REVIEW OF RELATED LITERATURE
CHAPTER-II

REVIEW OF RELATED LITERATURE

The need for related literature has been widely recognized in the world of research. It provides the researchers a broad and deep understanding of the published research work of the related field. The abstracts of the related studies and their findings pertaining to the present study are highlighted in this chapter. This further helped the scholar to interpret his findings as supporting evidences to evaluate the significance of this study.

A careful review and exploration of the literature related to the present study is essential to have an insight into the research already carried out in this field. In India very little research has been done as compared to the research conducted in other advanced countries.

Capitalizing on the reviews of expert researchers can be fruitful in providing helpful ideas and suggestions. Keeping this in mind the research scholar made an attempt to go through the related literatures in libraries of M.D. University, Rohtak, K.U.K., Punjabi University, Patiala, CCSHAU, Haryana Agricultural University, Hisar, Punjab University, Chandigarh, Laxmibai National Institute of Physical Education Gwalior, N.S., NIS Patiala to collect the related literature.

The literature was also reviewed through various internet sites of spots sciences. The literature which is found relevant to the present study has been abstracted in this chapter to provide the back ground material to evaluate the significance of this study as well as to interpret its findings.

Thomas (1978)\(^1\) conducted a comparative study of wrestling and soccer team. Wrestling and soccer contributed significantly to the improvement on cardio-vascular endurance, but the gain in physical fitness was not significant and neither sport appeared superior to other.

Boon (1978)\(^2\) administered the AAPHER Youth Fitness Test on 100 rural and urban boys. The urban boys were superior to the rural boys and the differences were

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significant at .01 level. The samples were weaker on the same component of physical fitness.

Tuteja (1979) studied comparison of physical fitness of rural and urban students. AAPHER Youth Fitness Test and NPE test were used. The age of subjects was from 14-17 years. The results revealed that the mean score on AAPHER test was slightly higher in case of urban high school students. Further, the mean score of rural high school students was slightly higher than that of urban high school students in NPEP test. However, none of the mean score was found statistically significant at .05 level of confidence.

Uppal (1980) reported the effect of 10 weeks participation effect on strength variables. The subjects participated for ten weeks in general course of physical education, besides participating in track and field, basketball, volleyball, rhythmic gymnastics and yogic exercises. The subjects regularly participated in a conditioning programme of thirty minutes duration, six days a week which involved calisthenics, endurance, running, circuit training and strength development exercises. The results revealed that regular participating in programme of games and sports leads to several changes in muscles, increase in leg grip and arm strength of women students.

James (1984) conducted a study to determine the effect of a selected training programme on physical fitness for this study. The subjects were 38 boys and 38 girls in three grade and six classes. All were given Krecher’s Physical Sill test for elementary school children before and after five weeks of lighter volleyball, gymnastics or rhythms, and the data were analysed with analysis of covariance. The volleyball and gymnastics group showed mean significant beyond 0.01 level.

Spaniol (1990) investigated to determine the effects combining periodized strength training and aerobic training on muscular strength, anaerobic power, aerobic capacity and body composition.

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5 A.J. James, "A study to determine the effect of selected skills programme on physical fitness". Completed Research in Health, Physical Education and Recreation, Vol. 6, 1984.
6 Frank J. Spaniol, "The physiological effects of combining periodized strength training and aerobic training". Dissertation abstract International 5 : 2 (August, 1990), 448-A.
Dutko (1993) conducted a study, the purpose of which was to compare two progressive strength training protocols, a plyometric exercise protocol and two flexibility protocols for improving the strength and flexibility of quadriceps and hamstrings muscles complex of high school weight training students. Sixty men 16-18 years of age volunteered for 6 weeks 3 days a week, quadriceps and hamstrings muscular complex strength and flexibility study.

In the study undertaken by Stine (1997) 65 male subjects were tested the first week of the terms on the independent variables of strength, power and cardiovascular endurance and ranked high, medium or lower tests on dependent variables were given last two weeks. There tests results determined the dependent variables relationship to independent variables by use of statistical procedures. The findings indicated strength and cardiovascular endurance had no significant relationship to the following.

Dependent variables: speed of serve, combination of service placement on speed and the Hewitt’s back board test, correlation, coefficient test showed significant predictability of strength and power to Hewitt’s backboard test and strength alone to percentage of wins.

Bucy (2000) compared the effect of three methods of training in physical fitness. Groups were randomly assigned 11 weeks exercise programme in addition to regular physical education classes, three times a week. Isobinetic exercise group used eight exercises, requiring nine minutes per day for five days a week. Analysis of data showed that all groups improved significantly in physical fitness strength and weight. Isometric exercise group had significantly greater strength in past test than the exercise calisthenics groups.

"Sutherland and Ismail (2000) studied the effect of circuit training on the physical fitness level of first and second grade children. The experimental group (N= 45), comprising of boys and girls, had circuit training and free play during recess for

10 M.S. Sutherland and Ismail, “Factor analytic derivation of the MHPC INM ratio implications for studying the link between physical fitness and depress”. Biological Psychology, 579-583, 2000.
12 weeks. The control group (N=44) had free play for twelve weeks. Although both groups significantly improved in physical fitness scores (standing broad jump, bench push ups, curl ups, squat jump and 30 yard dash), the experimental group was significantly (P. 01) better than the central group in physical fitness scores at the end of the study.

**Jones and Carter (2000)**\(^{11}\) conducted a meta-analysis to review the effect of endurance training on the key parameter of aerobic(endurance)fitness and attempts to relate these changes to the adaptation seen in the body's physiological system with training. There are 4 key parameters of aerobic fitness that affect the nature of the velocity-time curve that can be measured in the human athlete. These are the maximal oxygen uptake (VO2max), exercise economy, the lactate/ventilatory threshold and oxygen uptake kinetics. Other parameters that may help determine endurance performance, and that are related to the other 4 parameters, are the velocity at VO2max (V-VO2max) and the maximal lactate steady state or critical power.

**Hall and Lane (2001)**\(^{12}\) the aim of the present study was to examine the effects of rapid weight loss on mood and performance among amateur boxers. 16 experienced amateur boxers were taken as the subject of the study. In stage 1, structured interviews were used to assess the type of strategies that boxers used to reduce weight and the value of performing at their desired weight in terms of performance. In stage 2, boxers completed a 4 x 2 minute (1 minute recovery) circuit training session. Boxers completed the circuit training session on three different occasions with a week between each. The first test was used to familiarise the boxers with the circuit training task; the second and third tasks were at their training weight and championship weight, respectively. Participants were given one week to reduce their body weight to their championship weight using their preferred weight making strategies; boxers reduced their body weight by an average of 5.16% of body weight. Boxers typically lost weight by restricting fluid and food intake in the week leading to competition. Repeated measures multivariate analysis of variance results indicated that rapid weight loss among boxers was associated with poor performance, increased anger, fatigue, and tension, and reduced vigour. Strategies used to make weight by boxers are associated with poor performance and a negative mood profile.


