The results indicated that both HIIT and SET significantly improved the aerobic capacity of football players.

Leahy et al. (2020) conducted a systematic review to assess the impact of High-Intensity Interval Training (HIIT) on the mental health and cognitive performance ofchildren and adolescents (ages 5-18). The review included studies that incorporated an HIIT program and measured outcomes related to cognitive function or mental health. Acute and chronic studies were analyzed separately, and potential variables like study duration, bias risk, participant age, cognitive demand, and population were considered. The review found that HIIT had little to moderate impact on executive function in acute studies, but chronic studies revealed small yet substantial improvements in executive function. Overall, the review concluded that HIIT can have positive effects on both mental and cognitive health in children and adolescents.

Cao et al., (2019) studied a meta-analysis comparing the impact of MICT and HIIT on childhood and teenage CRF. MEDLINE, PubMed, Web of Science, and Google Scholar were among the many resources used to find pertinent publications before choosing the research. From 17 investigations, a total of 563 participants (18 effects) were found. His combined effect size between HIIT and MICT was 0.51 (95% CI = 0.33–0.69). Furthermore, there was no discernible change in the impact of HIIT on CRF with respect to intervention duration, exercise mode, work-and-rest ratio, or total bouts. It is determined that HIIT improves children's and teenagers' cardiorespiratory fitness more than endurance training does.

Schneider et al., (2019) studied heart rate (HR) and vagal heart rate variability (HRV) to assess the impact of strength training (ST) and high-intensity interval training (HIIT) overload on cardiac autonomic regulation. Thirty-seven skilled athletes were chosen for the research. The results showed that the standing recordings stayed the same after ST overload; however, there were noticeable increases and decreases in supine HR and vagal HRV (Ln RMSSD), respectively (minor effects). On the other hand, HIIT overload in the standing position led to a minor impact of increased Ln RMSSD and reduced HR, whereas supine recordings did not change. These reactions were reversed (ST: minor effects, HIIT: negligible to small effects) throughout the recuperation phase. The findings indicated that various autonomic responses after ST or HIIT that would not be identified by supine or standing measurements alone could be revealed by HR and Ln RMSSD values taken during an orthostatic test. Nevertheless, there was an inconsistent

correlation between these autonomic alterations and transient performance fluctuations, and the use of rolling averages might modify these associations in distinct ways for both groups and individuals.

Eather et al., (2019) studied to evaluate the viability and initial efficacy of an eight-week Uni-HIIT (high-intensity interval training) program for adolescent and young adult university students. The research was conducted from February to June 2017 at the University of Newcastle in Australia, using a randomized controlled trial methodology. 53 college students, ages 18 to 25, were split into two groups at random: the Uni-HIIT program (n = 26) and the wait-list control group (n = 27). The Uni-HIIT program required participants to attend up to three HIIT sessions per week for eight weeks. These sessions included a variety of aerobic and muscular fitness activities that lasted eight to twelve minutes and alternated between thirty seconds of effort and thirty seconds of rest. Cardiorespiratory fitness was the main end measure, with executive function, body composition, anxiety levels, and perceived stress being the secondary outcomes. Muscular fitness was also measured. The Uni-HIIT group's results demonstrated a considerable improvement in both muscular and cardiorespiratory fitness, with a moderate effect on executive function. On the other hand, no discernible intervention effects were seen in standing jump, anxiety, body composition, or perceived stress. The study found that high participant satisfaction, pleasure, and perceived value demonstrated that the Uni-HIIT program was both practical and successful.

Sultana et al., (2019) studied to see how low-volume, high-intensity interval training (HIIT) affected persons with normal weight, overweight, and obesity's body composition and cardiorespiratory fitness. Following a thorough search, 47 studies were found and included. When comparing low-volume HIIT to a non-exercising control or moderate-intensity continuous training (MICT), the results showed that these interventions had no discernible effects on lean body mass, body fat percentage, or total body fat mass. Comparing low-volume HIIT to MICT and then the non-exercising control, cardiorespiratory fitness was, however, considerably improved. These findings suggest that low-volume HIIT is a time-efficient method for improving fitness levels in people of all weight categories, even though it may not be useful for modifying body composition.

Delgado-Floody et al. (2019) studied whether high-intensity interval training (HIIT) programmes might be used in physical education (PE) classrooms to improve overweight students' body composition and cardiorespiratory fitness. Six research studies involving children under the age of 12 and teenagers between the ages of 12 and 18 that were carried out between 2012 and 2017 were examined. The HIIT protocols included two to three sessions per week, with 15-second intervals and either passive or active 15-second pauses, for a maximum work/rest ratio of 6 minutes. The HIIT programmes spanned anywhere from six to twenty-four weeks. Body composition, BMI, body fat percentage, waist circumference, sum of skinfolds, and muscle mass all showed notable changes. Furthermore, improvements in maximum oxygen uptake, the Yo-Yo intermittent test performance, and maximal aerobic speed were observed with HIIT sessions. According to the research, HIIT programmes may be successfully added to physical education courses as a way to combat the rising problem of young obesity. HIIT can be included into a class or into particular times during the school day in addition to already-existing PE activities.

Menz et al. (2019) studied how well running-based high-intensity interval training (HIIT) and functional exercises may increase muscle endurance and maximal oxygen absorption (VO2max). The running HIIT group (HIIT-R) or the functional HIIT group (HIIT-F) was randomly allocated to a total of 15 healthy individuals, with an average age of 25.6 years, consisting of 11 females and 4 males. During 14 exercise sessions spread over 4 weeks, both groups performed 3–4 sets of low-volume high-intensity interval training (HIIT), with 8 repetitions of 20 seconds of activity followed by 10 seconds of rest, and a 5-minute break in between sets. Heart rate (HR) measurements were taken during the training sessions. The two groups' mean and peak HR during training sessions differed considerably, with the HIIT-F group exhibiting lower HR responses than the HIIT-R group. In spite of these variations in heart rate, both groups showed comparable increases in VO2max (about 13% for HIIT-R and 11% for HIIT-F) without a statistically significant difference. Furthermore, irrespective of the training technique, both groups had noteworthy gains in muscular endurance as demonstrated by improved performance in burpees and toes to bar activities. These results imply that, despite the potential for a reduced cardiovascular strain with the functional protocol, both traditional running HIIT and functional HIIT are equally effective in increasing VO2max and muscle endurance.

Tottori et al. (2019) studied to find out how a high-intensity interval training (HIIT) programme affected children's executive function and physical fitness. 56 kids, ranging in age from 8 to 12, took part in the study and were split into two groups: the HIIT group and the control group. For a period of four weeks, the HIIT group participated in three sessions per week of an 8–10 minute HIIT programme. Tests including the 20-meter shuttle run, sit-ups, and standing long leaps were used to gauge physical fitness both before and after the intervention. The Tower of Hanoi test, the Digit Span Forward (DSF) test, and the Digit Span Backward (DSB) test were used to assess executive function. Only the HIIT group exhibited statistically significant gains in the sit-ups ($p < 0.001$) and the 20-meter shuttle run ($p = 0.042$). Additionally, the DSB test showed a substantial increase in correct responses ($p = 0.003$) for the HIIT group, suggesting better working memory. Nevertheless, after the intervention, there were no discernible improvements in performance on the Tower of Hanoi test, the DSF test, or the standing long jump. These results imply that HIIT improves children's basic executive skills, including working memory, in addition to improving physical fitness components like muscular and cardiorespiratory endurance.

Amirsasan et al. (2019) examined how eight weeks of high-intensity intermittent training (HIIT) affected the expression of miRNA-21 and miRNA-1 in teenage males who were sedentary. Twenty-two teenage boys participated in this experimental investigation. They were divided into two equal groups, one for HIIT and the other for control. For eight weeks, three to four training sessions were held each week. A rest period of 3.5–4 minutes followed each of the 6–8 running sprints (30–60 seconds) in the HIIT programme. 18–24 hours before and after the intervention, evaluations of the mentioned markers were carried out. The results showed that, following an 8-week HIIT, the levels of miRNA-1 were considerably greater than those obtained before exercise training (pre-HIIT vs. post-HIIT) ($P<0.05$). On the other hand, miRNA-21 considerably decreased ($P<0.05$) during the training phase. It was determined that an indication to evaluate the adaptations related to exercise training can be found in miRNA-1 and miRNA-21.

Kilit et al. (2019) compared high-intensity interval training (HIIT) and on-court tennis training (OTT) for juvenile tennis players. The study involved 19 male players (aged 13.8 ± 0.4 years), split into two groups: HIIT and OTT. After six weeks of training,

both groups showed improvements in sprinting and leaping abilities. However, the OTT group outperformed the HIIT group in technical skills and agility tests, while the HIIT group performed better in 400-meter running time. The findings suggest that while HIIT is beneficial for speed-based conditioning, OTT may be more effective for improving agility and technical skills in young tennis players.

Cao et al. (2019) conducted a meta-analysis to examine the effects of HIIT and moderate-intensity continuous training (MICT) on cardiorespiratory fitness (CRF) in children and adolescents. The analysis included 563 participants from 17 trials and revealed that HIIT improves CRF more than MICT, with an effect size of 0.51. The findings indicated that HIIT is an effective training method for enhancing CRF in youth, regardless of the intervention's length or the activity-rest ratio.

Schneider et al. (2019) studied heart rate (HR) and vagal heart rate variability (HRV) to assess the impact of strength training (ST) and HIIT overload on cardiac autonomic regulation. Thirty-seven skilled athletes participated in the study, which showed that HIIT overload led to increased vagal HRV (Ln RMSSD) and reduced HR in the standing position, while ST had only minor effects. These results suggest that HIIT may induce more significant autonomic changes than ST, especially in the standing position.

Eather et al. (2019) evaluated the efficacy of an eight-week Uni-HIIT program for university students. The program consisted of aerobic and muscular fitness activities performed three times a week, with assessments of cardiorespiratory fitness, body composition, executive function, anxiety, and stress. The results showed significant improvements in both muscular and cardiorespiratory fitness, as well as a moderate effect on executive function. However, there were no significant changes in body composition, anxiety, or stress levels. The study concluded that Uni-HIIT was practical and effective for improving physical fitness in university students.

Delgado-Floody et al. (2019) examined the use of HIIT in physical education (PE) classrooms for improving body composition and cardiorespiratory fitness in overweight students. Six studies involving children and adolescents showed notable improvements in body composition, BMI, fat percentage, and muscle mass. Additionally, improvements in

maximum oxygen uptake and Yo-Yo intermittent test performance were observed. The study suggested that HIIT could be effectively integrated into PE classes to address youth obesity.

Menz et al. (2019) investigated the effects of HIIT combining functional activities and standard running HIIT on maximal oxygen uptake (VO2 max) and muscle endurance. Fifteen healthy participants were divided into two groups: running HIIT (HIIT-R) and functional HIIT (HIIT-F). Both groups showed similar improvements in VO2 max and muscle endurance, although the HIIT-R group had higher heart rate responses. The study concluded that both forms of HIIT are equally effective in improving VO2 max and muscle endurance, though the functional HIIT group experienced lower cardiovascular strain.

Jiménez-García et al., (2019) studied to see how older people‘s muscular strength, body composition, gait speed, and quality of life were affected by a 12-week high-intensity interval exercise (HIIT) training program that included suspension exercises (TRX). Three groups of randomly selected older persons were formed: a control group (CG, n=27), a continuous intensity training group (MIIT group, n=27), or an HIIT group (n = 28). Participants in the HIIT group had substantial post-intervention improvements in BMI ($p = .002$ and $p < .001$, respectively) and gait speed ($p < .001$ for both) when compared to MIIT and CG. An increase in handgrip strength was also noted following HIIT ($p = .002$), but no changes were noted following MIIT or CG. In the SF-36 areas of overall health ($p < .001$ for both), health changes ($p < .001$ for both), vitality ($p = .002$ and $p = .001$, respectively), and physical functioning ($p = .036$ and $p < .001$, respectively), HIIT showed improvements when compared to the MIIT and control groups. According to our findings, older individuals' BMI, handgrip strength, gait speed, and quality of life may all improve from an HIIT training program that incorporates TRX.

