A comparison of physical and performance characteristics of NCAA Division I football players: 1987 and 2000

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A thesis
Presented to the
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of the Requirements for the Degree
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By
Craig A. Secora
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THESIS ACCEPTANCE

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Committee

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Chairperson

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A COMPARISON OF PHYSICAL AND PERFORMANCE CHARACTERISTICS OF
NCAA DIVISION I FOOTBALL PLAYERS: 1987 AND 2000

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University of Nebraska, 2002

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Few studies have established normative data on performance variables of football
and fewer exist that compare results from one decade to the next. In 1985, Olson and
Hunter compared the data from 1974 and 1984 on 13 Division I team's. Berg, Latin and
Baechle (1990) collected normative data on 40 Division I teams and made comparisons
to rankings, offensive vs. defensive players, position comparisons, and major
conferences. However, this research is outdated and no current research has assessed the
changes in performance variables over time for Division I football players. The purpose
of this study is to compare normative data from present Division I NCAA football teams
and to make comparisons to 1987 Division I NCAA football teams using Berg et al.
(1990) data.

Surveys were sent out to all Division I Universities that offered football,
requesting data on the starters at each position (excluding kickers). Players were divided
into 8 positions for comparisons: quarterbacks (QB), running backs (RB), receivers
(WR), tight ends (TE), offensive linemen (OL), defensive linemen (DL), linebackers
(LB), and defensive backs (DB). Comparisons included height, weight, bench press and squat strength, vertical jump, vertical jump power, 40-yard dash speed, and body composition. Independent T-tests were used to analyze the data with level of significance at p≤0.01.

It was hypothesized that (1) vertical jump power would be greater for present LB's and DL than previous LB's and DL, (2) percent body fat would not be different between the two groups for each, (3) present LB's would be faster then previous LB's, (4) present DL would be faster then previous DL. Present football players (all positions) have significantly greater vertical jump power than previous football players. Present WR, DB, and LB's had significantly less body fat while OL had significantly more body fat. Present LB's were significantly faster than previous LB's. There was no differences in speed present and previous DL.

In the last 10 or so years, Division I college football players in general have become bigger, stronger, faster, and more powerful. Further research is warranted to investigate if these trends will continue.

Key words: vertical jump power, percent body fat, longitudinal study.
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I would like to express my appreciation to my wife for her love, encouragement, support, and understanding while writing this thesis. Finally, not only am I thankful for the love and support of my mother, but I am thankful for computer assistance throughout the completion of this study.
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CHAPTER I – INTRODUCTION & JUSTIFICATION

Introduction

Over the past decades, strength development and conditioning have become a more significant role in collegiate athletics. Today's collegiate football player participates in year round conditioning intending on enhancing athletic performance. With the popularity of college football today, research should be abundant with regards to improvement in performance. However, little research has assessed the performance progress over time.

Wilmore and Haskell (1972) assessed the body composition of 44 professional football players and reported body fat values ranging from 4.0 to 29.2%. Crews and Meadors (1978) looked at the correlation between reaction time, speed, and body composition in football players. It was determined that athletes who exceeded their predicted optimal playing weight were significantly slower running at 5, 15, and 40 yards than players weighing less than predicted optimal playing weight. Reaction time followed the same trend but the results were not statistically significant. Burke, Winslow, and Strube (1980) showed improvement in body composition, strength and speed over 8 weeks for a trained collegiate football team.

Few studies have established normative data on performance variables of football and fewer exist that compare results from one decade to the next. In 1985, Olson and Hunter compared the data from 1974 and 1984 on 13 Division I teams. These comparisons reported that 1984 players were faster, taller, heavier and possessed more absolute strength than the 1974 athletes. Berg, Latin and Baechle (1990) collected
normative data on 40 Division I teams and made comparisons to rankings, offensive vs. defensive players, position comparisons, and major conferences. Black and Roundy (1994) studied the relationship of playing status (nonstarter vs. starter) and variables that predicted superior performance (bench press and squat strength, vertical jump height, 40 yard dash time) of 11 universities. When positions were compared to the performance variables 40% of all significant relationships favored the starters. Schmidt (1999) studied strength and physical parameters in Division III football players. Data on upper body and lower body strength, explosive power, speed endurance, muscular endurance, flexibility, and body compositions were compared with positions and playing status. Results showed that starters were significantly better in upper and lower body strength and explosive power. However, this research is outdated and no current research has assessed the changes in performance variables over time for Division I football players.