David (2002) conducted a study on school boys ranging between fourteen to seventeen years of age to find out the relationship between physical fitness, heart rate and pulse rate. She found negative and significant relationship of physical fitness to heart rate and pulse rate. Heart rate/ pulse rate are highly related to performance in sports. Thus, it indicated that physical fitness is related to performance.

Guidetti et al. (2002) in this study eight elite Italian amateur boxers (first series of AIBA ranking) were assessed in 2 testing sessions, a week apart. In the first testing session all subjects underwent anthropometric measurements from which body fat percentage, upper arm and forearm muscle cross-sectional areas were estimated. In the second testing session all subjects performed grip strength measures and a maximal treadmill test to assess oxygen consumption (VO2), blood lactate and heart rate at maximal effort, at individual anaerobic threshold, and at individual ventilatory threshold. The athletes were ranked following the criteria of world amateur AIBA ranking. In this ranking the first ranked boxer had the highest score gained participating in international tournaments. A Spearman rho correlation analysis revealed that the VO2 at individual anaerobic threshold (46.0+/−4.2 ml x kg\(^{-1}\) x min\(^{-1}\), r=0.91) and the hand-grip strength (58.2+/−6.9 kg, r=0.87) were highly related (p<0.01) to boxing competition ranking. VO2(max)(57.5+/−4.7 ml x kg\(^{-1}\) x min\(^{-1}\), r=0.81) and wrist girth (17.6+/−0.6 cm, r=0.78) were moderately (p<0.05) related. These data suggest that there are two basic factors related to boxing performance: physical fitness as indicated by individual anaerobic threshold and maximal oxygen consumption, and upper-body muscular strength as indicated by hand-grip strength.

Kravitz et al. (2003) Eighteen trained volunteers (12 men and 6 women: age = 22.0 +/- 2.8 years, height = 170.79 +/- 7.67 cm, weight = 71.54 +/- 12.63 kg) participated in 2-minute, randomized fitness boxing trials, wearing 0.34-kg punching gloves, at various tempos (60, 72, 84, 96, 108, and 120 b.min\(^{-1}\)). During each trial, oxygen uptake (VO2), heart rate (HR), and ventilation (VE) were measured continuously. A rating of perceived exertion (RPE) was attained at the conclusion of each trial. Subjects were able to attain VO2 values ranging from 26.83 to 29.75

ml.kg(-1).min(-1), which correspond to 67.7-72.5% of VO(2)max. The HR responses yielded results ranging from 167.4 to 182.2 b.min(-1), or 85 to 93% of HRmax. No significant difference (p > 0.05) was seen with VO(2) between trials, although a significant difference (p < 0.05) was observed with HR, VE, and RPE. It appears that boxing speed is associated with increased VE, HR response, and perceived effort but not with VO(2). Energy expenditure values ranged from 9.8 to 11.2 kcal.min(-1) for the boxing trials. These results suggest that fitness boxing programs compare favorably with other exercise modalities in cardiovascular response and caloric expenditure.

Simranjeet Singh et al. (2003) evaluated the purpose of the study was to see the difference between fitness of senior junior (girls) hockey players. The subjects for this study were Hockey girls attending the camps at SAINSNIS, Patiala. Five tests were administered to assess the physical fitness level. The data was statistically analyzed. It was found that there is not significant difference between senior and junior group in 30 m and standing broad jump test performance. The junior group was found to be significantly superior in Agility and Endurance ability. The senior group was found to be significantly better in shoulder strength.

Siegler et al. (2003) evaluated changes in soccer-specific power endurance of 34 female high school soccer players throughout a season either with or without an intermittent, high-intensity exercise protocol. Thirty-four female high school soccer players were tested prior to the 2000 fall season and again 10 weeks later. The tests included an abridged 45-minute shuttle test (LIST), hydrostatic weighing, vertical jump, 20-m running-start sprint, and 30-second Wingate test. The experimental group (EG; n=17, age 16.5 ± 0.9 years) completed a 10-week in-season plyometric, resistive training, and high-intensity anaerobic program. The control group (n=17, age 16.3 ± 1.4 years) completed only traditional aerobic soccer conditioning. Statistical significance was set at alpha <0.05. The experimental group showed significant improvements in the LIST (EG = delta 394 seconds ± 0.10 seconds), increase in fat-free mass (EG = delta 1.14 kg ± 1.22 kg), and decreases in fat mass (EG – delta 1.40 kg ± 1.47 kg) comparing pre- to postseason. This study indicates that a strength and
plyometric program improved power endurance and speed over aerobic training only. Soccer-specific power endurance training may improve match performance and decrease fatigue in young female soccer players.

Esposito (2004)\(^{18}\) studied to validate the use of heart rate (HR) in describing and monitoring physiological demands during soccer activities, the HR versus oxygen uptake (VO\(_2\)) relationship determined on the field during soccer-specific exercises was compared to that found in the laboratory during treadmill exercise. Seven male amateur soccer players [mean (SE), age 25.3 (1.2) years, body mass 72.9 (2.1) kg, stature 1.76 (0.03) m] performed three trials on the field (two laps of a purpose-made circuit including a variety of soccer activities) at different intensities (moderate, high and very high, according to their rate of perceived exertion) and an incremental test on a treadmill in the laboratory. HR increased linearly with VO\(_2\) during both field and laboratory tests according to exercise intensity (p<0.01). The mean correlation coefficients of HR-VO\(_2\) relationships obtained in the laboratory and on the field were 0.984 (0.012) and 0.991 (0.005) (p<0.001), respectively. The mean value of the HR-VO\(_2\) regression equation slope and intercept obtained in laboratory [0.030 (0.002) and 79.6 (4.6), respectively] were not significantly different compared to those found on the field [0.032 (0.003) and 76.7 (9.7)]. The present study seems to confirm that HR measured during soccer exercises effectively reflects the metabolic expenditure of this activity. Thus, with the aid of laboratory reference tests, the physiological demands of soccer activities can be correctly estimated from HR measured on the field in amateur soccer players.

Garstrecki et al. (2004)\(^{19}\) studied the comparison of selected physical fitness and performance variables between NCAA Division I and II football players. The purpose of the study was to compare selected physical fitness and performance variables between National Collegiate Athletic Association (NCAA) Division I and II football players. The subjects included offensive and defensive starters, excluding kickers and punters from 26 NCAA Division 23 and I Division II teams. Offensive players were grouped and compared by the following position: quarterback, running back, wide receiver, tight ended, and line. Defensive players were grouped and


compared by the following positions: line, linebackers, and back. Division I players were better in 58 of 117 comparisons (p=0.01). Division II players were not found to be better in any of the variables studied.

Secora (2004) conducted a study to compare physical and performance characteristics of NCAA Division I football players: 1987 and 2000. The purpose of the study was to compare normative data from present Division I national Collegiate Athletic Association football teams to those from 1987. Players were divided into 8 positions for comparisons: quarterback (QB), running back (RB), receivers (WR), tight ends (TE), offensive linemen (OL), defensive linemen (DL), linebackers (LB), and defensive back (DB). Comparison included height; body mass, bench press and squat strength, vertical jump, vertical jump power, 40-yd dash speed, and body composition. Independent 't' test were used to analyze the data with level of significance set at p<0.01. Significant difference (p=0.01) were found in 50 of 88 comparisons. From 1987 until 2000, Division I college football players in general have become bigger, stronger, faster, and more powerful.