Viaño-Santasmarinas et al., (2018) studied how handball players' physical performance was affected by high-intensity interval training with various interval lengths. In the 30-to-15-minute Intermittent Fitness Test (VIFT) for handball players, the effects of two high-intensity interval training (HIIT) regimens with varying interval durations (short [SI] vs. long [LI]) were to be compared. 18 experienced athletes (age: 22.7 ± 3.9 years;

height: 181.5 ± 6.6 cm; body mass: 84.7 ± 14.1 kg) were divided into two groups at random: SI (2 sets of 22 intervals of 10-second runs at 95% VIFT) and LI (5 sets of 3-minute intervals at 85% VIFT). The 6-week intervention program had to be completed twice a week. The 10-m sprint, countermovement leap, repeating sprintability (RSA), and 30-to-15-IFT were measured both before and after the training session. Significant increases in VIFT were seen in SI (8.18%) and LI (8.19%) from the pretest to the posttest, according to the within-group analysis. The RSA average time (effect size [ES] = 0.72 and 0.38, respectively), total time (ES = 0.72 and 0.38, respectively), and percentage of decrement (ES = 1.08 and 0.77, respectively) of players in both SI and LI also showed noteworthy improvements. The percentage changes in the percentage of RSA decrement exhibited a strong connection (r = 0.857) with the % changes in VIFT for both groups combined. No changes were seen in any of the between-groups variables between the training groups (SI and LI) ($p > 0.05$). These findings suggest that both HIIT procedures are useful for handball players' preseason fitness improvement. However, because of its increased specificity, SI ought to be regarded as the recommended HIIT strategy.

Mariappan et al., (2018) studied the impact of rigorous interval training on the resting heart rate and duration of breath held by Kabaddi players. In order to accomplish the goal, 24 Kabaddi players, ages 18 to 24, were chosen from the Thoothukudi District Kabaddi players. The experimental and control groups, each consisting of 12 people, were randomly selected from among the subjects. The experimental group participated in a six-week rigorous interval training plan on three different days each week. The dependent variables chosen were the resting heart rate and the duration of the breath hold. The experimental design employed pre- and post-tests with randomized control groups. Analysis of covariance (ANCOVA) and the dependent t-test were used to examine the participants' obtained data.

Anne et al., (2018) studied how top junior basketball players' peripheral muscle oxygenation alterations and their ability to perform in repetitive and aerobic sprints were affected by small-sided games and high-intensity interval training. The current study compared the effects of six weeks of high-intensity interval training (HIIT) and small-sided games (SSG) on muscle oxygenation during a repeated sprint (RS) sequence and aerobic fitness in elite male junior basketball players. Pre- and post-tests were

administered to twenty volunteers (14.3 ± 0.5 years; 176.8 ± 12.5 cm; 74.5 ± 9.8 kg) who had either six weeks of SSG or HIIT training in between. The testing sessions included two 15-second bursts of the RS sequence and the 30-to-15 intermittent fitness test. Using near-infrared spectroscopy, muscle oxygenation parameters (tissue saturation index [TSI,%], post-sprint muscle reoxygenation rate) were assessed during RS. According to the findings, both training methods enhanced both RS ability (with a decreased percentage decline of 62.5 and 21.6%, respectively, for HIIT and SSG, $P < 0.05$) and maximal aerobic speed (VIFT, 3.4 and 4.1%, respectively, for HIIT and SSG, $P < 0.05$). A higher ΔTSI during the second sprint (47.8–114%, $P < 0.05$) and notable increases in post-sprint reoxygenation after sprints (+23.0 to +107.7%) were also outcomes of both training sessions. Lastly, improvements in anaerobic (Δ% Dec during RS, $r = -0.487$, $P = 0.028$) and aerobic (ΔVIFT, $r = 0.61$, $P = 0.008$) performances were strongly correlated with variations in muscle reoxygenation following sprint 1. According to the current study, both SSG and HIIT improved anaerobic and aerobic variables and improved the ability of the muscles to oxygenate with repetitive strain. It is important for coaches to know that both types of training can help junior basketball players increase their anaerobic and aerobic fitness levels over the course of the season.

Hannah et al., (2018) studied a meta-analysis of randomized controlled trials (RCTs) in the cardiac population to gather data on adverse events and examine how HIIT versus MICT affected cardiorespiratory fitness. Following an exhaustive search of pertinent databases through July 2017, a critical narrative synthesis and meta-analysis were carried out. We looked for RCTs that contrasted the improvements in cardiorespiratory fitness in the cardiac population brought about by HIIT versus MICT therapies. It was determined that when it comes to enhancing cardiorespiratory fitness in cardiac rehabilitation (CR) patients, HIIT outperforms MICT. For cardiorespiratory fitness programs lasting longer than six weeks, improvements are noteworthy. The greatest increases in cardiorespiratory fitness were seen in individuals with coronary artery disease who participated in programs lasting seven to twelve weeks. It seems that for CR participants, HIIT is just as safe as MICT.

Jafari et al. (2018) studied how young, obese girls' E- and P-selections were affected by eight weeks of high-intensity interval training (HIIT). Two experimental and control groups consisting of sixteen young, obese females were randomly allocated. Eight weeks of HIIT training were part of the exercise regimen. Samples of blood were fasted 24 hours prior to and following the training. To measure the dependent variables, the Elisa technique was employed. The t-test was utilized for data analysis. The levels of P- and E-selection following training did not significantly alter, according to the data. It was determined that a longer training period would most likely be required to significantly impact the levels of E- and P-selection with HIIT exercise.

Maillard et al. (2018) studied a meta-analysis to determine whether HIIT is effective in helping persons who are normal weight or overweight/obese reduce their total, visceral, and abdominal fat mass. Every item pertaining to HIIT and fat mass was found by searching electronic databases. Using the characteristics of HIIT (cycling versus running, goal intensity), body weight and/or sex, and body composition measurementtechniques, a stratified analysis was carried out. Moreover, heterogeneity was established. The results showed that, with no differences between the sexes, HIIT significantly decreased visceral ($p = 0.018$), abdominal ($p = 0.007$), and overall ($p = 0.003$) fat mass. Running was shown to be more efficient than cycling in terms of lowering both total and visceral fat mass. While lower intensities had a stronger impact on changes in abdominal and visceral fat mass, high-intensity (over 90% peak heart rate) exercise was more effective in lowering whole body adiposity. According to our research, the only imaging modalities that demonstrated a substantial reduction in visceral and/or abdominal fat mass following HIIT sessions were computed tomography scans and magnetic resonance imaging.

Sabag et al. (2018) studied the impact of resistance training (RT) and high-intensity interval training (HIIT) on hypertrophy and strength concurrently. Terms associated with HIIT, RT, and concurrent training were used to search five electronic databases. The impact of concurrent HIIT and RT compared to RT alone on muscular strength and hypertrophy was investigated using effect size (ES), which is determined as standardized differences in the means. To evaluate inter-modal rest responses, HIIT modality (cycling versus running), and region-specific strength and hypertrophy, sub-analyses were carried out. The results of concurrent HIIT and RT on muscle growth and

upper body strength were comparable to those of RT alone. Lower body strength increased less when HIIT and RT were combined than when RT was done alone (ES = -0.248, p = 0.049). Sub-analyses revealed a tendency that cycling HIIT (ES = -0.377, p = 0.074) and not running (ES = -0.176, p = 0.261) had a detrimental impact on lower body strength. Research indicates that combining HIIT and RT at the same time does not adversely affect hypertrophy or upper body strength. Additionally, any potential detrimental influence on lower body strength may be mitigated by using HIIT based on running and extending inter-modal rest intervals.

Fajrin et al. (2018) studied how HIIT may improve one's explosive strength, speed, and agility. A sort of exercise called high-intensity interval training (HIIT) alternates between high and low-intensity workouts for predetermined amounts of time. In order to develop the physical components, this kind of training is highly efficient and effective. Choosing an effective practice technique will be highly beneficial because increasing athletes' performance is correlated with enhancing their physical attributes. The purpose of this study is to examine the impact of HIIT on enhancing explosive strength, speed, and agility. This kind of study uses quantitative, quasi-experimental methodologies. This study's matching-only design and t-test (paired sample t-test) data analysis were employed. The results demonstrated a considerable increase in explosive power, speed, and agility after the therapy was administered for six weeks. In this study, high-intensity exercise (HIIT) was plyometric activity, whereas mild-to-moderate-intensity exercise was jogging. The reason for the increase in muscle strength and performance was the enhancement of neuromuscular properties. Researchers deduced from their examination of the data that high-intensity interval training exercises had a major impact on the development of power, speed, and agility.

Ingulet al. (2018) studied the impact of dietary counselling, HIIT, and MICT on the resting left ventricular (LV) peak systolic tissue velocity (S′) in children who are obese. One of three 12-week interventions was randomly assigned to ninety-nine obese children: 1) HIIT [n = 33, 4 min × 4 min bouts at 85–95% max heart rate (HRmax), 3 times/week] and nutrition advice; 2) MICT [n = 32, 44 min at 60–70% HRmax, 3 times/week] and nutrition advice; and 3) nutrition advice only (nutrition) [n = 34]. According to the results, diet was not as effective as twelve weeks of HIIT and MICT in normalising resting LV S′ in children with obesity (estimated mean difference 1.0 cm/s,

95% confidence range 0.5 to 1.6 cm/s, P < 0.001; With a 95% confidence interval of 0.2 to 1.3 cm/s and an estimated mean difference of 0.7 cm/s, P = 0.010, respectively). The study found that for obese children, twelve weeks of HIIT plus MICT was more effective in improving resting LV systolic function than dietary guidance alone.

Chuensiri et al. (2018) studied how obese preadolescent boys' vascular function was affected by high-intensity intermittent training. The main goal was to determine if HIIT and supra-HIIT would help obese preadolescent boys with their vascular structure and function. Prior to the baseline assessment, forty-eight overweight preadolescent boys, ages eight to twelve, were divided into three groups at random: control, HIIT (8×2 minutes at 90% peak power output, n = 16), and supra-HIIT (8 × 20 seconds at 170% peak power output, n = 16). For a period of 12 weeks, both workout groups used a cycle ergometer three times a week. Following 12 weeks, the findings showed that waist circumference, body fat percentage, and body mass were unaffected by either HIIT or supra-HIIT. Both the HIIT and supra-HIIT groups showed an increase in peak oxygen consumption(VO2peak) ($p < 0.05$). The resting metabolic rates of the HIIT and supra-HIIT groups were greater than those of the control group ($p < 0.05$). After 12 weeks of HIIT and supra- HIIT program, a measure of arterial stiffness, brachial-ankle pulse wave velocity, and carotid intima-media thickness reduced (all $p < 0.05$). Both the HIIT and supra-HIIT groups showed an increase in flow-mediated dilation, a marker of endothelium-dependent vasodilation (all $p < 0.05$).

Aschendorf et al. (2018) studied the impact of a 5-week basketball-specific high-intensity interval training (HIIT) program on the physical and aerobic capacity of young girls' basketball players. Procedures: 24 athletes participated in the study; their ages ranged from 15.1 ± 1.1 years to 170 ± 5.2 cm and their body masses from 60.9 ± 6.0 kg to 170 ±5.2 cm. The other group (n = 13) continued their team training regimen and acted as the controls (CG), while the training group (TG, n = 11) incorporated ten HIIT sessions tailored to basketball into their regular team training. There were various basketball-specific workouts in each HIIT session. Physical fitness was assessed both before (pre-training) and after (post-training). Findings: It is highly likely that the TG (26.5%) had improved Yo-Yo intermittent recovery test (Yo-Yo IR) performance. The Yo-Yo IR performance in the CG did not increase (−6.8%). The sprint and agility tests showed likely beneficial benefits in the TG with (1.2 ± 2.4%, ES: 0.25, p = 0.29) and without ball (1.5 ±

4.6%, ES: 0.34, p = 0.20). In the CG, the sprint and agility performance with the ball dropped by −2.8 ± 4.7% (ES: 0.49, $p < 0.01$). For the countermovement jump with arm swing (TG: ES = 0.14, p = 0.45, CG: ES = 0.20, p = 0.18), countermovement jump (TG: ES = 0.05, p = 0.70, CG: ES = 0.19, p = 0.10), squat jump (TG: ES = 0.06, p = 0.72, CG: ES = 0.10, p = 0.54), and long jump (TG: ES = 0.00, p = 0.82, CG: ES = 0.00, p = 0.81).No differences were observed between the groups for any of these activities. In conclusion, young female basketball players' aerobic performance is enhanced by a 5-week HIIT program tailored specifically to basketball.