Statement of Problem

The purpose of this study was to compare normative data from present Division I NCAA football teams and to make comparisons to 1990 Division I NCAA football teams using Berg et al. (1990) data. Comparisons included height, weight, bench press and squat strength, vertical jump, vertical jump power, 40-yard dash speed, and body composition.
Delimitations

Subjects were NCAA Division I football players. For convenience, only the starters at each position both offensive and defensive were used. Positions included quarterback, running back, wide receiver, tight end, tackles, guards, and centers for offense. Defensive positions included linemen, linebacker, and defensive backs. The variables studied were both physical and performance related. Comparisons included height (cm), weight (kg), percent body fat (%), fat free mass (kg), forty yard dash (s), vertical jump (cm), power (kgm s\(^{-1}\)), bench press (kg), bench press/weight (%), squat (kg), and squat/weight (%).

Limitations

One of the main limitations to the study was the low number of subjects from each institution. For convenience of the coaches, only data from the starter was requested. Another limitation is the variability of the methodology and the testers. No criteria were set on how the results would collected. It was up to the coach to collect the results and report the methods of collection. In addition, each institution had their own test administrator, which caused limitations to the validity of the results. It is not known how many of the coaches have experience in testing and assessments. This survey will not investigate nutrition, supplement or anabolic steroid practices of college football players.
Hypotheses

The following hypothesis were tested:

1. Percent body fat will not be significantly different between present athletes and previous athletes for like positions.
2. Present linebackers (LB) will be significantly faster (40-yard dash) than previous LB.
3. Present LB will be significantly more powerful (vertical jump power) than previous LB.
4. Present defensive linemen (DL) will be significantly faster than previous DL.
5. Present DL will be significantly more powerful than previous DL.

These hypotheses were tested at the .01 level. No other differences were thought to exist between the positions and variables but were tested for significance.

Definition of Terms

For clarity throughout the study, the following terms are defined:

Conceptual Definitions

Body composition – the partitioning of body mass into fat-free mass and fat mass (Plowman & Smith, 1997).

Strength- Ability of a muscle or muscle groups to exert maximal force against a resistance in a single repetition (Plowman & Smith, 1997).

One repetition maximum- (1 RM) the maximum amount of weight a person can lift once (Baechle, 1994).
Vertical Jump- (VJ) a jump upward measured by the height of center of gravity or hand reach (Adrian & Cooper, 1989).

Functional Definitions

Present players- Division I football players from the year 2000-2001.

Previous players - Division I football players from 1987.

Justification

Results from this study could be used in a number of ways. The strength and conditioning or football coach could compare the long-term changes of a program over a similar time span, which could provide feedback to their programs results compared to others. Enabling them to modify the program. This study will also establish current norms for present and future comparisons. The strength and conditioning or football coach could create a profile for athletes from these norms. This profile could be used to evaluate position or individual players. The coaches and athletes could use the results to set obtainable goals. The coaching staff can use this information to reverse possible negative trends.
Chapter II - Review of Literature

It is surprising how little information is available today on the long-term changes in physical and performance characteristics of college football players. Many studies have reported descriptive characteristics such as body composition, upper and lower body strength, vertical jump and speed of college, high school and professional football athletes. These variables have been analyzed to predict optimal performance and success. Other studies have been conducted to report changes in performance variables over short periods, most commonly less than or equal to one year. Fewer studies have been conducted to show changes in performance variables from decade to decade in football. This review will examine studies that are descriptive, comparative and short duration.