Thomas (2004) studied on cheerleading which traditionally considered as a non-athletic activity, which require high level of fitness. Despite the trend of cheerleaders performing increasingly difficult and athletic skills, very little is known about their fitness levels. The purpose of the study was to provide a physiological profile of the fitness status of a squad of collegiate cheerleaders. Eighteen cheerleaders (11 men and 7 women) participated in this study. Each subject completed a Bruce protocol maximal treadmill test, underwater weighing repetition maximum bench press, sit and reach test, pushups, curl ups, and isokinetic strength testing. The mean and SD were calculated to provide the physical fitness profile for each parameter. Comparison to normative data demonstrated that cheerleaders have a high level of fitness and scores similar to other collegiate athletes.

Vanheest et al. (2004) studied the characteristics of elite open-water swimmers. Open water swimming (5, 10 and 25 km) has many unique challenges that separate it from other endurance sports, like marathon running and cycling. The


characteristics of a successful open-water swimming are unclear. The purpose of the study was to determine the physical and metabolic characteristics of a group of elite level open water swimmers. The open water swimmers were participating in a 1-week training camp. Anthropometric, metabolic, and blood chemistry assessments were performed on the athletes. The swimmers had a VO$_2$ peak of $5.51 \pm 0.96$ and $5.06 \pm 0.57$ ml.kg$^{-1}$. min$^{-1}$ for males and females respectively. Their lactate threshold (LT) occurred at a pace equal to 88.75% of peak pace for males and 93.75% for females. These elite open water swimmers were smaller and lighter than competitive pool swimmers. They possess aerobic metabolic alterations that resulted in enhanced performance in distance swimming. Trainers and coaches should develop dry-land programs that will improve the athlete's muscular endurance. Furthermore, programs should be designed to increase the LT velocity as a percentage of peak swimming velocity.

Wisloff (2004)$^{23}$ determined whether maximum strength correlates with sprint and vertical jump height in elite male soccer players. Seventeen international male soccer players (mean (SD) age 25.8 (2.9) years, height 177.3 (4.1) cm, weight 76.5 (7.6) kg, and maximal oxygen uptake 65.7 (4.3 ml.kg$^{-1}$ min$^{-1}$) were tested for maximum strength in half squats and sprinting ability (0.30 m and 10 m shuttle run sprint) and vertical jumping height. There was a strong correlation between maximum strength in half squats and sprint performance and jumping height. Maximum strength in half squats determines sprint performance and jumping height in high level soccer players. High squat strength did not imply reduced maximum oxygen consumption. Elite soccer players should focus on maximum strength training, with emphasis on maximum mobilization of concentric movements, which may improve their sprinting and jumping performance.

Kelestimur et al. (2004)$^{24}$ in this preliminary study, they have assessed the pituitary functions in boxers. Eleven actively competing or retired male boxers with a mean age of 38.0 +/- 3.6 yr and 7 age-, sex- and BMI-matched healthy non-boxing controls were included in the study. Biochemical and basal hormonal parameters including IGF-I levels were measured. To assess GH secretory status in boxers and


healthy controls, GHRH (1 microg/kg)+GHRP-6 (1 microg/kg) test was performed. After GHRH+GHRP-6 test, mean peak GH level in boxers and in controls were 10.9 +/- 1.7 and 41.4 +/- 6.7 microg/l, respectively (p < 0.05). Peak GH levels in 5 (45%) boxers were found to be lower than 10 microg/l and considered as severe GH deficient. In the control group, mean IGF-1 levels (367 +/- 18.8 ng/ml) were significantly higher than that obtained in boxers (237 +/- 23.3 ng/dl) (p < 0.01). All the other pituitary hormones were normal including ADH as no signs and symptoms of diabetes insipidus. There was a significant negative correlation between peak GH levels and boxing duration, and between peak GH levels and number of bouts. In conclusion, we think that boxing is a cause of TBI, and GH deficiency is very common among boxers. Further studies including large number of boxers, both professional and amateur, are needed to clarify pituitary dysfunction in boxers.

Moriarity et al. (2004) Objectives of present study was to determine whether participation in a 7-day amateur boxing tournament is associated with acute deterioration in cognitive test performance. A prospective study was done of 82 collegiate amateur boxers participating in a 7-day single elimination tournament and a group of 30 matched nonboxing control participants. No participants had a history of recent concussion or past history of brain injury. For boxers, cognitive assessment using a computerized test battery was performed before the tournament and within 2 hours of completing each bout. Tests of simple and choice reaction time, working memory, and learning were administered. Analysis of variance was conducted to compare the serial performance of control participants with that of boxers participating in one, two, and three bouts. The 82 boxers fought 159 times. Cognitive testing was performed after 142 of these bouts. On simple reaction time, choice reaction time, and working memory tasks, the serial performance of boxers participating in three bouts (n = 22) was equivalent to that of boxers participating in two bouts (n = 22) and one bout (n = 32) and to nonboxing control participants (n = 30). An improvement in performance was observed on the learning task in boxers participating in three bouts. Boxers whose bout was stopped by the referee (n = 7) displayed significant slowing in simple and choice reaction time. With the exception of boxers whose contest is stopped by the referee, amateur boxers participating in

multiple bouts during a 7-day tournament display no evidence of cognitive dysfunction in the immediate postbout period.

Bianco et al. (2005) Objectives of the study was to investigate the prevalence of ocular injuries in a large population of boxers over a period of 16 years, in particular, the most severe lesions that may be vision threatening. Clinical records of the medical archive of the Italian Boxing Federation were analysed. A total of 1032 boxers were examined from February 1982 to October 1998. A complete ophthalmological history was available for 956, who formed the study population (a total of 10 697 examinations). The following data was collected: age when started boxing; duration of competitive boxing career (from the date of the first bout); weight category; a thorough ocular history. The following investigations were carried out: measurement of visual acuity and visual fields, anterior segment inspection, applanation tonometry, gonioscopy, and examination of ocular fundus. Eighty age matched healthy subjects, who had never boxed, formed the control group. Of the 956 boxers examined, 428 were amateur (44.8%) and 528 professional (55.2%). The median age at first examination was 23.1 (4.3) years (range 15-36). The prevalence of conjunctival, corneal, lenticular, vitreal, ocular papilla, and retinal alterations in the study population was 40.9% compared with 3.1% in the control group (p< or =0.0001). The prevalence of serious ocular findings (angle, lens, macula, and peripheral retina alterations) was 5.6% in boxers and 3.1% in controls (NS). Boxing does not result in a higher prevalence of severe ocular lesions than in the general population. However, the prevalence of milder lesions (in particular with regard to the conjunctiva and cornea) is noteworthy, justifying the need for adequate ophthalmological surveillance.