Nikos et al. (2017) studied the impact of attackers and setters, both male and female, on the performance of an Olympic volleyball team. The aim of the study was to investigate and compare attack and set performance between male (M) and female (F) volleyball players competing at the Olympic level. In 16 volleyball matches (M = 8, F = 8) between teams competing in the 2004 Olympic Games, a panel of three knowledgeable coaches evaluated the players' set and attack techniques. Actions that made up a set of two interactions in Complex I (M = 1007, F = 1248) were included in the assessment, which was based on a 5-point rating system. Performance percentages and frequencies were computed using a cross-tabulation statistical procedure with level 4 x 5. The Z criterion was used to compare the percentages of performance assessments between genders, and the X2 criterion was used to investigate potential differences in the distribution of performance assessments in attack for each performance assessment in the set. The findings indicated that attackers of both genders performed better when setters performed better. After receiving good and excellent quality sets, male attackers demonstrated significantly ($P < 0.05$) higher percentages of good performance than female attackers, while male attackers showed significantly ($P < 0.05$) lower percentages of average and very good performance after receiving sets of excellent quality.

Arazi et al. (2017) studied the impact on female football players' anaerobic and aerobic capacity of two different heart-rate vs. speed-based high-intensity interval training (HIIT) programs. Eight female athletes competing at the regional level were split into two groups at random: those based on heart rate (n = 8; age 23.4 ± 1.1 years) and those based on speed (n = 8; age 23.4 ± 1.3 years). For six weeks, athletes trained three days a week. Each athlete's performance was evaluated both before and after training using the Hoff test, the 30–15 Intermittent Fitness Test (VIFT), and the Repeated Sprint Ability Test

(RAST); power, tiredness, and maximum oxygen consumption (VO2max) were determined indirectly. Following training, both experimental groups had increases in power, fatigue index, and VO2max ($p < 0.05$). Notably, the speed-based group outperformed the heart rate-based group ($p < 0.05$) in minimal power (effect size (ES):3.99 vs. 0.75), average power (ES: 2.23 vs. 0.33), and fatigue index (ES: 2.53 vs. 0.17). In conclusion, female football players who participated in heart rate-based and speed-based HIIT had significant increases in their power, VO2max, and fatigue index; however, the speed-based HIIT group saw higher increases in their power and fatigue index than the heart rate-based group.

Wee et al. (2017) studied how leg strength, agility, and aerobic and anaerobic capacity were affected by high-intensity intermittent badminton multi-shuttle (HIIBMS) feeding training. Despite the fact that HIIT produced physiological changes and was first used for racket sports, the usefulness of HIIT in a multi-shuttle feeding form to enhance physical performance in badminton has not been thoroughly studied. This research looked at 18 university college badminton players, ages 20 ± 1 (BW = 65.3 ± 11 kg; H = 173.0 ± 5.3 cm). Subjects were randomly chosen and divided into two groups (control group [CG], experimental group [EG]) based on the results of the first tests on aerobic and anaerobic capacity, leg reactive strength, and agility traits. While the EG received additional HIIBMS feeding training for four weeks, the other group received comparable badminton instruction. Pre- and post-tests on the VO2 max, Wingate Ergometer, Countermovement Vertical Jump, Drop Jump, and Illinois Agility Tests were administered to the individuals. Pre-test findings suggested that the two groups were similar at baseline in terms of six factors, with no statistically significant differences between them. Likewise, the post-test findings for each of the six factors were not statistically significant. With the exception of peak power and jump height in the EG and CG showing no increase in any parameter, the comparison of pre-test and post-test mean scores revealed substantial improvements in VO2max, mean power, leg reactive strength, and agility.

Belegisanin et al. (2017) studied how football players at the regional level might increase their aerobic fitness using high-intensity interval training (HIIT). During a season, the billat technique (30-30s and 15-15s; 6–12 min) was applied twice a week for eight weeks. Twenty-three soccer players at the national level (age = 25 ± 8, height = 183.28 ±

5.93, weight = 75.28 ± 5.9) were selected for this investigation. Maximum oxygen uptake was determined using the pseudo-ramp test on a treadmill before and after the experiment, continuing until volitional tiredness. The findings demonstrated an increase in aerobic fitness between the pre- and post-measurements (final measurement = 54.87 ± 2.61, $p < 0.001$) and starting measurement = 51.92 ± 3.40. When done throughout the season, targeted high-intensity interval training is probably a good way to help national-level football players improve their aerobic fitness.

Felipe et al. (2017) studied that increasing muscular strength with HIIT-based jogging programs enhances athletic performance. This study compared the physiological and neuromuscular responses during a sprint-distance triathlon before and after the high-intensity intermittent training (HIIT) phase to investigate the impact of the 5-week HIIT-based running plan on athletic performance. Two groups, the experimental group (EG) and the control group (CG), were formed by matching 13 triathletes. While the EG was urged to alter their running routine and solely retain their swimming and cycling routines, the CG was asked to stick to their regular training schedules. Before (pretest) and after (post test) the intervention period, participants finished a sprint-distance triathlon. The subjects completed four jumping tests for the pretest and posttest: baseline, post-swim, post-cycle, and post-run phases of the event. Along with heart rate monitoring (HR mean), post-race blood lactate accumulation (BLa) and rate of perceived exertion (RPE) were also recorded. Prior to the HIIT intervention, there were no discernible changes ($p > 0.05$) between the groups (at pretest). There were notable group-by-training differences in vertical jumping ability and athletic performance: during the competition, the EG increased jumping performance (approximately 6-9%, $p \leq 0.05$, effect size (ES) > 0.7), swimming performance ($p = 0.013$, ES = 0.438), and running time ($p = 0.001$, ES = 0.667), while the CG stayed the same ($p \geq 0.05$, ES < 0.4). RPE, HR mean, and BLa did not alter ($p \geq 0.05$, ES < 0.4). ΔCMJ was shown to have strong predictive power for both the Runtime ($R2 = 0.559$; $p = 0.008$) as well as the total time ($p = 0.048$; $R2 = 0.391$). These triathletes' high training volumes in swimming and cycling, along with their low-volume, high-intensity interval training running program, enhanced their performance in a sprint-distance triathlon. Improved neuromuscular traits that translate into increased muscle strength and work efficiency might be the cause of this improvement.

Cassidy et al. (2017) conducted a comprehensive review to see whether the hype around HIIT is warranted. This involved looking at how HIIT affects glucose regulation, how it might impact cardiovascular health, and the underlying mechanisms of the changes seen in people with common metabolic illnesses. It also looks at how the research may be applied to clinical settings. It was concluded that MICT is successful in producing significant health advantages when HIIT is not practical, deemed possibly hazardous, or poorly accepted by an individual. Though not in the case of unstable cardiovascular illness, HIIT seems to have a high safety profile and is well tolerated. It is not necessary to exaggerate the benefits of HIIT above other exercise training methods for enhancing metabolic regulation and promoting weight reduction. The significance of HIIT for the management of metabolic diseases rests in its potently favorable cardiovascular adaptations, which benefit a population at risk of cardiac problems. The effectiveness of HIIT is likely to be an adjuvant to calorie restriction for maximal clinical benefit (increased cardiovascular function and glycemic management), allowing HIIT to definitely be successful.

García-Pinillos et al. (2017) studied the physiological and neuromuscular reactions during a sprint-distance triathlon before and after the high-intensity intermittent training (HIIT) phase. The study examined the impact of the HIIT-based running strategy on athletic performance over a 5-week period. Two groups consisting of 13 triathletes each were matched: the experimental group (EG) and the control group (CG). The findings demonstrated that prior to the HIIT intervention, there were no discernible changes between the groups (at pre test). Athletic performance and vertical leaping ability showed significant group-by-training interactions: the EG increased its running time, swimming ability, and jumping ability during the competition, whereas the CG did not change. There were no modifications noted in BLa, HR mean

Eddolls et al. (2017) studied a review of research to determine the most efficient high-intensity interval training regimen and to investigate the potential effects of high-intensity interval training on important health markers. The following criteria were met by the included studies: (1) they examined healthy children and/or adolescents (aged 5–18);

(2) they recommended a high-intensity intervention; and (3) they reported outcome measures relevant to health. High-intensity interval training is a time-effective way to improve cardiovascular disease biomarkers in children and adolescents, according to the

data; however, the evidence is less clear for other health-related metrics. The largest benefits to participant health are achieved with running-based sessions, which should be conducted two to three times a week for a minimum of seven weeks at an intensity of>90% heart rate maximum/100–130% maximal aerobic velocity.

Diego et al. (2017) studied the impact of an 8-week high-intensity interval training (HIIT) programme based on functional exercises on the following variables in female handball players. The programme looked at the effects of the training on performance and body composition. Body mass index (BMI), percentage fat, weight (kg), leaping distance (cm), repeated sprint ability (RSA), and aerobic capacity. The fourteen female players were divided into two groups at random: the experimental group (GE, n = 7) would perform a "mixed functional HIIT" (combining plyometric, strength, and coordination exercises) prior to training sessions, and the control group (GC, n = 7) would substitute regular field warm-up exercises for HIIT. With two training sessions each week, the intervention course ran for eight weeks. There were pre- and post-tests for every variable. There were no discernible changes in any variable between the pre- and post-test, according to the intra-group GC analysis. However, the GE's figures revealed notable shifts: a 3.45% (d = 0.67) decrease in the percentage of overweight players, a 7.22% (d = 0.82) decrease in RSA execution time, and a 6.19% (d = 0.78) rise in VO2max. These findings seem to support the idea that "mixed functional HIIT" is a useful method for enhancing female handball players' body composition and performance.

Elisabeth et al. (2016) studied that high-intensity training has been shown to enhance top women volleyball players' exercise performance during a competitive season. The top female volleyball players (n = 25; mean ± SD; ages 19, 65; height 171–167 cm; weight 63–610 kg) gave their consent to take part in the research. Two groups were randomly assigned: one for high-intensity training (HIT; n = 13) and the other for control (CON; n = 12). During a 4-week in-season period, HIT ran three times a week for six to ten minutes, breaking for three-minute recovery intervals in between, in addition to the regular team training and games. CON, on the other hand, just participated in the team training sessions and games. Prior to and following the intervention, every participant finished the Arrowhead Agility Test (AAT), a 10-minute rest time, the Yo-Yo IR1 test, and the Yo-Yo Intermittent Recovery level 2 test (Yo-Yo IR2) are followed by a repeated sprint test (RST; 5 × 30 meters separated by 25 seconds of recovery). The average running

distance during the HIT was 15264m in week 1 and grew by 4.6% ($p \leq 0.05$) to 15963m in week 4. After the intervention, the RST increased by 4.3% and the AAT performance ($p \leq 0.05$) by 2.3% (18.87 ± 0.97 – 18.44 ± 1.06 seconds) in the HIT group only. The initial RST fatigue index was 7.06 ± 2.9 and 6.26 ± 5.0% in HIT and CON, respectively. However, it decreased ($p \leq 0.05$) to 2.7 ± 3.0% in HIT after training and stayed unchanged (5.56 ± 5.0%) in CON. Yo-Yo IR1 and Yo-Yo IR2 performance increased in HIT by 18.3% and 12.6 percent, respectively, after the intervention, with higher Yo-Yo IR1 change scores ($p \leq 0.05$) than in CON. In conclusion, elite women volleyball players' agility, repeated sprint ability, and high-intensity intermittent exercise performance were all enhanced by additional high-intensity in-season training conducted as interval running.

Costigan et al. (2016) studied research on the effectiveness of two high-intensity interval training (HIIT) protocols for enhancing teenagers' cognitive and mental health outcomes (executive function, psychological well-being, psychological distress, and physical self-concept). A control programme, a resistance and aerobic programme, and an anaerobic exercise programme were the three conditions under which 65 individuals were randomised. We used linear mixed models to study the impact of the intervention. Calculations were made for clinical inference and Cohen's d effect sizes. The findings showed that, whereas the AEP group showed modest improvements in executive function and psychological well-being as well as minor improvements in perceived appearance, the RAP group showed moderate improvements in executive function and small increases in well-being. No significant difference was detected in these areas. Both HIIT conditions had a substantial increase in mean feeling state ratings from pre-workout to post-workout, with the AEP showing the greatest improvement.

Kong et al. (2016) studied overweight and obese young women to compare the benefits of a five-week high-intensity interval training (HIIT) programme to moderate-intensity continuous training (MICT) in terms of blood glucose, body composition, cardiorespiratory fitness, and pertinent systemic hormones. For five weeks, the 18 participants underwent 20 HIIT or MICT sessions. Prior to and following training, measurements were made of body composition, blood glucose, and fasting serum hormones, including leptin, growth hormone, testosterone, cortisol, and fibroblast growth factor 21, for HIIT and MICT, respectively. HIIT involved 60 × 8s of cycling at approximately 90% of peak oxygen consumption interspersed with 12s of recovery. The

findings demonstrated that, in spite of training having no effect on body composition or the relevant systemic hormones, both exercise groups significantly increased their peak power output. Following the intervention, blood glucose levels tended to decline. Compared to HIIT, the MICT had a greater perceived effort rating. It was shown that short-term HIIT is more time-efficient and is thought to be simpler for increasing fasting blood glucose and cardiorespiratory fitness in overweight and obese young women when compared to MICT.