Descriptive Studies

Many researchers have conducted studies that have collected normative data and profiled football players. These studies have looked at high school, college and professional football players. Gleim (1984) conducted a study of 51 National Football League (NFL) players to measure variables that dictate success. The players were divided into four positions: line (OL), tight ends-linebackers (TE/LB), offensive backs and quarterbacks (OB), and defensive backs and wide receivers (DB/WR). Variables tested included anthropometric data, leg strength, manual muscle tests, flexibility, performance tests, oxygen consumption, injury history, and playing time. Body composition data were taken by an A-scale ultrasound device and a specific population equation was used to determine percent body fat. Skeletal diameters were taken at the
ankle, knee, elbow, wrists, bi-iliac, bitrochanteric, biacromial, and bideltiod. Leg
strength was determined by the Cybex II dynamometer, with peak torque generated at 60
degrees per second for knee extension and flexion, hip flexion, abduction and adduction.
Total flexibility was determined by summing eight sites using a 0 to 5 scale with 0 being
least and 5 being the most flexible. The eight sites consisted of supination of the palms,
extension at the elbows, external shoulder rotation, hamstrings, knee recurvatum, internal
hip rotation, external hip rotation and ability to sit in the lotus position. Performance
tests included a hand held timed 40-yard dash, chin-ups with palms facing the body, dips,
and the vertical jump. Oxygen consumption was measured on only six players and was
determined an insufficient measurement. Playing time was broken down into three
categories: 1.) Special teams player only, 2.) Non starter but participated frequently,
3.) Starters. Statistical significance was determined at the .01 level. Discriminant
analysis was used to interrelate the variables to produce the four position categories.

The results show that for % fat, for the OL, TE-LB, OB, and DB-WR groups the
average was 17.0 ± 2.4%, 12.5 ± 1.06%, 9.6± 2.4%, 5.7 ± 1.3%, respectively. Vertical
jump heights were 24.7 ± 2.7 in, 26.2 ± 2 in., 26.5 ± 4.1 in, and 29.0 ± 2.8 in,
respectively. Forty yard dash times for the groups were 5.08 ± .21s, 4.93 ± .14s, 4.81 ±
.21s, 4.58 ± .12s, respectively. This study reveals that all groups differed from each other
in percent body fat (% fat). Percent fat correlated highly r = .786 with 40 yard time. The
fatter the players were the slower they were. It was also shown that a significant
correlation r = .775 exists between bi-iliac diameter and 40 yard time. The narrower the
hips the faster 40-yard time. Dips and vertical jump in relation to strength or
anthropometric values confirmed no significant correlation. Discriminant analysis revealed, professional football teams using three basic variables of size, fatness, and total leg strength can be classified into positions.