Chamari (2005) studied a new test to assess aerobic performance in soccer by means of a specific dribbling track: the Hoff test. They further determined whether improvement in maximum oxygen uptake was reflected in increased distance covered in the Hoff test. 18 male soccer players (14 years old) both were tested in the laboratory and using the Hoff test before and after 8 weeks of soccer training. The distance covered in the Hoff test correlated significantly with maximum oxygen uptake.

uptake, and improved by 9.6% during the 8 week training period, while maximum oxygen uptake and running economy improved by 12 and 10%, respectively. Backward multiple regressions showed maximum oxygen uptake to be the main explanatory variable for the distance covered in the Hoff test. The present study demonstrated a significant correlation between laboratory testing of VO\(_2\) (max) and performance in the Hoff test. Furthermore, training induced improvements in VO\(_2\) (max) were reflected in improved performance in the Hoff test. It was suggested that there should be a goal for active U-15 soccer players to cover more than 2100 meters in the Hoff test, as this required a VO\(_2\) (max) to above 200 ml.kg\(^{-1}\) min\(^{-1}\), which should serve as a minimum in modern soccer.

**McMillan (2005)**\(^{28}\) studied physiological adaptations to a 10 week high intensity aerobic interval training program performed by professional youth soccer players, using a soccer specific ball dribbling track. Eleven youth soccer players with a mean (SD) age of 16.9 (0.4) years performed high intensity aerobic interval training sessions twice per week for 10 weeks in addition to normal soccer training. The specific aerobic training consisted of four sets of 4 min work periods dribbling a soccer ball around a specially designed track at 90-95% of maximum heart frequency, with a 3 min recovery jog at 70% of maximal heart frequency between intervals. Mean VO\(_2\) max improved significantly from 63.4 (5.6) to 69.8 (6.6 ml. Kg\(^{-1}\) min\(^{-1}\), or 183.3 (13.2) to 201.5 (16.2) ml. Kg\(^{-1}\) min\(^{-1}\) (p<0.001). Squat jumps and counter movement jump height increased significantly from 37.7 (6.2) to 40.3 (6.1) cm and 52.0 (4.0) to 53.4 (4.2) cm, respectively (p<0.05). No significant changes in body mass, running economy, rate, of force development, or 10 m sprint times occurred. Performing high intensity 4 min intervals dribbling a soccer ball around a specially designed track together with regular soccer training is effective for improving the VO\(_2\) max of soccer players, with no negative interference effects on strength, jumping ability, and sprinting performance.

**McIntyre (2005)**\(^{29}\) evaluated and compared the mid-season physiological profiles of elite players. Physiological assessment was carried out on 29 inter-country


Gaelic footballers, 30 inter-country hurlers, and 21 League and Ireland soccer players. Significant differences were reported for % body fat (p<0.05), aerobic capacity (p<0.05), flexibility (p<0.05), upper body strength (p<0.05), upper body strength endurance (p<0.05), abdominal endurance (p<0.05) and speed endurance (p<0.05), while there were no differences recorded for height, weight, or speed levels. A relatively heterogeneous body size is evident for all three sports. Soccer players had lower body fat levels, greater aerobic capacity, greater strength endurance, and greater flexibility compared to both Gaelic footballers and hurlers, possibly due to specific training and conditioning programmes or physical adaptation to match play. The greater strength of both Gaelic footballers and hurlers and the superior speed endurance levels of Gaelic footballers also reflect the physical nature of the sports. Similar speed levels amongst all three sports reflect the importance of speed for performance. The various physiological attributes for Gaelic football, soccer, and hurling reflect the physical requirements for success and participation in each of these field games.

Cronin and Hansen (2005)\textsuperscript{30} conducted a study on the relationship between strength and power and measures of first-step quickness (5-m time), acceleration (10-m time), and maximum speed (30-m time). The correlations between the 3RM, drop jump, isokinetic strength measures, and the 3 measures of sport speed were nonsignificant. Correlations between the jump squat (height and relative power output) and countermovement jump height and the 3 speed measures were significant. The squat and countermovement jump heights as well as squat jump relative power output were the only variables found to be significantly greater in the fast players.

Kittel et al. (2005)\textsuperscript{31} Boxer that take part on contests regularly are characterized by high strains on the locomotor system. Especially the area of shoulder girdle and neck can be overused by the fighting posture and standard techniques, that are often associated with non-physiological patterns. A sample of 11 young boxers (age 14.6 +/- 0.6 years; 7.3 +/- 0.6 training units per week) and a control group (CG) of 52 male pupils (age 15.4 +/- 0.4 years) the static of head, shoulder girdle, and pelvis was detected by somatoscopy. Additionally, cyclical rotations of the cervical

spine were measured using the 3-d-motion recording system CMS70 (Zebris, Germany) and the active range of motion was analysed. RESULTS: In comparison to the CG, head and shoulder of the boxers were ventralised more often (p < 0.01). Furthermore, highly significant group differences in the bilateral position of the shoulder heights and the iliac crests were detected in the frontal plane. On average, the active maximum rotation of the boxers was decreased by 17.8 degrees (p = 0.006; d = 0.800). Our study was able to detect significant differences in the analysed functional parameters of the locomotor system that may be explained by boxing specific strains and which are prerequisites of optimal performance. As long-term pathologic effects can not be excluded, adequate compensational exercises should be integrated in the training.

McIntyre (2005) undertook the study to examine the physiological profile, and its relation to playing position for elite college Gaelic footballers. METHOD: The subjects were 28 elite Gaelic footballers (12 backs, 12 forwards, and four midfielders; mean (SD) age 21 (1.67) years), who won a major intervarsity tournament (Sigerson Cup) three times in succession. The team means for stature (1.81 (0.05) m), body mass index (81.6 (6.5)) and percentage body fat (14.5 (3.1) %), power output by Wingate test (absolute power 912 (152) W or 10.72 (1.6) W/kg) and sit and reach test (22.3 (5.5) cm) displayed no significant differences when analyzed according to playing position. However, midfielders did have significantly larger body mass than backs and greater maximum oxygen consumption and greater vertical jumping ability than backs and forwards. Midfielders also had greater absolute handgrip strength. The differences exhibited by midfielders despite identical training suggest that they stem from physiological adaptation to competition rather than training.

Chatterjee et al. (2006) objective of this study was aimed to estimate the energy expenditure in Indian female boxers during sparring. A total of 20 female boxers were subjected. Energy expenditure was estimated using the same individual’s HR-VO2 regression equation. Heart rate was recorded through radiotelemetry. Results reveal that average and maximum energy expenditure considering the total duration of boxing are 12.7 +/- 1.3 and 14.4 +/- 1.6 kcal/min. It is concluded that depending on the severity of energy expenditure female boxing comes under heavy

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category and as it is a pioneer attempt in India, further studies in this aspect are really required which will guide the coaches regarding the energy expenditure pattern in women boxing.