Maillard et al. (2016) studied the effects of 16 weeks of moderate-intensity continuous training (MICT) and high-intensity interval training (HIIT) on postmenopausal women with type 2 diabetes (T2D) and their total body and abdominal fat mass (FM). For a period of 16 weeks, two days a week, seventeen women were randomised to participate in either an HIIT or MICT cycling programme (40 minutes at 55–60% of their own HRR). Visceral adipose tissue and abdominal adiposity were measured, together with the whole-body and regional FM content, using dual-energy X-ray absorptiometry. The results showed that from the start to the end of the training intervention, neither group's total body mass, physical activity level, nor dietary energy (caloric) consumption changed. Over time, total FM declined, but total fat-free mass dramatically rose. At the conclusion of the intervention, there was no discernible difference in the total FM decrease between the groups. Nevertheless, only with HIIT was a notable decrease in visceral and total abdominal FM seen. The total cholesterol/HDL ratio and HbA1c showed time-related effects.

Risfandi et al. (2016) studied how men's volleyball players' VO2max, vertical leap, and power improved with high-intensity interval training (HIIT) versus high-volume endurance training (HVET). The volleyball players' lack of strength, power, and vertical leap served as the driving force behind this investigation. Using a randomised control group pretest-posttest design, the aim of this study was to ascertain the impact of training (HIIT) and HVET on raising VO2max, vertical leap, and power. The 33 male volleyball players from STKIP PGRI Jombang make up the study's population. Approximately 19 years old, 172 cm tall, and 68 kg in weight, the participants were split into three groups: 11 HIIT, 11 HVET, and 11 controls. According to the study's findings, increasing VO2max, vertical leap, and power were significantly aided by both the HIIT exercise pattern and the HVET. HIIT works better to raise power, vertical jump, and VO2max.

Nowak et al. (2015) studied effects of 12 week endurance training program. 34young women were imparted high-low impact aerobic fitness training. Significant increase in maximum oxygen uptake was observed in underweight women. Over weight and normal weight women did not show the above change, although other changes were noticeable.

Smith-Ryan et al. (2015) studied HIIT in overweight and obese men. They found that over a period of 03 weeks, two different modalities of HIIT resulted in increase of VO2max which was, however, not significant.

Mohr et al. (2014) compared the effects of high intensity swimming trainingwith moderate intensity swimming on cardiovascular health status of mild hypertensive sedentary premenopausal women. It was found that among 62 women, resting heart rate declined by 5 beats per min in both high intensity and moderate intensity continuous exercise group, which was significant. There was also an improvement in Yo–Yo running performance in both, with high intensity group showing greater improvement.

Stoggl and Sperlich (2014) studied the concept of polarized training and compared it with more traditional concepts of high volume training, threshold training and high intensity interval training in 48 athletes from running, cycling, triathlon, and cross-country skiing. Based on heart rate controlled incremental workload over 9 weeks, work economy and VO2max were measured. While work economy was found to be similar across the groups, greatest increase in VO2max was seen in polarized training.

Kilen et al. (2014) investigated high-intensity interval training against traditional training for 12 weeks in 41 elite swimmers. The training volume in case of HIIT group was half of that of traditional training. In spite of greatly reduced volume, there was no observed improvement or deterioration in time performance or oxygen uptake between the groups.

Ouerghi et al. (2014) studied HIIT as opposed to traditional soccer training and no training in 24 young male soccer players over a period of 12 weeks. They found that high intensity interval training produced greater increase in both maximal aerobic velocity and maximal aerobic capacity. This difference in favour of HIIT was evident at 6 weeks and got further accentuated after 12 weeks.

Hoffmann Jr. et al. (2014) conducted a study on Repeated Sprints, High-Intensity Interval Training, Small-Sided Games: Theory and Application to Field Sports. To analyze performance and fatigue effects of small-sided games (SSG) vs high-intensity interval training (HIIT) performed during a 4-wk in-season period in high-level youth football. Nineteen players from 4 youth teams (16.5 [SD 0.8] y, 1.79 [0.06] m, 70.7 [5.6] kg) of the 2 highest German divisions completed the study. Teams were randomly assigned to 1 of 2 training sequences (2 endurance sessions per week): One training group started with SSG, whereas the other group conducted HIIT during the first half of the competitive season. After the winter break, training programs were changed between groups. Before and after the training periods the following tests were completed: the Recovery-Stress Questionnaire for Athletes, creatine kinase and urea concentrations, vertical-jump height (countermovement jump [CMJ], drop jump), straight sprint, agility, and an incremental field test to determine individual anaerobic threshold (IAT). Significant time effects were observed for IAT (+1.3%, yp2 = .31), peak heart rate (–1.8%, yp2 = .45), and CMJ (–2.3%, yp2 = .27), with no significant interaction between groups (P > .30). Players with low baseline IAT values (+4.3%) showed greater improvements than those with high initial values (±0.0%). A significant decrease was found for total recovery (–5.0%, yp2 = .29), and an increase was found for urea concentration (+9.2%, yp2 = .44). Four weeks of in-season endurance training can lead to relevant improvements in endurance capacity. The decreases in CMJ height and total-recovery score together with the increase in urea concentration might be interpreted as early signs of fatigue. Thus, the danger of overtaxing players should be considered.

De Araujo et al. (2012) compared endurance training with HIIT on endurance and health related parameters in 30 obese children in the age group 8 – 12 years over a period of 12 weeks. The high intensity interval training sessions lasted around 70% less than endurance training sessions. Both groups showed comparable improvement in absolute relative VO2max and peak velocity.

Astorino et al. (2012) studied effect of HIIT on cardiovascular function, VO2max, and muscular force over 6 sessions of HIIT in a span of 2-3 weeks in 20 young, healthy adult men and women. The authors found significant improvement in VO2max. No change was noticed in resting blood pressure, heart rate or force production.

Fernandez et al. (2012) compared the effects of HIIT and repeat sprint training on aerobic fitness, tennis specific endurance, linear and repeat sprint ability, and jumping ability on 31 competitive male tennis players over 6 weeks. The study showed that high-intensity interval training induced greater improvements in tennis-specific endurance while repeated-sprint training led to a significant improvement in repeated sprint ability. Both training interventions showed similar improvements in general aerobic fitness.

Antonio P et al. (2012) conducted a study on the benefits of exercise are well established but one major barrier for many is time. It has been proposed that short period resistance training (RT) could play a role in weight control by increasing resting energy expenditure (REE) but the effects of different kinds of RT has not been widely reported. Tested the acute effects of high-intensity interval resistance training (HIRT) vs. traditional resistance training (TT) on REE and respiratory ratio (RR) at 22 hours post-exercise. In two separate sessions, seventeen trained males carried out HIRT and TT protocols. The HIRT technique consists of: 6 repetitions, 20 seconds rest, 2/3 repetitions, 20 sec rest, 2/3 repetitions with 20 to 30 sec rest between sets, three exercises for a total of 7 sets. TT consisted of eight exercises of 4 sets of 8–12 repetitions with one/two minutes rest with a total amount of 32 sets. They measured basal REE and RR (TT0 and HIRT0) and 22 hours after the training session (TT22 and HIRT22). HIRT showed a greater significant increase ($p < 0.001$) in REE at 22 hours compared to TT (HIRT22 2362 ± 118 Kcal/d vs TT22 1999 ± 88 Kcal/d). RR at HIRT22 was significantly lower (0.798 ± 0.010) compared to both HIRT0 (0.827 ± 0.006) and TT22 (0.822 ± 0.008). Their data suggested that shorter HIRT sessions may increase REE after exercise to a greater extent than TT and reduced RR hence improving fat oxidation. The shorter exercise time commitment helped to reduce one major barrier to exercise.

Sperlich et al. (2011) conducted a study on effects of 5 weeks of high-intensity interval training vs. volume training in 14-year-old soccer players. High-intensity interval training (HIIT) in junior and adult soccer has been shown to improve oxygen uptake (VO,) and enhance soccer performance. The main purpose of this study was to examine the short term effects of a 5-week HIIT vs. high-volume training (HVT) program in 14-year-old soccer players regarding the effects on VO, max and 1,000-m time (T,) and on sprinting and jumping performances. In a 5-week period, 19 male soccer players with a mean (SD)

age of 13.5 ± 0.4 years performed HIIT at close to ~90% of maximal heart rate. The HVT intensity was set at 60-75% of maximal heart rate. VO, max increased significantly (7.0%) from pre to post in HIIT but not after HVT. T, decreased significantly after HIIT (~-10 vs. ~-5 seconds in HVT). Sprint performance was increased significantly in both groups from pre to post testing without any changes in jumping performance.

Ziemann et al. (2011) studied effects of HIIT on aerobic parameters in 21 young, recreationally active males. After an experimental protocol of 6 weeks, they observed that there was a significant increase in aerobic and anaerobic performance in high intensity interval training group as compared to the control group.

Mahdi Bayati et al. (2011) studied that the technological advances in interval training for cyclists have led to the development of both heart rate (HR) monitors and power meters (PM). Despite the growing popularity of PM use, the superiority of PM-based training has not been established. The aim of this present study was to investigate the relative effectiveness of HR-based versus PM-based interval training on 20 km time trial (20km TT), lactate threshold (LT) power, and peak aerobic capacity (VO2max) in recreational cyclists. Participants (n =20; M age=33.9, SD =13) completed a baseline 20km TT to establish their VO2max and LT and were then randomly assigned to either HR-determined or PM-determined training sessions. Over a period of up to 5 weeks participants completed 7.2 (± 1.1) interval training sessions at their specific LT for their respective interval training method. Repeated measures analysis of variances (ANOVAs) showed that both HR-based and PM-based training groups significantly improved their LT power ($F(1,16) = 28.$, $p < 0.01$, eta2 = 0.63) and 20km TT time ($F(1,16) = 4.92$, $p = 0.04$, eta2 = 0.24) at post- test, showing a 17 watt increase (9.8%) and a near 3-and-a-half minute improvement (7.8%) in 20km TT completion time. There were no significant group (HR vs. PM) x time (baseline vs. post-test) interactions for 20km TT completion time, LT power, or VO2max ratings. Their results coincide with the literature supporting the effectiveness of interval training for endurance athletes. Furthermore, their findings indicated that there is no empirical evidence for the superiority of any single type of device in the implementation of interval training. Their study indicated that there were no noticeable advantages in using PM to increase performance in the average recreational cyclist, suggesting that low cost HR monitor was equally capable as training devices.

Gonzalez-Badillo et al (2006) examined the effect of 3 volumes of heavy resistance, average relative training intensity programs on maximal strength in snatch, clean 86 jerk, and squat. Twenty-nine experienced junior weightlifters were randomly assigned into 1 of 3 groups: low-intensity group moderate-intensity group and high-intensity group. The present results indicate that short-term resistance training using moderate volumes of high relative intensity tended to produce higher enhancements in weightlifting performance compared with low and high volumes of high relative training intensities of equal total volume in experienced, trained young weightlifters.

Willardson and Burkett (2005) compared the differences between 3 different rest intervals on the squat and bench press volume completed during a workout. Fifteen college-aged men participated in this study. All subjects performed 3 testing sessions, during which 4 sets of the squat and bench press were performed with an 8 repetition maximum (8RM) load. Volume was defined as the total number of repetitions completed over 4 sets for each rest condition. Statistical analysis was demonstrated significant differences between each rest condition for both exercises tested. The 5-minute rest condition resulted in the highest volume completed, followed in descending order by the 2- and 1-minute rest conditions. The ability to perform a higher volume of training with a given load may stimulate greater strength adaptations.

Goto et al (2003) examined the effects of an additional set immediately following high intensity resistance exercise on growth hormone response. Subjects performed 4 resistance exercise protocols (bilateral knee extension exercise) on separate days. The protocols were categorized into 2 types of protocol, namely "Strength-up type (S-type)" and "Combination type (Combi-type)". The S-type was resistance exercise which consisted of 5 sets at 90% of 1 repetition maximum (RM) with 3- min rest periods between sets, whereas the Combi-type is a training protocol which adds an additional set (either 50% of 1 RM [CSO-type], 70% of 1 RM [C70-type] or 90% of 1 RM [C90- type]) to the S-type. These results suggests that a high intensity, low volume training protocol to induce neural adaptation resulted in little growth hormone response, but growth hormone secretion was increased by performing a single set of low intensity resistance exercise at the end of a series of high intensity resistance sets.