A study to describe 40 NCAA Division I College football teams was conducted by Berg, Latin and Baechle (1990). These teams were compared by height, weight, bench press, squat, 40-yd dash speed, vertical jump, power and body fat. Other comparisons were made between offense and defense, positions, major conferences, and ranked vs. unranked teams in the final polls (AP - Associated Press or UPI - United Press International). Subjects included starters at all offensive and defensive positions excluding kickers from each institution during 1987. Along with these data, method of collection was requested. Results from the 1 RM bench press and squat strength tests were then divided by body weight to obtain relative strength as a percent. Vertical jump heights were converted to power by the Lewis Nomogram. The players were also grouped by positions, which included: (a) quarterbacks; (b) offensive backs; (c) tight ends; (d) wide receivers; (e) offensive tackles, guards and centers; (f) defensive line; (g) linebackers and (h) defensive backs. Data analysis included: analysis of variance (ANOVA), omega squared to explain percent variance of the variables, Spearman rank order correlations for selected variables, and calculation of descriptive statistics. Significance was set at the .01 level. Comparisons from teams mean scores showed significant differences were evident among teams for all variables excluding height and weight. Omega square analysis bared that the range in variability was 2% to 21%. Vertical jump, squat/weight, squat, and % fat have the highest omega square percentages
21%, 18%, 16% and 16%, respectively. When comparing ranked vs. unranked teams, Berg et al. (1990) found significant differences (p<.01) in 3 of the 10 variables. The mean scores for ranked teams were higher than unranked teams in vertical jump (cm), vertical power (kgm s⁻¹), bench press/weight (%). However, omega square analysis showed 5% or less variance explained for the three significant variables. When comparing ranked vs. ranked and ranked vs. unranked teams the only significant variable for both comparisons was vertical jump power. Comparisons were made between offensive and defensive players. Seven out of 10 variables revealed significant differences (p<.01) with the defensive players significantly different in 4 of the 7 variables. Berg et al revealed offensive players were heavier, with more fat and slower, more powerful (vertical jump), stronger in bench press and squat. Defensive players were leaner, faster (40-yd dash), stronger (when bench press is relative to body weight), and jump higher (vertical jump). Omega square analysis was no higher than 3% for any variable. Comparison between positions revealed significant differences in all 10 variables and also indicated very high omega square values. The requirements of the positions in football and the differences in physiques for these positions help to explain the differences. Lineman are heavier, stronger, slower and fatter than positions that require athletes to be leaner, faster, and more powerful such as defensive backs and linebackers. 

Berg et al. compared collegiate athletes of 1987 to professional football players of the early 1970's and reported that the 1987 defensive players are leaner by 1%, and stronger by 31 lb. in the bench press than 1970 NFL defensive players. The college linebackers and defensive lineman were also reported to be leaner than the NFL players,
however, differences in measuring body fat make the comparisons limited in relevance.
The collegiate linebacker's bench-pressed less, while the collegiate lineman bench-pressed more than the NFL players. There were several findings reported. Teams were similar when compared to most of the variables. Offensive and defensive differences were small. Difference between positions are large and meaningful (omega square). Teams in major conferences are similar compared to most variables. Final rank could not be predicted from the 10 variables. Power (kgm$^{-1}$) was significantly related to final rank. One of the strengths of this study is the large sample size.

Williford, Kirkpatrick, Scharff-Olson, Blessing, and Wang (1994) conducted a similar study of Berg et al., by determining the performance and physical characteristics of a successful high school football team. These characteristics were then compared to other reported data from high schools, college, and professional football studies. Eighteen players were divided into two groups: backs (n=8) and linemen (n=10). Variables tested were body composition by hydrostatic weighing and seven site skin fold thickness, maximal strength by 1 RM of the bench press and squat, flexibility by the sit and reach test, speed by the 36.6 m sprint and power by the vertical jump. To determine differences between backs and linemen a one-way analysis of variance was used, and a Duncan's multiple range test was used to compare means when a significant (p < .05) F ratio was found.

The linemen were significantly heavier, higher % fat, greater FFM, and stronger (both squat and bench press). The backs were more powerful (vertical jump) and faster
Comparisons to other studies revealed, this highly successful high school football team had similar strength profiles to prior reported college players.

Black and Roundy (1994) compared body weight, bench press and squat strength, vertical jump, and 36.6 m run time on 1,618 players from 11 Division I universities. These variables were used to predict starters and non-starters. Players were divided into 16 positions in which all positions were represented on offense and defense. A two-way (2x16) fixed factor analysis of variance was used with an analysis for each of the five variables. Fischer's least significant difference test was used to make post hoc multiple comparisons. Level of significance was set at the p < .05 level. A biserial correlation coefficient was used to assess the relationship between a continuous variable and a dichotomous variable.

Results indicated significant differences (p< .05) for 10 of the 16 positions for bench press strength, 7 of 16 for 36.6 m dash, 6 of the 16 in squat strength, 3 of 16 in vertical jump height, and 5 of 16 in body weight of starters vs. non-starters. Players with higher scores in strength, power and speed were usually selected as starters by their coaches.