Geithner et al. (2006) conducted a study to describe and compare physical, fitness, and skating performance characteristics of forwards (F), defensemen (D), and goalies (G). Subjects were 112 University of Alberta women players (21.4 ± 2.9 years of age). A full anthropometric battery was conducted on each player. Significant positional differences were found for bicristal breadths (D > G, F > G); relaxed arm circumference (D > F, G > F); supraspinale and biceps skinfolds (G > D, G > F); and endomorphy (G > F). Significant differences among positions were also found for the MRSS (G > D > F) and agility tests (G > D, G > F). D tended to have the most robust build overall. F were leaner than D and G, and their smaller relaxed arm circumference measurements most likely reflect less subcutaneous fat on the upper arm. F had greater anaerobic power than D, followed by G, and they tended to have greater aerobic capacity. F and D were more agile than G. Performance demands appear to be position specific. F need to be the most versatile and fit because of a greater amount and variety of work performed both during practices and games; their required degrees of versatility and fitness are followed by those required of D and G.

Katie et al. (2006) the aim of the study was to analyze the relations of cognitive processors and conative regulators with specific motor abilities of elite boxers. Three sets of variables including 3 cognitive and 6 conative variables as predictors, and 6 specific motor (boxing) variables as criteria were used in a sample of 92 boxers. A series of regression analyses between the set of cognitive variables and particular criterion variables revealed a predominant impact of serial processor on specific motor abilities based primarily on specific speed (frequency of boxing technique performance). The series of regression analyses also showed a predominant negative impact of dysregulation of the organ function regulators from the set of conative variables on the manifestation of specific motor abilities in boxers. The data obtained in the study was used to develop an alternative model of the motor - cognitive - conative processes in boxing.

Ostojic et al. (2006)36 studied to describe structural and functional characteristics of elite Serbian basketball players and to evaluate whether players in different positional roles have different physical and physiological profiles. Physiological measurements were taken of 60 players during the final week of their preparatory training for competition. According to positional roles, players were categorized as guards (n = 20), forwards (n = 20), and centers (n = 20). The results of the present study demonstrate that a strong relationship exists between body composition, aerobic fitness, anaerobic power, and positional roles in elite basketball.

Silvestre et al. (2006)37 undertook the study to examine changes in body composition (BC) and physical performance tests (PT) resulting from a competitive season in soccer. Twenty-five male collegiate players were tested before (PRE) and after (POST) the 2003-2004 National Collegiate Athletic Association season. The following tests were performed: BC (anthropometric and dual energy x-ray absorptiometry measurements), vertical jump (VJ), 9.1-m (9 m) and 36.5-m (36 m) sprint, lower-body power (LP), total body power (TP), and cardio respiratory endurance (VO2max). Training was divided into soccer-specific training: field warm-up drills, practices, games, and additional conditioning sessions. The only significant improvements across the season were for TP (17.3%) and for LP (10.7%). In conclusion, soccer athletes who begin a season with a high level of fitness can maintain, and in some cases improve, body composition and physical performance from before to after a competitive season.

Tahara (2006)38 undertook the study to evaluate the physical and physiological ability of selected soccer players of Kunimi High School in Nagasaki Prefecture, Japan. Total 72 members aged between 16 and 18 years old between 1986 and 1994 were tested. They consisted of 66 outfield players (12 forward players, 23 midfielders, 31 defenders) and 6 goalkeepers. The following results were obtained: 1. The average of 66 outfield players was 172.7 cm of height, 64.6 kg of weight, 54.0

cm of girth of thigh, and 90.0 cm of girth of hip, 9.3% of %Fat, 58.6 kg of FFM, 33.9 kg. m (-1) of FFM/Ht and 113.8 kg. m (-3) of FFM index. The mean vital capacity was 4.25 L and total lung capacity was 5.58 L. The mean maximal ventilation was 138.7 L.min (-1), VO2 max was 3.95 L.min (-1), and VO2 max/Wt was 61.4 ml.kg.min (-1).min (-1). 2. Goalkeepers were taller and heavier than outfielders, and had a smaller mean value of VO2 max/Wt than outfielders (p<0.01). 3. For 23 out of the 72 players measured twice with an interval of about one year, FFM increased and %Fat reduced significantly, while V (E) max, VO2 max and VO2max/Wt did not change.

Vescovi et al. (2006) conducted a study on Physiological profiles of soccer players with respect to playing positions, the purpose of this investigation was to determine and compare positional characteristics (physical and physiological) of Division I College female soccer players. Sixty-four university soccer players volunteered to participate and were evaluated at the end of their spring season. Test items height and body mass, acceleration (9.14 m), speed (18.28 and 36.58 m), agility (Pro-agility and Illinois), lower body power (countermovement jump), and estimated aerobic capacity (20 meter beep test). Mean (±SD) height and body mass were 168.4 ± 5.9 cm and 64.8 ± 5.9 kg, respectively. No significant differences were observed between positions, however defenders and keepers tended to be taller and heavier compared to forwards and midfielders. Positional differences did not appear for any of the other performance tests. Yet, defenders tended to show slightly slower times for the speed and agility tests while keepers tended to be slower on the agility tests compared to forwards and midfielders. Aerobic capacity was similar across the four positions. Similar physical and physiological characteristics were found within this sample of Division I female college soccer players.

Yaggie and Campbell (2006) conducted a study on the effect of a 4-week balance training program on specified functional tasks. Thirty-six subjects were randomly placed into control (C; n = 19) and experimental groups (Tx; n = 17). The Tx group trained using a commercially available balance training device (BOSU). Postural limits (displacement and sway) and functional task (time on ball, shuttle run, and vertical jump) were assessed during a pretest (T1), a posttest (T2), and 2 weeks

post training (T3). Multivariate repeated measures analysis (alpha = 0.05) revealed significant differences in time on ball, shuttle run, total sway, and fore/aft displacement after the exercise intervention (T2). T3 assessment revealed that total sway and time on ball remained controlled; however, no other measures were retained. Balance training improved performance of selected sport-related activities and postural control measures, although it is unclear whether the effect of training would transfer to general functional enhancement.

Zetterberg et al. (2006)\textsuperscript{41} the present study aimed to determine whether amateur boxing and severity of hits are associated with elevated levels of biochemical markers for neuronal injury in cerebrospinal fluid. DESIGN: Longitudinal study. Referral center specializing in evaluation of neurodegenerative disorders. Fourteen amateur boxers (11 men and 3 women) and 10 healthy male nonathletic control subjects. The boxers underwent lumbar puncture 7 to 10 days and 3 months after a bout. The control subjects underwent LP once. Neurofilament light protein, total tau, glial fibrillary acidic protein, phosphorylated tau, and beta-amyloid protein 1-40 (Abeta([1-40]))and 1-42 (Abeta([1-42])) concentrations in cerebrospinal fluid were measured. Increased levels after a bout compared with after 3 months of rest from boxing were found for 2 markers for neuronal and axonal injury, neurofilament light protein (mean +/- SD, 845 +/- 1140 ng/L vs 208 +/- 108 ng/L; \textit{P} = .008) and total tau (mean +/- SD, 449 +/- 176 ng/L vs 306 +/- 78 ng/L; \textit{P} = .006), and for the astroglial injury marker glial fibrillary acidic protein (mean +/- SD, 541 +/- 199 ng/L vs 405 +/- 138 ng/L; \textit{P} = .003). The increase was significantly higher among boxers who had received many hits (>15) or high-impact hits to the head compared with boxers who reported few hits. In the boxers, concentrations of neurofilament light protein and glial fibrillary acidic protein, but not total tau, were significantly elevated after a bout compared with the nonathletic control subjects. With the exception of neurofilament light protein, there were no significant differences between boxers after 3 months of rest from boxing and the nonathletic control subjects.