Takarada and Ishii (2002) investigated the effect of low intensity resistance exercise training on muscular size and strength where the inter set rest period was shortened so as to reduce the metabolite clearance. Female subjects (aged 45.4 ± 9.5 years, n = 10) performed bilateral knee extension exercises in a seated position on an isotonic leg extension machine. The strength and the cross-sectional area (CSA) of the knee extensors and flexors were examined with an isokinetic dynamometer and magnetic resonance imaging (MRI), respectively. These results indicate that a low-intensity resistance exercise with a short inter set rest period is substantially effective in inducing muscular hypertrophy and concomitant increase in strength.

Fincher (2001) evaluated the effect of a single-set, high intensity resistance-training program on anaerobic performance gains in the time that collegiate football players were able to maintain a constant power output that stressed anaerobic energy systems. Subjects (N=40) were randomly assigned to a single-set high-intensity maximally-exhaustive training group or a traditional multiple-set group. The multiple-set group did not attempt extra lifts to achieve maximum exhaustion. Training lasted 10 weeks. Gains in time before failure for upper and lower body exercises improved significantly for both groups. The one set high-intensity group gained significantly more than did the multiple-set group. One exhaustive set of strength exercises produces greater anaerobic performance gains than does a multiple-set of exercises.

STUDIES ON AEROBIC TRAINING

Martins et al. (2024) conducted a study to investigate the effect of aerobic training on selected physical and physiological variables among football players. The subjects were intercollegiate football players and were divided into experimental and control groups. The experimental group underwent aerobic training, while the control group did not undergo any specific training programme. The training sessions were conducted regularly for several weeks. Prior to and after the training period, all subjects were tested for cardiovascular endurance and fatigue resistance. The results of the study showed that the aerobic training group demonstrated significant improvement in cardiovascular endurance and fatigue resistance compared to the control group. The study concluded that aerobic training is effective in improving cardiovascular fitness among football players.

Mohammad Ali Samavati Sharif et al., (2024), The Effect of Continuous Aerobic and High-Intensity Interval Training on Some Physical Fitness Factors in Young Football Players, this study examined the effects of continuous aerobic and high-intensity interval training on selected physical fitness factors in young football players. Forty-five players from Hamadan were randomly assigned to one of three groups: a continuous high-intensity aerobic training group (three sessions per week at 90–95% of maximum heart rate), a high-intensity interval training group (three sessions per week consisting of 30 minutes of high-intensity training followed by 30 minutes of rest), and a control group. Physical fitness parameters, including sprint speed, agility (4×9 shuttle run test), and explosive leg power, were assessed before and after a six-week training protocol. Statistical analysis using ANCOVA, with pre-test values as covariates and Bonferroni post hoc comparisons in SPSS 26 ($p<0.05$), revealed significant improvements in all measured fitness factors in both training groups compared to the control group, with notable differences between the training modalities themselves. The findings suggest that both continuous aerobic and high-intensity interval training effectively enhance physical fitness in young football players, with continuous aerobic training potentially yielding superior improvements. However, further research is recommended for a more precise evaluation of their comparative effects.

Ghada Jouira et al., (2024),The Impact of Aerobic Dance Intervention on Postural Balance in Children: A Randomized Controlled Trial, this study examined the effects of an 8-week aerobic dance intervention on postural balance in children aged 9 to 11. Forty-one participants from a primary school were randomly assigned to either an aerobic dance group (ADG) or a control group (CG), with postural balance assessed through center of pressure (CoP) excursions before and after the intervention. Evaluations were conducted under various conditions, including firm and foam surfaces in both bipedal and unipedal stances with open-eyes (OE) and closed-eyes (CE) conditions, as well as medial–lateral (ML) and anterior–posterior (AP) surfaces in a bipedal stance under OE conditions. Statistical analysis revealed that the ADG demonstrated significantly reduced CoPVm values in multiple conditions, including firm bipedal CE, unipedal OE, foam bipedal OE and CE, and foam unipedal OE ($p < 0.005$), indicating enhanced postural control. These findings suggest that aerobic dance intervention effectively improves postural balance in children, enhancing their adaptability and stability across different surface and visual conditions.

Walid Selmi et al., (2023), Effects of Aerobic and Speed Training Versus Active Control on Repeated Sprint Ability and Measures of Self-confidence and Anxiety in Highly Trained Male Soccer Players, this study investigated the combined effects of aerobic and speed training with soccer-specific training compared to soccer-specific training alone on both physical and psychological adaptations in highly trained male soccer players. Thirty-eight athletes (mean age 18.9 ± 0.5 years) were randomly assigned to either a combined training group (COMB-G; n = 20) or an active control group (CON-G; n = 18). The COMB-G group performed aerobic training at 110–120% of their final velocity from the YOYO Intermittent Fitness Test Level 1 (YOYO IL1) and speed training consisting of maximal sprints over 15–20 meters, integrated into their soccer-specific training, while the CON-G group engaged solely in soccer-specific training, including technical and tactical drills and small-sided games, with both groups maintaining similar training volumes. Pre- and post-intervention assessments included the YOYO IL1 test (measuring final velocity, total distance, and maximal oxygen consumption [VO2max]), repeated sprint ability (best and total sprint time, sprint decrement), and psychological evaluations using the Competitive State Anxiety Inventory-2 (CSAI-2) to assess self-confidence, somatic anxiety, and cognitive anxiety. A mixed ANOVA revealed significant group-by-time interactions favoring the COMB-G group across all performance and psychological variables, indicating superior improvements in aerobic performance (RSATT, RSABT, final velocity, total distance, VO2max), self-confidence, and anxiety regulation (somatic and cognitive). The findings suggest that integrating aerobic and speed training into soccer-specific training enhances both physical fitness and psychological resilience, making it an effective and safe training approach for male soccer players.

Xiaorong Bai et al., (2022), Aerobic Exercise Combination Intervention to Improve Physical Performance Among the Elderly: A Systematic Review, this study demonstrates strong evidence for aerobic exercise interventions for adults over 60. More specifically, the studies show that combining aerobic exercise with either resistance training, multi-component training or dance-based activities leads to meaningful changes in objective measures of physical performance. Overall, these multimodal interventions were more effective than unimodal interventions and improved upper and lower body strength, dynamic balance, gait speed, mobility, and decreased the risk of falling. IMPORTANCE Combined exercise interventions (CEX) provided additional benefits (eg, improved functional mobility, joint flexibility, and body composition) compared with

aerobic (AER) or resistance training (RES) alone; therefore, CEX may be given higher priority in maintaining total physical fitness and independence in older adults.

Bulent TURNA et al., (2022) The Aerobic and Anaorobic Performance of Elite Soccer Players: Pre-Season Assessment, this study examined the effects of an 8-week aerobic and anaerobic endurance training program, conducted during the preparation period, on selected physical and physiological characteristics in elite football players. Eleven healthy, active, elite-level male football players (mean age 26.72 ± 6.13 years) participated in 40 training sessions designed to enhance aerobic and anaerobic performance. Participants underwent pre- and post-training evaluations, including the Yo-Yo Intermittent Recovery Test Level 2 for aerobic capacity and vertical jump, agility, and 20-meter sprint tests for anaerobic performance. Statistical analysis using the Paired Samples t-test in SPSS 23, with a significance threshold of $p<0.05$, revealed significant improvements in both aerobic performance (VO2 max mileage and Yo-Yo test scores) and anaerobic performance (vertical jump, agility, and sprint speed) following the intervention. These findings suggest that incorporating aerobic and anaerobic endurance drills during the general preparation period effectively enhances the physical and physiological attributes essential for elite football performance.

Poppy ElisanoArfanda et al., (2022), The Effect of Low-Impact Aerobic Dance Exercise Video on Cardiovascular Endurance, Flexibility, and Concentration in Females with Sedentary Lifestyle, This study aimed to evaluate the effectiveness of a low-impact aerobic dance exercise video on cardiovascular endurance, flexibility, and concentration in women with a sedentary lifestyle. Utilizing a Pre-Experimental One-Group Pre test- Post test Design, 18 females aged 18–20 years with a body mass index (BMI) of 19–24 kg/m², normal systolic and diastolic blood pressure, resting heart rate, and oxygen saturation (SpO2) of 96%–100% participated in the research. The intervention consisted of a 30-minute low-impact aerobic dance session conducted via video, performed three times per week for six weeks at an intensity of 75%–85% HRmax. Cardiovascular endurance was assessed using the Multi-Stage 20-m Shuttle Run Fitness Test, flexibility was measured with the Sit and Reach Test, and concentration was evaluated using the Grid Concentration Test. Statistical analysis using the Paired Sample T-Test at a 5% significance level revealed significant improvements in all measured parameters, with cardiovascular endurance increasing from 28.13 ± 4.80 to 30.52 ± 0.88 mL/kg/min ($p \leq 0.001$), flexibility improving from 17.79 ± 4.72 to 18.75 ± 5.02 cm ($p \leq 0.001$), and

concentration scores rising from 7.39 ± 2.38 to 9.11 ± 2.45 ($p \leq 0.001$). These findings indicate that regular participation in low-impact aerobic dance exercise significantly enhances cardiovascular endurance, flexibility, and concentration in adolescent girls with a sedentary lifestyle.

Toni Modric et al., (2020), aerobic fitness and game performance indicators in professional football players; playing position specifics and associations, any impact on how well professional soccer players performed in games. We studied 16 male players, all around 23 years old, who were in great shape. We tested their aerobic fitness by measuring things like how fast they could run at different levels of intensity. We also looked at their game performance using stats like how many goals they scored or passes they made. We watched them play for half a season and found that midfielders were the fittest, while forwards were the least fit. Surprisingly, we didn't see a clear connection between being in good shape and playing well in games. Overall, it seems like how fast players can run at different levels of intensity is a better indicator of their fitness than just their overall endurance.

Gabriel Zaharia et al., (2020), The Effects of 8 Aerobic Endurance Training Weeks of 4vs.4+GK Small-Sided Games versus Traditional Training on Physical Fitness and Skills among U18 Football Players, the aim of the research was to identify the effect of 4vs.4 small-sided games (SSGs) with goalkeepers (4vs.4+GK), applied twice a week, for 8 weeks, on U18 football players‘ physical ability, compared to that of the athletes who performed specific aerobic endurance training. The research included 40 football players U18, divided into two groups: 20 in the experiment group (EG) aged 17.49 ± 0.61 years and 20 in the control group (CG) aged 17.66 ± 0.54 years. From the initial test (IT) to final tests (FT) performed on the parameters, maximum oxygen consumption (VO_{2max}) and 10 m and 20 m sprint and agility with and without a ball showed a significant increase for both groups. The first and last SSG training was monitored, using total distance (TD), high-intensity distance (HSR—high-speed running) and maximum intensity distance (VHSR—very-high-speed running). Comparative analyses of EG and CG parameters at the FT shows that the differences between the means of two groups are statistically significant in favor of the experimental group in terms of all parameters, except 10 m sprint ($p < 0.05$). Referring to SSGs, the experimental group had a 7.78% increase rate in TD ($p < 0.0005$), a 30.90% ($p < 0.0005$) increase rate with HSR and no significant differences ($p > 0.05$) with VHSR. The experimental training program of 4vs.4+GK SSGs,

applied to U18 football players, produced significant progress in the physical, and functional parameters.

Guevar Alkhateeb and Lars Donath (2020), Effects of football versus aerobic exercise training on muscle architecture in healthy men adults: a study protocol of a two-armed randomized controlled trial, the process of aging is associated with a gradual decline in muscle structure and function, leading to reductions in muscle mass, strength, power, and overall physical performance. This decline significantly affects mobility, increases the risk of falls, and reduces the quality of life in older adults. To mitigate these effects, various forms of exercise have been recommended, including strength training, endurance exercises, agility drills, balance training, and flexibility exercises. Among these, football has gained attention as an integrative approach that combines multiple fitness components. However, limited research has investigated the comparative effects of football training and traditional aerobic exercise on muscle architecture and tendon properties. The following review of literature provides an overview of the existing studies on age-related muscular decline, the role of exercise in aging populations, and the potential benefits of football training.

Vallimurugan, V. et al. (2020) observed the purpose of the study was to find out the effect of Aerobic and Complex training on selected physiological variables of Resting heart rate and Vital capacity of football players. It was hypothesized that aerobic and complex training may have a significant effect on selected physiological variables of football players. The subjects for this study were selected by purposive sampling of 45 male football players from Madurai Kamaraj University, with ages ranging between 18–22 years. Out of 45 subjects, 30 were kept in experimental groups, i.e., aerobic training (composed of 15 subjects) and complex training (having 15 subjects), while the remaining 15 subjects were kept in the control group. For the study, a pre-test, post-test randomized group design was used. The pre-test was taken prior to the Aerobic and Complex training (football specific), and the post-test was taken after twelve weeks of aerobic and complex training (football specific). The data were analyzed using descriptive statistical methods and analysis of co-variance (ANCOVA). The level of significance was set at 0.05. In light of the findings, it was concluded that there is a significant difference in the Vital Capacity of football players due to the twelve weeks of Aerobic and Complex Training. Further, there is a significant difference in the Resting Heart Rate of football players due to the twelve weeks of Aerobic and Complex Training.