Similar to Gleim (1984), Snow, Millard-Stafford, and Rosskopt (1998) profiled NFL players, but decided to concentrate solely on body composition and to compare two methods of assessments (7 site skin-folds (SF) and hydrostatic weighing (HW)). Thirty-six NFL players were tested by HW to the nearest .05 kg with a Chatillion scale. Residual volume was measured with a nitrogen analyzer and closed circuit oxygen dilution. Seven site skin-folds were taken by Lange calipers at the chest, axilla, triceps,
subscapula, suprailium, abdomen and thigh. Subjects were grouped into five positions for analysis: DB, OB and WR, LB, OL and TE, and DL. Differences HW and SF were measured by a pair t-test with statistical significance set at p< .05. Data were compared to NFL players of 1972 and 1976.

Comparisons of body composition revealed that SF % fat values were significantly lower in OL/TE than HW % fat values. There were no differences in values for other positions. When compared to 1972 athletes, % fat was significantly greater by 9.8, 2.8, and 2.4% for current OL/TE, OB, and Defensive linemen. Current OL/TE possessed greater FFM and FM (7 kg and 16.3 kg) then 1976 NFL athletes. Defensive backs and linebackers of 1998 have similar body fatness to DB and LB of 1976. This study showed that most of the additional weight (OL/TE) was due to higher fat mass.

Schmidt (1999) conducted a study similar to Berg et al (1990) and Black and Roundy (1994) but assessed the strength and physical characteristics of NCAA Division III football players. Ten variables were tested on 78 Division III athletes. The variables included: Body composition, seated medicine ball put, sit and reach, vertical jump, timed sit-ups (1 minute), pull-ups, 1 RM leg press, 1 RM bench press, dips, and 300-yard shuttle run. Body composition was measure from a 2-site skin fold equation. Medicine ball put was conducted, in the seated position, by throwing a 5-lb medicine ball as far as possible. The 300-yard shuttle run consisted of 12 single 25-yard runs. Comparisons were measured by a (2 x 3) analysis of variance, with a Tukey's post hoc multiple comparison for specific differences. The level of significance was set at p < .05.
Physical characteristic comparisons by position were consistent with previous studies: offensive linemen were heavier and had more body fat than backs and linebackers. Backs were leaner than linebackers and linemen. Muscular endurance tests indicated that backs were significantly better than linemen in sit-ups, dips, pull-ups as well as the 300 yard shuttle. In muscular strength scores, the linemen were significantly stronger ($p < .05$) than backs in the seat medicine ball put, bench press, and leg sled.

When compared to Division I and II athletes, Division III athletes are shorter, lighter, have more body fat and scored lower on vertical jump and bench press by 3%, 9%, 8%, 20%, and 16%, respectively.

In summary, researchers have looked at many variables to explain football players at all levels. Comparisons have been made to predict starters vs. non-starters, positions, optimal performance characteristics, and differences between the different levels of football (high school, college, professional). In general, offensive linemen are stronger (absolute strength), fatter, possess greater fat free mass, and slower than linebackers and backs. Backs are leaner, faster, and more powerful and have greater relative strength than linemen. Linebackers generally fall in between the lineman and backs. When comparing the levels of football, for most variables the better values are reported for professional football players followed by college and then high school. It was also shown for most variables excluding % fat, as the research became more current, performance and physical results improved.
Short Duration Studies

Strength coaches, football coaches, and researchers like to manipulate protocol and observe the changes that take place for the purpose of performance enhancement. This can be classified as a short duration study, which can last as little as 4 weeks to one year.