Amvakoudis et al. (2007)\textsuperscript{42} studied the effects of prolonged basketball skills training on maximal aerobic power, isokinetic strength, joint mobility, and body fat.

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\textsuperscript{42} Amvakoudis, Efstratios; Vrabas, Ioannis S; Galazoulas, Christos ; Stefanidis, Panagiotis; Metaxas, Thomas I; Mandroukas, Konstantinos; "Effects of basketball training on maximal oxygen uptake,
percentage, in young basketball players, and controls of the same age. 20 basketball players and 18 control boys participated in the study. All subjects were tested every 6 months for VO$_2$max, peak torque values of the quadriceps and hamstrings at 180 and 300° s$^{-1}$ and range of motion of the knee and hip joints. Body fat percentage was assessed at the beginning and the end of the experimental period. Results showed that the basketball group had lower heart rate values in same ages and higher VO$_2$ values in the initial test compared with the control in submaximal intensity. At the end of the 18-month follow-up period no significant differences were observed in isokinetic strength and joint mobility of the lower limbs between the 2 groups. On the contrary, the boys of the trained group had significantly lower percentage body fat, compared to controls.

Beckwith et al. (2007) the purpose of this study was to validate an instrumented boxing headgear (IBH) that can be used to measure impact severity and location during play. The instrumented boxing headgear data were processed to determine linear and rotational acceleration at the head center of gravity, impact location, and impact severity metrics, such as the Head Injury Criterion (HIC) and Gadd Severity Index (GSI). The instrumented boxing headgear was fitted to a Hybrid III (HIII) head form and impacted with a weighted pendulum to characterize accuracy and repeatability. Fifty-six impacts over 3 speeds and 5 locations were used to simulate blows most commonly observed in boxing. A high correlation between the HIII and instrumented boxing headgear was established for peak linear and rotational acceleration ($r^2 = 0.91$), HIC ($r^2 = 0.88$), and GSI ($r^2 = 0.89$). Mean location error was 9.7 +/- 5.2 masculine. Based on this study, the IBH is a valid system for measuring head acceleration and impact location that can be integrated into training and competition.

Chatterjee et al. (2007) the present study was undertaken with an objective to frame out the lipid profile of Indian Women Boxers. The study was based on a sample of 45 women boxers (age 17 ~ 24 years) attending Senior National Women Boxing Camp at Sports Authority of India. Each subject was evaluated for Lipid muscle strength, and joint mobility in young basketball players" Journal of strength and conditioning research, 21(3), pp 930-936, 2007

Profile variables at the beginning and end of the six weeks training camp. Fasting blood samples were taken from the antecubital vein by venipuncture. Before the samples drawn the subjects were asked to take rest for ten minutes. The blood sample was analyzed by HITACHI UV-2000 spectrophotometer (Japan). Standard techniques and procedures were followed for all the estimation. Volume and intensity of different components of training was measured by observational and physiological methods. Data were subjected to statistical treatment like mean and standard deviation. Test of significance (t-test for paired sample) was applied to assess the difference in pre & post-test. Results reveal that mean (+/-SD) Cholesterol, Triglyceride, LDL, HDL - Cholesterol and Cholesterol / HDL Cholesterol ratio was 144.7 +/- 3.6 mg%, 59.7 +/- 17.5 mg% 81.4 +/- 21.1 mg% 51.3 +/- 8.2 mg% and 2.8 +/- 0.5 respectively as found in the pre-test. Significant difference (P < 0.01) was observed in Cholesterol, LDL-Cholesterol, HDL Cholesterol level in the post-test. The study concludes that women who practice sport of boxing on regular basis have a favorable lipid profile. A significant change in lipid profile of the boxers was observed after 6 weeks' training program.

David et al. (2007)\textsuperscript{45} conducted a study to examine the effect of 12 weeks of medicine ball training on high school baseball players. Group 1 (n = 24) and group 2 (n = 25) performed the same full-body resistance exercises according to a stepwise periodized model and took 100 bat swings a day, 3 days per week, with their normal game bat for 12 weeks. Group 2 performed additional rotational and full-body medicine ball exercises 3 days per week for 12 weeks. Although both groups made statistically significant increases in dominant and nondominant torso rotational strength and the medicine ball hitter's throw, group 2 showed significantly greater increases in all 3 variables than group 1. Furthermore, both groups made significant increases in predicted 1RM parallel squat and bench press after 4, 8, and 12 weeks of training; however, there were no differences between groups.

Markovic et al. (2007)\textsuperscript{46} conducted a study to evaluate the effects of sprint training on muscle function and dynamic athletic performance and to compare them with the training effects induced by standard plyometric training. Male physical


Education students were assigned randomly to 1 of 3 groups: sprint group (SG; n = 30), plyometric group (PG; n = 30), or control group (CG; n = 33). It was conclude that short-term sprint training produces similar or even greater training effects in muscle function and athletic performance than does conventional plyometric training.

Cressey et al. (2007) conducted a study on the effects of 10 weeks of lower-body UST on performance in elite athletes. Nineteen healthy, trained members (ages 18-23 years) of a National Collegiate Athletic Association Division I collegiate men's soccer team participated. The experimental (US) group (n = 10) supplemented their normal conditioning program with lower-body exercises on inflatable rubber discs; the control (ST) group (n = 9) performed the same exercises on stable surfaces. Bounce drop jump (BDJ) and countermovement jump (CMJ) heights, 40- and 10-yard sprint times, and T-test (agility) times were assessed before and after the intervention. The ST group improved significantly on predicted power output on both the BDJ (3.2%) and CMJ (2.4%); no significant changes were noted in the US group. Both groups improved significantly (US = 2.9%, ST = -4.4%) on T-test performance; no statistically significant changes were apparent between the groups.

Melrose et al. (2007) conducted a study on the physical and performance characteristics of adolescent club volleyball players. Twenty-nine adolescent girls, aged 12 to 17 years (14.31 ± 1.37) were participants in this investigation. All athletes were members of a competitive volleyball club.

For purposes of analysis, players were divided into 2 age groups: 12 to 14 years (group A) and 15 to 17 years (group B). Significant differences were found between age groups for the following values: HT, WT, LBM, IHG, ILS, SBJ, and SVV. Results suggested that age, experience, LBM, shoulder, hip, and thigh girths, strength, and balance are key physical performance characteristics of adolescent girls who play volleyball.

Sirotic and Cuttos (2007) studied to determine the physiological factors that best relate to a generic PHIIR simulation that reflects team sport running activity.