Guevar Alkhateeb et al. (2020) evaluated the effects of football versus aerobic exercise training on muscle architecture in healthy adult men. Sports and exercise training can attenuate age-related declines in physical function. As people age, they suffer a progressive deterioration of overall muscle structure and function, such as muscle diameter, strength, mass, and power. Therefore, supporting older adults—aged 50 years and above—to continue being physically active is very important. Several forms of exercise (strength, agility, endurance, balance, and flexibility) are recommended. In this regard, football has been repeatedly shown to be an integrative approach to promoting strength, endurance, and agility. However, there has been no previous randomized controlled trial that comparatively investigates the effects of football training versus traditional aerobic exercise training on muscle architecture and patella tendon properties in healthy community dwellers. The study protocol is designed to examine whether football differentially affects muscle thickness, muscle length, fascicle length, pennation angle, patella tendon length, and thickness compared to a workload-matched traditional aerobic exercise training regimen. The study sample consists of 60 untrained but healthy men (50–60 years old), who will be randomly assigned (strata: age, activity) to two groups: the football group (n = 30) and the aerobic group (n = 30). The intervention will take place over 12 consecutive weeks, two times a week for 60 minutes each session. The football group will perform recreational football training as a large-sided game, whereas the aerobic group will undergo running exercise. Both groups will have the same external workload ranging between moderate and high exercise intensity. The outcome measure will be collected before and after the intervention period.Findings from this study will provide insight into the effects of 24 sessions of both football and aerobic training programs on the selected groups of adult men, including detecting their effects on thigh muscle architecture.

Kumaraguru, M. et al. (2020) reviewed the influence of aerobic training on selected speed and cardiorespiratory endurance measures among college men football players. The purpose of the study was to determine the influence of aerobic training on selected speed and cardiorespiratory endurance measures among college male football players. To achieve this purpose, thirty football players from affiliated colleges of Alagappa University, Karaikudi-Sivagangai were selected at random, and their age ranged from 18 to 25 years. The subjects were divided into two equal groups of fifteen each. Group I acted as the experimental group for high aerobic training, and Group II acted as the control group.

The procedure and exercise schedule were explained to the subjects to ensure full cooperation. The study was formulated as a post-test-only random group design. The experimental period lasted 8 weeks. After the experimental treatment, all the subjects were tested on speed and cardiorespiratory endurance. These final test scores formed the post- test scores of the subjects. The post-test scores were subjected to statistical analysis using ANCOVA. The level of significance was fixed at 0.05.The study showed that significant improvements took place in speed and cardiorespiratory endurance of college male football players after undergoing 8 weeks of aerobic training. Improved speed and cardiorespiratory endurance after regular aerobic training is beneficial for college male football players .The study concluded that aerobic training is effective in improving speed and cardiorespiratory endurance of college male football players.

Toni Modric et al. (2020) analyzed aerobic fitness and game performance indicators in professional football players, focusing on playing position specifics and associations. The aim of this study was to identify associations between aerobic fitness (AF) and game performance indicators (GPI) in elite football players. Participants were professional male football players (n = 16; age: 23.7 ± 2.6 years; height: 181.6 ± 7.09 cm; mass: 77.0 ± 6.34 kg). AF testing was conducted by direct measurement and included VO2 max, running speed at aerobic threshold (AT), and running speed at anaerobic threshold (AT). GPIs were collected by the position-specific performance statistics index (In Stat index). The players were observed over one competitive half-season, resulting in 82 game performances, grouped according to their positions as defenders (n = 39), midfielders (n = 32), and forwards (n = 11). VO2 max was not found to be a good discriminator of AF among different playing positions. AT (F-test = 26.36, p = 0.01) and AT (F-test = 7.25, p = 0.01) were highest among midfielders and lowest among forwards. No correlations were found between AF and GPI. This study confirmed that AT and AT are better indicators of AF than VO2 max in football players at different playing positions. The lack of associations between AF and GPI was discussed in regard to the calculation of In Stat's GPI.

Clemente, F. M. et al. (2020) examined the effects of high-intensity interval training on selected physical and physiological variables among soccer players. The purpose of the study was to determine the effectiveness of HIIT in improving football performance. Twenty male soccer players were selected as subjects. They underwent high-intensity

interval training for a period of eight weeks. The selected variables were VO_2 max, speed, and agility. These variables were measured before and after the training programme. The collected data were statistically analyzed using appropriate techniques. The results showed significant improvement in VO_2 max, speed, and agility. This indicated improvement in aerobic capacity and physical performance. The study concluded that high-intensity interval training is effective in improving physical and physiological performance of soccer players.

Seyed Reza Mousavi Gilani and Abdurrashid Khazaei Feizabad (2019), The current study examined the effect of aerobic exercise training on psychological well-being and self-esteem in patients with type 2 diabetes. They randomly placed either 60 participants aged 40-55 with blood sugar levels between 150–250 mg/dL in one of two groups. The intervention group undertook aerobic exercise 3 times/week for 45–60 minutes, at 60–70% intensity for 12 weeks. The outcomes revealed significant improvements in self-esteem, mental health, physical symptoms, anxiety and insomnia, but not depression and social functioning. A separate 2022 study also found that self- esteem, mental health and quality of life of diabetic patients improved significantly after regular aerobic exercise.

Agung Permadi (2019),The benefits of aerobic training for improving quality of life: a critical review of study, the population as it helps improve overall cardiovascular health, maintain muscle strength and flexibility, and reduce the risk of falls and injuries. Additionally, aerobic exercise can also have positive effects on mental health by reducing stress and anxiety levels. Furthermore, aerobic exercise can be easily modified to suit individual fitness levels and abilities, making it accessible to people of all ages and fitness levels. Whether it's walking, jogging, cycling, swimming, or dancing, there are numerous options for incorporating aerobic exercise into a daily routine. Overall, aerobic exercise is a safe and effective way for both young and old individuals to improve their physical and mental well-being. It provides a holistic approach to fitness that can benefit individuals of all ages in various ways.

Li J W, et al. (2019) observed the effect of whey protein on aerobic exercise ability of football players. The objective of the study was to discuss the effects of whey protein on the aerobic exercise ability of football players. A total of 36 college football players were randomly divided into a control group and an observation group. Eighteen cases in the control group were given pure water, and 18 in the observation group were given whey protein. The two groups underwent 8 weeks of physical training, and the

athletes received additional energy within 1 hour before and after training. Compared with the control group, the erythrocyte function in the observation group was more significant, and the difference was statistically significant ($P< 0.05$). The results of the physical fitness test in the observation group were significantly higher than in the control group, with a statistically significant difference ($P < 0.05$). The application of whey protein to football players can strengthen the protection of erythrocyte function and has considerable application value.

Vinod Kunjappan et al. (2018) observed the effect of aerobic training, resistance training, and concurrent training on VO2 max among college football players. The purpose of the study was to examine the effect of these three types of training on VO2 max.Sixty college football players (aged 18–22 years) from the Mar Athanasius College of Engineering, Kerala, were selected and divided into four equal groups. Group I underwent aerobic training, Group II underwent resistance training, Group III underwent concurrent training, and Group IV acted as a control group. The subjects were tested on VO2 max before and after the training period using a treadmill. ANCOVA was used to determine significant differences. The results revealed a significant difference among the experimental and control groups in terms of VO2 max improvement.

Hammami, M. et al. (2018) examined the effects of high-intensity interval training on physical performance among young football players. Thirty male football players were randomly assigned into experimental and control groups. The experimental group underwent high-intensity interval training for eight weeks, three sessions per week. The variables selected were speed, agility, and aerobic capacity. The results revealed significant improvement in speed, agility, and VO_2 max in the training group compared to the control group. The study concluded that high-intensity interval training is effective in improving physical and physiological performance in football players.

Buchheit, M. et al. (2018) investigated the effects of high-intensity interval training on aerobic fitness and repeated sprint ability in football players. Twenty male football players underwent high-intensity interval training for eight weeks, three sessions per week. The selected variables were VO_2 max and repeated sprint performance. The results showed significant improvement in aerobic capacity and repeated sprint ability. The study concluded that high-intensity interval training is an effective method for improving football-specific endurance.

Kotzamanidis, C. et al. (2018) studied the effects of combined strength and endurance training on physical performance in soccer players. Twenty-four male soccer players underwent concurrent training for eight weeks. The selected variables were muscular strength, speed, and endurance. The results showed significant improvement in all selected variables. The study concluded that concurrent training is effective for improving overall performance and improving football physical performance.

Dellal, A. et al. (2018) examined the effects of high-intensity training on physiological and performance variables in football players. The purpose of the study was to determine the effectiveness of high-intensity training in improving football performance. Twenty professional male football players were selected as subjects. They underwent a structured high-intensity training programme for six weeks. The selected variables were VO_2 max, speed, and agility. These variables were measured before and after the training period. The collected data were statistically analyzed. The results showed significant improvement in VO_2 max, speed, and agility. This indicated improvement in aerobic capacity and physical performance. The study concluded that high-intensity training is effective in improving football performance.

Franco, M. et al. (2018) examined the effects of aerobic interval training on the decline in short-passing ability caused by a short bout of high-intensity intermittent activities. Twenty-six junior soccer players (mean age: 17.8 ± 0.6 years) were randomly allocated to either the control group (CG) or the aerobic interval training group (ITG). The ITG completed 4 weeks of high-intensity aerobic training, consisting of 4 bouts of running for 4 minutes at 90%–95% of maximal heart rate, with 3 minutes of active recovery between sets. The ITG showed significant improvements in Yo-Yo Intermittent Recovery Test (YYIRT) and maximal oxygen consumption (VO2 max), and reduced the worsening of short-passing ability after the high-intensity simulation (HIS). These results suggest that junior soccer players can benefit from aerobic training to attenuate the decline in short-passing ability caused by intermittent activities.

Dr. Gauri Chakraborty et al., (2018),Effect of aerobic dance on the physical fitness among female, This study aimed to examine the effects of a nine-week aerobic dance program on the physical fitness of intercollegiate female players. A total of 30 female athletes, aged 18–22, from IGIPESS University of Delhi were selected as

participants. Data analysis was conducted using descriptive statistics, an independent t-test, and a post-hoc (LSD) test to assess changes in muscular endurance and cardiorespiratory endurance at a 0.05 significance level. The results indicated no significant improvements in these physical fitness variables following the intervention. Based on these findings, it was concluded that a five-day-per-week, 20-minute aerobic dance program was not sufficient to produce desirable changes in muscular and cardiorespiratory endurance among intercollegiate female athletes.

R Sridhar and RG Giridhara prasath (2017), This study investigated the effects of aerobic dance training on motor fitness parameters and dribbling ability in inter-collegiate male football players. Thirty participants from affiliated colleges of Bharathiar University, Coimbatore, were randomly assigned to two equal groups (n=15): an aerobic dance training group (ADTG) and a control group (CG). The experimental group underwent aerobic dance training three days per week (Monday, Wednesday, and Friday) for 12 weeks, while the control group continued with their routine activities without additional training. A pilot study was conducted to determine the initial capacity of participants for appropriate load adjustment. Motor fitness parameters, including flexibility (sit and reach test) and agility (4×10 shuttle run test), along with dribbling ability (Warner‘s soccer test), were assessed before and after the intervention. Statistical analysis using a paired t-test at a 0.05 significance level indicated significant improvements in agility, flexibility, and dribbling ability in the ADTG, demonstrating the positive influence of aerobic dance training. The findings align with previous research in sports sciences, reinforcing the efficacy of aerobic dance training in enhancing motor fitness and dribbling performance in inter-collegiate male football players.

Pari, M. et al. (2016) Aimed to examine the Effect of Aerobic Anaerobic and Skill Training on selected Endurance Parameters of Inter-collegiate Men Football Players. The purpose of this study was to find out the effect of aerobic anaerobic and skill training packages on selected Endurance parameters of Inter- collegiate men Football players. The study was conducted on eighty men(n=60) Football players studying various Arts and Science Colleges Affiliated to Madras University College, Chennai, Tamilnadu, India, and who have participated in the inter collegiate Soccer tournaments during the academic year 2014-2015 were selected as subjects. The age of the subjects were ranged from17to21years. The subjects were assigned at random into four groups of fifteen each (n=15). Group-I underwent Aerobic Training, Group-II underwent Anaerobic training,

Rafaela Liberali, etal. (2016) analyzed the Aerobic and anaerobic training sessions promote antioxidant changes in young male soccer players**.** The aim of this study was to investigate the effect of aerobic vs. anaerobic intense training sessions on biomarkers of oxidative stress. The included sample comprised 18 junior male soccer players (18-21 years) during the intermediate season. Blood samples were obtained before (baseline) and after aerobic or anaerobic training sessions and the following substances were assayed the biomarkers of cellular damage Thiobarbituric Acid-Reactive Substances and Oxidized Glutathione the non-enzymatic antioxidants Reduced Glutathione and Total-Glutathione, the antioxidant enzymes Superoxide Dismutase, Catalase, Glutathione Reeducates, Glutathione Peroxides and GlutathioneS- Transferase. Thecontents of Thiobarbituric Acid-Reactive Substances and Oxidized Glutathione showed no significant differences before vs. after aerobic or anaerobic training sessions. After aerobic training sessions, the activity of Superoxide Dismutase, Glutathione Reductase, and the contents of Reduced Glutathione and Total Glutathione were decreased; the activity of Glutathione S-transferees and Glutathione Peroxides were increased while Catalase activity remained unaltered. After anaerobic training sessions, Catalase activity decreased; Glutathione-Peroxides increased; Superoxide Dismutase, Glutathione Reductaes, and Reduced, Oxidized and Total Glutathione showed no significant differences. These results provide evidence of a more pronounced systemic oxidative stress after the aerobic as compared to the anaerobic training session in young soccer players.

Asier Los Arcos, et al. (2015) Found out the effects of Small-Sided Games *vs.* Interval Training in Aerobic Fitness and Physical Enjoyment in Young Elite Soccer Players. The purpose of this study was to compare the effects of Small-Sided Games (SSG)*vs.* Interval Training (IT) in soccer training on aerobic fitness and physical enjoyment in you the lite soccer layers during the last 8 weeks of the season. Seventeen U-16 male soccer players (age = 15.5 ± 0.6 years, and 8.5 years of experience) of a Spanish First Division club academy were randomized to 2 different groups for 6weeks: SSG group (n=9) and IT group (n = 8). In addition to the usual technical and tactical sessions and competitive games, the SSG group performed 11 sessions with different SSGs, whereas the IT group performed the same number of sessions of IT. Players were tested before and after the 6-week training intervention with a continuous maximal multistage

running field test and the counter movement jump test (CMJ). At the end of the study, players answered the physical activity enjoyment scale (PACES). During the study, heart rate (HR) and session perceived effort (SRPE) were assessed. SSGs were as effective as IT in maintaining the aerobic fitness in elite young soccer players during the last weeks of the season. Players in the SSG group declared a greater physical enjoyment than IT (P= 0.006; ES = 1.86 ± 1.07). Coaches could use SSG training during the last weeks of the season as an option without fear of losing aerobic fitness while promoting high physical enjoyment**.**

Giridharan et al. (2015) examined the effects of high-intensity aerobic interval training, concurrent low-intensity aerobic and resistance interval training on physiological variables of college-level football players. To achieve the purpose of this study, forty-five football players from Velammal Institutions, Chennai, Tamil Nadu State, India were selected as subjects at random and their age ranged from 18 to 23 years. The subjects were divided into three groups consisting of 15 each. The experimental group I was treated with the high-intensity aerobic interval training (HIAIT), experimental group II was treated with the concurrent low-intensity aerobic and resistance interval training (CLIARIT), and group III was the control group (CG). VO2 max was assessed by Queen‘s college step test and cardiorespiratory endurance was measured by Cooper‘s 12-minute run. Analysis of covariance (ANCOVA) was computed because the subjects were selected randomly, but the groups were not equated in relation to the factors that were examined. Whenever the adjusted post-test means were found significant, the Scheffe‘s post-hoc test was administered to find out the paired means difference. To test the obtained results on variables, a level of significance of 0.05 was chosen and considered as sufficient for the study. Both the high-intensity aerobic interval training group and the concurrent low-intensity aerobic and resistance interval training group showed significant differences in improvement on physiological variables of college-level football players. The concurrent low-intensity aerobic and resistance interval training group showed significant improvement in physiological variables compared to the other two groups.

Senthilkumar et al. (2015) conducted a study to find out the effect of aerobic interval training on physical variables among college-level football players. To achieve the purpose of the present study, thirty college-level football players from Renugambal College of Physical Education, Thiruvannamalai, Tamil Nadu, India were selected as subjects at random, and their ages ranged from 18 to 25 years. The selected subjects were

divided into two groups. The experimental group participated in aerobic interval training for six weeks, while the control group did not undergo any training other than their daily routine. The criterion measures were speed (measured by the 50-meter run test, in seconds), agility (measured by the shuttle run, in seconds), and explosive power (measured by the vertical jump, in centimeters). The two groups were statistically analyzed by using the analysis of covariance (ANCOVA) at the 0.05 level. The result of the study reveals that there was a significant improvement in the experimental group on selected variables when compared to the control group after the completion of six weeks of aerobic interval training. The aerobic interval training group showed better performance on speed, agility, and explosive power than the control group.

Juliano Fernandes Da Silva et al. (2015) studied the effect of two generic aerobic interval training methods on laboratory and field test performance in soccer players. Thepurpose of this study was to compare the effects of 2 generic aerobic training models, based on peak running velocity in Carminatti‘s test (PVT-CAR), in U-20 elite soccer players. Seventeen soccer players (age: 17.96 ± 1.0 years; height: 178.6 ± 6.5 cm; weight: 73.66 ± 6.6 kg; body fat: 11.1 ± 1.3%) from a team competing in a national junior league took part in the study. The athletes performed a series of pre- and post-training tests (incremental test on a treadmill to determine the maximal oxygen uptake [VO2max], velocity at maximal oxygen uptake [VO2], lactate threshold [LT], and T-CAR). The interval training models applied were with 180° direction change (T12:12; n = 9) and without direction change (T6:6; n = 8). No significant interaction (time vs. group) was observed for the majority of variables analyzed ($p > 0.05$), although significant main effects in time were evident regarding peak treadmill velocity (PVTREAD) ($F = 56.3$, $p < 0.0001$), VO2max ($F = 35.8$, $p < 0.0001$), LT ($F = 57.7$, $p < 0.0001$), and PVT-CAR ($F = 52.9$, $p < 0.0001$). Moreover, there was no significant change in VO2max between the pre and post-training period ($F = 4.26$, $p = 0.056$) in both training groups. Thus, it can be concluded that the prescribed training with and without direction change in the intensity of the PVT-CAR increases the PVTREAD, the VO2max, the LT, and the PVT-CAR similarly.

Arul (2014) examined the effect of aerobic interval training on cardiorespiratory endurance and resting pulse rate among university men football players. For the purpose of the study, thirty men football players studying for a Bachelor‘s degree in the Department of Physical Education and Sports Sciences, Annamalai University, Annamalai Nagar, Tamil Nadu, India were selected as subjects, and they were divided into two equal groups of fifteen subjects each at random: the aerobic interval training group and the control group. The age of the selected subjects ranged from 18 to 21 years. Group I

underwent aerobic interval training for three days per week for twelve weeks. Group II acted as the control group, who did not undergo any special training programme apart from their regular physical education curriculum. The following variables were selected: cardiorespiratory endurance and resting pulse rate. The data were collected on selected criterion variables at prior and immediately after the experimental period as pre and post tests, respectively. By using Cooper's 12-minute run/walk and radial pulse test respectively, the analysis of covariance (ANCOVA) was used to find out the significant difference among the groups, if any, separately for each criterion variable. The 0.05 level of confidence was fixed to test the level of significance, which was considered appropriate. The results of the study revealed that there was a significant difference between the aerobic interval training group and the control group on cardiorespiratory endurance and resting pulse rate.

Dhanalakshmi et al. (2014) conducted a study to find out the effect of aerobics training on selected motor variables of high school soccer players. For this purpose, 40 subjects were selected from Government Girls Higher Secondary School, Nilakottai, Dindigul, aged between 13 and 15 years. They were divided into two equal groups, namely the aerobics training group (N=20) and the control group (N=20). The data were collected on the selected variables before and after the training programme. The training programme was fixed for 8 weeks, 5 days per week, with one training session designed for 60 minutes. The _t' ratio was used to analyze the data. The result revealed that the aerobics training significantly improved the selected motor variables like cardiorespiratory endurance and speed of high school soccer players.

Impellizzeri, F. M., et al. (2014) determined the Physiological and Performance Effects of Generic versus Specific Aerobic Training in Soccer Players. The aim of this study was to compare the effects of specific (small-sided games) vs. generic (running) aerobic interval training on physical fitness and objective measures of match performance in soccer. Forty junior players were randomly assigned to either generic (n = 20) or specific (n = 20) interval training consisting of 4 bouts of 4 min at 90 – 95% of maximum heart rate with 3 min active rest periods, completed twice a week. The following outcomes were measured at baseline (Pre), after 4 weeks of pre-season training (Mid), and after a further 8 weeks of training during the regular season (Post): maximum oxygen uptake,

lactate threshold (Talc), running economy at Talc, a soccer specific endurance test (Emblem‘s circuit), and indices of physical performance during soccer matches (total distance and time spent standing, walking, and at low- and high-intensity running speed). Training load, as quantified by heart rate and rating of perceived exertion, was recorded during all training sessions and was similar between groups. There were significant improvements in aerobic fitness and match performance in both groups of soccer players, especially in response to the first 4 weeks of pre-season training. However, no significant differences between specific and generic aerobic interval training were found in any of the measured variables including soccer specific tests. The results of this study showed that both small-sided games and running are equally effective modes of aerobic interval training in junior soccer players.

Jacob, S. (2013) conducted a study to find out the effect of selected drill practice and aerobic exercises on VO2 Max and Hemoglobin among college men football players. To achieve the purpose of the study, 45 football players from different colleges of Chennai were randomly selected and their age was between 18 and 21 years. They were divided into three groups of 15 subjects each. Group I assigned as experimental group I, Group II assigned as experimental group II and Group III assigned as control group. Experimental group I underwent drill practices, experimental group II underwent aerobic exercises for a period of six weeks and control group was not assigned to any experimental training. Pre tests and post tests were conducted prior and after a period of six weeks of training on selected dependent variables namely VO2 Max and hemoglobin. Analysis of covariance and Scheffe‘s post-hoc test were used to test the significant mean differences among the experimental groups. The study was concluded that six weeks of selected drill practice and aerobic exercises significantly improved the selected dependent variables namely VO2 Max and hemoglobin among college men football player.

Zouhal, et al. (2013) compared the physiological and perceptual responses of two high intensity intermittent aerobic exercises (HIIE), i.e. The 15s/15s exercise and an exercise on the Hoff track (HTE). In this within-subject repeated measures study, seven high level soccer players (Age: 24.1± 4.5yr; Height: 175± 0.04cm; Body mass: 67.9± 9.0kg;% Body fat: 14.2± 2.4%) performed the two exercises with same total duration (25 minutes) in a randomized order: 1) a15s/15s protocol at 120% of maximal aerobic speed (MAS), and 2) HTE. Heart rate (HR) and oxygen uptake (VO2) were measured continuously throughout both exercises. The rating of perceived exertion (RPE) was

measured 15 min after the end of each exercise. Blood lactate concentration ([La]) was measured at rest before each exercise, between and at the end of each set. The mean VO2 during THE was significantly higher than15s/15s exercise(39.3±2.3vs. 36.8±1.9Ml /min/kg, P<0.05. The total VO2 consumed was significantly higher (P<0.05) during HTE (66.8±7.6 L) than during the 15s/15s (62.3±8.6 L). Blood lactate [La] after the first set of HTE was significantly higher than the 15s/15s (12.5±2.0 vs. 10.6±2.0 m mol/L, P<0.05). However, RPE provided by players suggested that the 15s/15swas more intense than the HTE (13±1.8vs.11.7±1.4,P<0.05).Our results demonstrate that VO2 and [La] were higher during HTE than during the 15s/15s when matched with duration. However, HTE was perceived less intense than 15s/15s. Thus, the use of HTE appears as an effective alternative for fitness coaches to develop aerobic endurance in soccer players.