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The second purpose of this study was to determine the relationship between common performance tests and the generic PHIIR simulation. Following a familiarization session, 16 moderately trained (VO$_2$max = 40.0 ± 4.3 ml·kg$^{-1}$·min$^{-1}$) women team sport athletes performed various physiological, anthropometrical, and performance tests and a 30-minute PHIIR sport simulation on a non-motorized treadmill. The mean heart rate and blood lactate concentration during the PHIIR sport simulation were 164 ± 6 b·min$^{-1}$ and 8.2 ± 3.3 mmol·L$^{-1}$, respectively. Linear regression demonstrated significant relationships between the PHIIR sport simulation distance and running velocity attained at a blood lactate concentration of 4 mmol·L$^{-1}$ (LT) ($r = 0.77$), 5 × 6-second repeated cycle sprint work ($r = 0.56$), 30-second Wingate test ($r = 0.61$), peak aerobic running velocity ($V_{max}$) ($r = 0.69$), and Yo-Yo Intermittent Recovery Test (Yo-Yo IR1) distance ($r = 0.50$), respectively.

Zant and Bouillon (2007)$^{50}$ studied to assess the aerobic and muscular strength effects of strength cycle training (SCT), comparing it to similar standard cycle training. A total of 28 recreationally-trained adult subjects (9 men, 19 women) were paired for VO$_2$ peak and randomly assigned to either SCT or Monark cycle training (MCT). Subjects trained 3 days per week following a progressive interval protocol for 9 weeks under supervised conditions. Training resulted in significant increases in VO$_2$ peak and submaximal power output significant reductions in sub maximal VO$_2$, HR, and RPE in both groups. Significant increases in bilateral isokinetic knee extension and left ankle plantar flexion were noted following training in both groups. No group differences were detected in any variable.

Vehrs et al. (2007)$^{51}$ conducted a study to evaluate the validity of the desktop CardioCoach metabolic system to measure VO$_2$max and VE$\text{max}$. Sixteen subjects (mean age = 19.5 ± 3.2 years) completed 2 maximal graded exercise tests following the same protocol before and after 7 and 14 weeks of endurance training. The time to test completion and the final treadmill grade of the exercise tests performed by both the CardioCoach and the TrueOne increased over the 3 testing periods, confirming an improvement in cardiorespiratory fitness resulting from the 14 weeks of training. A linear growth curve analysis indicated that there were statistically significant


differences between VO2max as measured by the True One and the CardioCoach before and after 7 weeks of training but not after 14 weeks of training. Significant differences also existed in VEmax (L x min⁻¹) as measured by the True One and the Cardio Coach before after 7 week and after training. Although significant growth of VO2m and VE max was measured by the True One over 14 weeks of training, the Cardio Coach was unable to detect growth in VO2max.

**Carrey et al. (2007)**⁵² conducted a study to assess the relationship between aerobic capacity, as measured by the VO2max test, and recovery from high-intensity intermittent exercise. Eleven female collegiate hockey players agreed to participate. It was concluded that ability to recover from high-intensity intermittent exercise is not related to aerobic capacity. Coaches and trainers probably do not need to include aerobic training in their practices, because the high-intensity interval training commonly seen in hockey training also improves aerobic capacity, as reflected in the high VO2max values of these subjects.

**Miller et al. (2007)**⁵³ studied to determine whether there were seasonal changes in Aerobic capacity and body composition at 3 time points over a 1-year period in 26 Division 1A women soccer players from Texas A&M University. Subjects were tested in December, immediately following a 4-month competitive season; in April, following 15 weeks of strength and conditioning; and immediately prior to the start of the regular season in August, following a 12-week summer strength and conditioning program. Significant differences in VO2max were measured between August and December. No significant changes in aerobic capacity were found between April and August. Significant increases in body fat were measured between August and December, before and after the competitive season, respectively. No significant changes in body fat were found between April and August.

**Sbriccoli et al. (2007)**⁵⁴ Studied to describe the cardio respiratory fitness and lower limbs maximal muscle power of a selected group of Olympic Italian male (M) and female (F) judokas. Eleven subjects (6 M, 5 F) underwent 3 different tests. Lower

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limbs muscle peak power (PP) and mean power (MP) were determined during a 30-second Wingate test (WIN). Post-WIN blood lactate peak was also measured. Both PP and MP, measured during the WIN, were significantly higher in M than in F judokas. Post WIN blood lactate peak was 6.9 ± 2.8 mmol·l⁻¹ and 6.1 ± 1.8 mmol·l⁻¹ for M and F judokas, respectively (not significant). During the CT blood lactate peak was 9.9 ± 3.0 mmol·l⁻¹ (M) and 9.2 ± 2.0 mmol·l⁻¹ (F); these values being significantly higher than those obtained after the WIN (p < 0.05).

Umpierre and Stein (2007) more recently, studies using homodynamic evaluation additionally, resting blood pressure also seems to be influenced by chronic resistance training, with a slight reduction in both systolic blood pressure (SBP) and diastolic blood pressure (DBP). The measurement of pressure level after a simple resistance exercise session shows the occurrence of post-exercise hypotension in normal and hypertensive individuals; however, there is controversy as to the intensity of effort necessary to induce this effect. Additional research is necessary for an analysis of the efficacy of this intervention on validated outcomes, and for a greater understanding of the physiological mechanisms responsible for vascular adaptations.

Koutedakis et al. (2007) studied to assess the effects of a 12-week aerobic and muscular strength training program on selected dance-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 to exercise (n = 19) and control (n = 13) groups. After the end of the program the exercise group revealed significant increases in dance, VO max, flexibility, and leg strength tests compared to controls.

Killic (2008) conducted a study on the effects of an intensive combined training program based on the pretest scores of a university women's basketball team on their physical, physiological, biomotoric, and technical features. Twenty-four university volunteers were equally divided into two groups: an experiment group (intensive combined training group) and a control (technical training) group. The 10-

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week intensive combined training program was performed on the experiment group according to their pretest outcomes. It can be concluded that a 10-week intensive combined training program performed on university women basketball players had a significant effect on improving their physical, physiological, biomotoric, and technical features.