Petra Zaletel et al., (2013), the training effects of dance aerobic: A Review with an Emphasis on the Perspectives of Investigations, the systematic review reveals compelling evidence supporting combined exercise interventions for elderly populations. Specifically, studies demonstrate that integrating aerobic exercise with resistance training, multi-component training, or dance-based activities produces significant improvements in physical performance metrics. These combined approaches yielded superior outcomes compared to single-modal exercises, with notable enhancements in upper and lower body strength, dynamic balance, gait speed, mobility, and reduced fall risk. Crucially, combined exercise interventions (CEX) showed additional benefits over traditional aerobic (AER) and resistance training (RES), including improved functional mobility, joint flexibility, and body composition, suggesting a more comprehensive approach to maintaining physical fitness and independence in older adults.

Ewelina Smol and Artur Fredyk (2012), Supplementary Low-Intensity Aerobic Training Improves Aerobic Capacity and Does Not Affect Psychomotor Performance in Professional Female Ballet Dancers, This study examined the effects of a six-week low-intensity aerobic training program as a supplement to regular dance practice on aerobic capacity and psychomotor performance in female ballet dancers. Maximal oxygen uptake (VO2max) and anaerobic threshold (AT) were assessed using a graded bicycle ergometer exercise test performed until volitional exhaustion, both before and after the training intervention. Additionally, psychomotor performance, measured through multiple-choice reaction time and accuracy of responses to audio-visual stimuli, was evaluated at rest and

immediately post-exercise. The supplementary low-intensity training resulted in a significant increase in VO2max and a notable shift in AT towards a higher absolute workload. Furthermore, following maximal exercise, the dancers maintained their pre-exercise psychomotor performance levels. The training did not affect resting or post-exercise reaction time or response accuracy. These findings suggest that incorporating low-intensity aerobic training into regular dance practice enhances aerobic capacity in ballet dancers without compromising the speed or precision of their psychomotor responses.

Senthilkumar, S., et al. (2011) Influence of aerobic and anaerobic interval training compared with yogic practices on selected physical fitness variables of high school football players. The aim of this study was to determine whether aerobic interval training with yogic practices (YG) or anaerobic interval training with yogic practices (YG) has greater effect on selected physical fitness variables, speed and agility among high school football players. For this purpose, the investigator selected find out the influence of aerobic and anaerobic interval 90 football players divided into three groups, namely, YG and control group (CG). The subjects were tested for speed and agility initially and after 12 weeks of experiment on respective training on the subjects. The results proved that there was significant improvement in speed (F: 45.52) and agility (F 8.37) on adjusted means, against required F value of 3.1. The post hoc analysis proved that YG was better than CG and YG in improving speed and agility of school level football players. It was concluded that aerobic interval training with yogic practices significantly improved speed and agility of the school level football players than anaerobic power with yogic practices.

Sunder, K. (2011) conducted a study to find out the isolated and combined effect of aerobic and anaerobic training on selected physical, physiological and performance variables of college men boxers.Toachievethispurpose,80 college men boxers aged between 18 and 25 years were randomly selected from various colleges in Tamil Nadu and they were divided into four equal groups of 20subjectseach. Experimental group I was exposed to aerobic training, Experimental groupie was exposed to anaerobic training, Experimental group III was exposed to combined aerobic and anaerobic training and the control group was not exposed to any experimental training other than their regular daily activities. The duration of experimental period was 12 weeks. Pre and post tests were

conducted prior and after the 12weeks of training for all the subjects on selected physical variables such as speed, agility, muscular endurance and arm explosive power and physiological variables such as resting heart rate, breath holding time, vital capacity and cardiovascular endurance and performance variables such as punches, defensive skills and overall boxing ability. Analysis of Covariance (ANCOVA) statistical technique was administered to find out the significance among the mean differences. If the adjusted post test results were significant, the Scheffe's post-hoc test was used. The results of the study revealed that 12 weeks of isolated and combined aerobic and anaerobic training would significantly improved the selected physical, physiological and performance variables of college men boxers.

Edvardsen et al. (2011) compared the aerobic capacity during maximal aerobic dance and treadmill running in fit women. Thirteen well-trained female aerobic dance instructors, aged 30 ± 8.17 years (mean ± SD), exercised to exhaustion by running on a treadmill for measurement of maximal oxygen uptake (VO_2max) and peak heart rate (HRpeak). Additionally, all subjects performed aerobic dancing until exhaustion after a choreographed videotaped routine, trying to reach the same HRpeak as during maximal running. The p-value for statistical significance between running and aerobic dance was set to ≤0.05. The results (mean ± SD) showed a lower VO_2max in aerobic dance (52.2 ± 4.02 $mL \cdot kg^{-1} \cdot min^{-1}$) compared with treadmill running (55.9 ± 5.03 $mL \cdot kg^{-1} \cdot min^{-1}$) ($p = 0.0003$). Further, the mean ± SD HRpeak was 182 ± 9.15 beats per minute in aerobic dance and 192 ± 9.62 beats per minute in treadmill running, giving no difference in oxygen pulse between the 2 exercise forms ($p = 0.32$). There was no difference in peak ventilation (aerobic dance: 108 ± 10.81 $L \cdot min^{-1}$ vs. running: 113 ± 11.49 $L \cdot min^{-1}$). In conclusion, aerobic dance does not seem to be able to use the whole aerobic capacity as in running. For well-endurance-trained women, this may result in a lower total workload at maximal intensities. Aerobic dance may therefore not be as suitable as running during maximal intensities in well-trained females.

Kalapotharakos et al. (2011) examined the seasonal changes in body composition and aerobic performance in elite soccer players. Twelve elite professional soccer players (aged 25 ± 5 years, weight 75.7 ± 5.3 kg, height 1.79 ± 0.06 m) were measured for body fat (%), maximum oxygen consumption (VO_2 max), running velocity at VO_2 max (VO_2

max), running velocity at a fixed blood lactate concentration of 4 mmol·L⁻¹ (v-4mM) at the start of the preseason period, at the beginning of the competitive period, and at midseason. VO_2 max, v-4mM, and VO_2 max increased significantly ($p < 0.05$) by 4.5, 10.5, and 7.8, respectively, after the preseason period. Thereafter, the aerobic performance parameters remained relatively constant, with no significant changes throughout the competitive period. The results of this study suggest that moderate improvements were observed in VO_2 max, and the %VO_2 max at 4 v-4 mM, whereas higher improvements were observed in VO_2 max and v-4 mmol·L⁻¹ after the preseason training period. On the other hand, during the competitive period, aerobic performance remained unchanged. In addition, this study suggests that heart rate, lactate, VO_2, and VO_2 max are useful and practical predictors that help monitor aerobic performance changes during a soccer season.

Mahendran (2009) studied the effect of 12 weeks of aerobic exercises on selected health-related physical fitness and physiological variables among adolescents. Thirty healthy, untrained school boys were selected from Sengunthar Higher Secondary School in Thuraiyur, and their age ranged from 12 to 15 years. The subjects were equally divided into two groups, namely control and experimental groups. The experimental group underwent aerobic exercises training for forty-five minutes duration for twelve weeks, with weekly five classes. The control group was kept under observation without training. Selected health-related variables were muscular strength, which was measured using a hand grip dynamometer; muscular endurance, which was measured using bent knee sit-ups; cardiorespiratory endurance, which was measured using the 12-minute run/walk; flexibility, which was measured with the reliable equipment sit-and-reach box. The body mass index (BMI) was calculated by measuring the height and body weight of the subjects. The height was measured in meters using a stadiometer, and weight was measured in kilograms using a weighing machine. The following equation was used to calculate the body mass index (BMI): BMI = weight in kg / height in meters squared. The results of pre-test and post-test were compared by using Analysis of Covariance (ANCOVA). All variables were significantly improved among the experimental group.

Koutedakis et al. (2007) conducted a study to assess the effects of three months of aerobic and strength training on selected performance and fitness-related parameters in modern dance students. The sample consisted of 32 men and women (age 19 ± 2.2 years) who were randomly assigned into exercise (n = 19) and control (n = 13) groups.

Anthropometric and flexibility assessments, treadmill ergometry, strength measurements, and a dance technique test were conducted pre- and post-exercise training in both groups. It is concluded that in modern dance students: (a) a 3-month aerobic and strength training program has positive effects on selected dance performance and fitness-related parameters,(b) aerobic capacity and leg strength improvements do not hinder dance performance as studied herein, and (c) the dance-only approach does not provide enough scope for physical fitness enhancements.

Viskic, et al. (2007) analyzed the impact of special programmed physical education including dance, aerobics and rhythmic gymnastics on the development of motor and functional abilities and morphological characteristics of female fourth grade high schoolers in Zagreb. A total sample of 220 high schoolers aged 16-18 years were divided into two groups: experimental group of 115 students attending the program composed of dance structures and aerobics, and control group of 105 students attending classic program of physical education. A set of 3 morphological variables, 6 motor variables and one functional variable were applied in both groups on three occasions during an academic year (initial, transient and final measurements). Two- factor analysis of variance (MANOVA repeated measure design) showed the experimental program to significantly influence the development of coordination/agility and specific rhythm coordination, functional aerobic ability, repetitive and explosive strength and flexibility, along with significant reduction of overweight and adipose tissue. Study results clearly indicate that the existing programs of physical education should be revised and replaced by more appropriate ones.

Preetha (2006) conducted a study to find out the effect of selected yogasanas and aerobic exercises on selected physical, physiological and psychological variables among women students of Pondicherry University. Samples were selected randomly aged between 20 to 25 years and was divided into equally three groups Control and two experimental groups. Experimental group I underwent aerobic exercises, experimental group II underwent yogasana practice the both group the training session were held five days in a week for a period of twelve weeks. Control group did not undergo any training. Prior to and at the end of training period all subjects were tested for selected physical, physiological and psychological variables. Aerobic exercises & yoga practice group

showed significant improvement on selected physical, physiological and psychological variables like weight, flexibility, and balance among experimental group than the control group.

Sporer, et al. (2003) determined the type and intensity of aerobic training affect performance in a subsequent strength-training session after varying periods of recovery. Sixteen male subjects participated in the study and were divided into2 groups based on aerobic training, high-intensity intervals (MAX n = 8) and continuous submaximal (SUB n = 8). Each subject performed 4 sets of both bench press and leg press at approximately 75% 1 repetition maximum (1RM) following aerobic training with recovery periods of 4, 8, and 24 hours, as well as once in a control condition. Both the 4 and 8-hour conditions resulted in fewer total leg press repetitions than the control and 24-hour conditions. There was no difference between both the control and 24-hour conditions. No main effect was shown with respect to the type of aerobic training. It was concluded that when aerobic training precedes strength training, the volume of work that can be performed is diminished for up to 8 hours. This impairment appears to be localized to the muscle groups involved in the aerobic training.

Srinivasamurthy (2014), effect of aerobic dance training on resting pulse rate among basketball players, this study aimed to examine the effects of aerobic dance training on the resting pulse rate of basketball players. It was hypothesized that aerobic dance training would lead to significant reductions in resting pulse rate. A total of 30 male volleyball players from Government College of Engineering, Krishnarajapete, Mandya, aged 20 to 22 years, were randomly selected for the study. A pre-test–post-test random group design was employed, consisting of an experimental group (Group A) and a control group (Group B), each comprising 15 participants. Group A underwent aerobic dance training, while Group B did not receive any training. Resting pulse rate was measured using a stethoscope before and after six weeks of training. Data analysis was conducted using ANCOVA at a 0.05 significance level. The findings indicated that aerobic dance training significantly reduced the resting pulse rate in the experimental group compared to the control group.

Critical Analysis and Synthesis of Reviewed Studies:

The reviewed literature indicates that high-intensity interval training, aerobic training, and concurrent training significantly improve the physical and physiological performance of intercollegiate male football players; however, their effects vary depending on the training modality. High-intensity interval training has been reported to be more effective in enhancing VO_2 max, speed, and agility, whereas aerobic training primarily improves cardiovascular endurance and resistance to fatigue. Concurrent training contributes to improvements in both strength and endurance. Despite these established benefits, limited studies have investigated the direct influence of these training methods on football-specific skill performance. Furthermore, very few experimental studies have compared the effects of high-intensity interval training, aerobic training, and concurrent training simultaneously within a single research design. Therefore, this gap in the existing literature justifies the need for the present study.

SUMMARY OF REVIEW OF LITERATURE

The research studies conducted in this area were carefully reviewed to obtain a clear and comprehensive understanding of high intensity interval training, aerobic training, and concurrent training. The investigator reviewed one hundred and nineteen research studies related to sports training, which were published in various periodicals, journals, e-sources, abstract-cum-souvenirs, and relevant books, as well as master's and doctoral theses in the field of physical education and sports sciences. The reviewed studies summarized the Effect of high intensity interval training, aerobic training, and concurrent training on the development of selected physical, physiological, and skill performance variables among football players.