Trutschnigg et al. (2008)\textsuperscript{58} The aim of their study was to compare the relation between BMD, lean body mass, fat mass, physical activity energy expenditure (PAEE), and menstrual status in female boxers and in physically active females with low (C1) or average (C2) fat mass. Boxers (n = 11) and controls (C1, n = 16; C2, n = 17), aged 18-38 years, were assessed for BMD and body composition with dual-energy X-ray absorptiometry. Menstrual status and PAEE were determined from questionnaires. There was no difference in anthropometric measurements between boxers and C1 subjects, except that boxers had higher arm lean mass. However, both boxers and C1 subjects had a lower percentage of fat (p < 0.001) than C2 subjects (boxers, 14.6% +/- 2.0; C1, 15.5% +/- 4.2; C2, 25.8% +/- 3.4%), and boxers had a higher (p = 0.002) lean body mass index (lean body mass/height\textsuperscript{2}, where lean body mass is measured in kilograms and height is measured in metres) than C2 subjects. The PAEE of boxers was higher (p < 0.007) than that of controls (boxers, 5748 +/- 2284 ; C1, 2966 +/- 2258 ; C2, 2714 +/- 1722 kcal.week\textsuperscript{-1}). Oligomenorrhea was more common in boxers than in C1 and C2 subjects (boxers, 54.6%; C1, 18.8%; C2, 35.3%). Arm, leg, and spine BMD were higher (p < 0.008) in boxers than in C1 subjects, and arm BMD was higher in boxers than in C2 subjects. BMD Z scores were also higher (p < 0.05) in boxers (boxers, 1.1 +/- 0.8, C1, 0.1 +/- 0.7; C2: 0.3 +/- 1.1). High BMD in boxers, despite low fat mass, high PAEE, and an increased incidence of oligomenorrhea suggest that boxing has a positive effect on BMD.

Tanriverdi et al. (2008)\textsuperscript{59} Objective of the present study was to investigate the pituitary function in retired or active amateur boxers. DESIGN: Cross-sectional, observational study. SETTING: Turkey. PARTICIPANTS: 61 actively competing (n = 44) or retired (n = 17) male boxers of the Turkish National Boxing Team.


MEASUREMENTS: Body composition variables, pituitary volume (in 38 of 61 boxers), and pituitary function. RESULTS: 9 of 61 boxers (15%) had growth hormone (GH) deficiency and 5 of 61 boxers (8%) had adrenocorticotropic hormone deficiency. All boxers with GH deficiency except 1 were retired from boxing. Of 17 retired boxers, 8 (47%) had GH deficiency. Retired boxers with GH deficiency had significantly lower pituitary volume than retired boxers with normal GH.

CONCLUSION: This study suggests that retired boxers have a high rate of pituitary dysfunction. Therefore, investigation of pituitary function in boxers, particularly retired ones, is recommended.

Gursoy (2009)\textsuperscript{60} in this study the researchers evaluated the role of left- or right-handedness on the success of the boxer. The study was based on a sample of 22 active, semi-professional or amateur men boxers attending National Road Sport Men Boxing Club in Erzurum, Turkey. The boxers had been actively boxing for 4-15 years (mean 9.87), were aged 17-46 years (mean 32.25), and weighed 65-101 kg (mean 81.06). They were divided into two groups according to the research protocol (left- and right-handed boxers). The status of left- or right-handedness of the boxer included in the research was determined using the Oldfield (Edinburgh Handedness Inventory) Index. Then the boxers were categorized into two groups (win and defeat). Success rates in both groups were expressed in percentages. The data obtained from both of the groups were compared statistically by means of significance test between proportions (t test). It was concluded that left-handed people should never be forced to convert to right-handedness; instead they should be supported both verbally and in terms of equipment and they should be motivated, because the data obtained proved that left-handedness means success, especially in boxing.

Zetterberg \textit{et al.} (2009)\textsuperscript{61} in their study had to assess the potential of a panel of serum biomarkers to identify chronic neuronal injury in amateur boxers as compared to healthy controls without any history of head trauma. A panel of serum biomarkers was measured by a novel biochip array technique on the Evidence Investigator. Serum samples were taken after a 2-month period of nonparticipation in boxing. Boxers had higher serum levels of neuron-specific enolase. (NSE, median [range] 11 [2.3-41] ng/mL) than controls (4.8 [0.78-27] ng/mL, \( p = 0.014 \) but


unchanged levels of the other brain damage biomarker candidates, S-100B, brain-derived neurotrophic factor and heart-type fatty acid binding protein. The more than doubled median serum level of NSE in boxers after an extended resting period suggests that repetitive head trauma results in sustained release of this brain-specific protein to the peripheral circulation.

Morton et al. (2010)\textsuperscript{62} studied the professional boxing is a combat sport categorized into a series of weight classes. Given the sport's underpinning culture, boxers' typical approach to "making weight" is usually via severe acute and/or chronic energy restriction and dehydration. Such practices have implications for physical performance and also carry health risks. This article provides a case-study account outlining a more structured and gradual approach to helping a professional male boxer make weight for the 59-kg superfeatherweight division. Over a 12-week period, the client athlete adhered to a daily diet approximately equivalent to his resting metabolic rate (6-7 MJ; 40% carbohydrate, 38% protein, 22% fat). Average body-mass loss was 0.9 + or - 0.4 kg/wk, equating to a total loss of 9.4 kg. This weight loss resulted in a decrease in percent body fat from 12.1% to 7.0%. In the 30 hr between weigh-in and competition, the client consumed a high-carbohydrate diet (12 g/kg body mass) supported by appropriate hydration strategies and subsequently entered the ring at a fighting weight of 63.2 kg. This nutritional strategy represented a major change in the client's habitual weight-making practices and did not rely on any form of intended dehydration during the training period or before weighing in. The intervention demonstrates that a more gradual approach to making weight in professional boxing can be successfully achieved via a combination of restricted energy intake and increased energy expenditure, providing there is willingness on the part of the athlete and coaches involved to adopt novel practices.

Siegler and Hirscher (2010)\textsuperscript{63} investigated the effects of sodium bicarbonate on boxing performance ten amateur boxers volunteered to participate in 2 competitive sparring bouts. The boxers were prematched for weight and boxing ability and consumed either 0.3 g.kg\(^{-1}\) body weight (BW) of NaHCO\(_3\) (BICARB) or 0.045 g.kg\(^{-1}\) BW of NaCl placebo (PLAC) mixed in diluted low calorie-flavored cordial.


The sparring bouts consisted of four 3-minute rounds, each separated by 1-minute seated recovery. Blood acid-base (pH, bicarbonate \([\text{HCO}_3^-]\), base excess \([\text{BE}]\), and performance (rates of perceived exertion \([\text{RPE}]\), heart rate \([\text{HR}]\) \([\text{HR(ave)}]\) and \([\text{HR(max)}]\), total punches landed successfully) profiles were analyzed before (where applicable) and after sparring. The results indicated a significant interaction effect for \([\text{HCO}_3^-]\) \((p < 0.001)\) and \([\text{BE}]\) \((p < 0.001)\), but not for pH \((p = 0.48)\). Post hoc analysis revealed higher presparring \([\text{HCO}_3^-]\) and \([\text{BE}]\) for the BICARB condition, but no differences between the BICARB and PLAC conditions postsparring. There was a significant increase in punches landed during the BICARB condition \((p < 0.001)\); however, no significant interaction effects for \([\text{HR(ave)}]\) \((p = 0.15)\), \([\text{HR(max)}]\) \((p = 0.32)\), or \([\text{RPE}]\) \((p = 0.38)\). The metabolic alkalosis induced by the \(\text{NaHCO}_3\) loading elevated before and after sparring blood buffering capacity. In practical application, the findings suggest that a standard \(\text{NaHCO}_3\) loading dose \((0.3 \ \text{g.kg}^{-1})\) improves punch efficacy during 4 rounds of sparring performance.