Gettman, Storer, and Ward (1987) looked at the effects of a 14-week preseason conditioning program on selected performance variables. The subjects consisted of 51 NFL players who were pre-tested in percent body fat, maximum oxygen uptake, leg power, and agility. A three-site skin fold technique was used to measure percent body fat. Sum of the chest, abdomen and thigh were used. VO2 was achieved by completing a 15-stage treadmill test. Speed and incline ranged from 1.7 mph to 8.0 mph and 0 % to 14 % grade respectfully. Stage duration was 1 minute. Leg power was measured by a vertical jump test. Agility was measured by the Cozens dodging run test. Following a 14 week conditioning program which consisted of functional strength training, sprint training, aerobic endurance training, ballistics, plyometrics and power training, players were then post tested following the same testing protocol as the pretest. For analysis, players were divided into positions: DB, OB, LB, OL, and DL. Pretest and post-test scores were compared using a matched observations t ratio. Statistical significance was set at p < .05.

Following 14 weeks of training, percent body fat changes as a team decreased 9% with only the OL and DL being significant (p< .05). The OL decreased 2.5 % while the DL decreased 2.0 %. Lean body weight results showed significant increases for OL, DL.
The OL gained 7 lb of lean body weight while the DL gained 5 lb of lean body weight. The defensive backs showed no change in % fat however, put on 3 lb of lean body weight. The offensive line were the only position to improve significantly in leg power, while all positions except DL improved significantly in agility time. Overall, the OL position improved the most following 14 weeks of conditioning. Although changes were shown, comparisons were not made to other research.

Bolonchuk and Lukaski (1987) examined the changes in body composition and somatotype over a football season. Pre-season and post-season measures of somatotype and body composition were administered to 69 Division II football players. Somatotype was assessed using the Heath and Carter Somatotype Form, while body composition was estimated using the Durnin and Womersley body density equation and percent fat by Siri. A repeated measures ANOVA was used to identify changes over a season.

Analysis revealed that all five skin-fold sites: bicep, tricep, subscapular, suprailiac and calf decreased following a 13-week season. Bicep, subscapular, suprailiac, and calf changes were significant p< .05. For body composition measures, significant (p< .05) changes in lean body weight and density (increase) and body fat (decrease) were shown. Percent body data from this present study were compared to previous studies and little to no change was indicated. Somatotype changes indicated a shift from endomorph too mesomorph but the overall classification of this group remains endomorphic-mesomorph. It should be noted that the researchers compared all data as a team. No comparisons were made by position, or starters vs. non-starters.
While Bolonchuk and Lukaski (1987) showed positive changes in body competition over a season, Schneider, Arnold, Martin, Bell and Crocker (1998) investigated the detraining effects on collegiate football players. Detraining was defined as a decrease in performance and loss in physiological adaptation due to the reduction or elimination of training. This study divided 28 college football players into 2 groups: linemen or non-linemen. Subjects were tested pre-season and post-season on selected field performance tests, muscular strength and endurance tests, and maximal anaerobic and aerobic tests. The field performance tests were the 10 RM bench press, standing long jump, vertical jump, flexibility assessed by the sit and reach, and a 20-yard shuttle run. Muscular strength and endurance values were measured for both lower body (leg extension) and upper body (shoulder abduction) with a Cybex 340 isokinetic dynamometer. Anaerobic power was assessed by the Wingate Power Test. The standing long jump and vertical jump were also used to assess anaerobic power. VO2 max measures were conducted by a progressive treadmill test. Data were analyzed by a 2 x 2 (group x time) ANOVA with significance set at p < .05.

Results indicated that detraining was evident in the field tests. Both linemen and non-linemen significantly decreased in the bench press 7.7% and 8.1%, respectively. The non-lineman significantly decreased by 4.5% in the vertical jump, while the linemen decreased 2.8% but was not significant. Results of the standing long jump and 20 yard shuttle run, indicated decreases though not statistically significant. Measures of muscular strength and endurance showed that non-linemen decreased significantly (p < .05) in shoulder abduction by 9.19%. The researchers felt bench press strength decreased due to
lower strength training intensity during the season and peak levels of strength were more likely reached following pre-season conditioning.

In summary, short duration studies help to assess how changes affect team and player performance. These short-term studies can be used to test a variety of variables that can affect performance, which can include ergogenic aids, detraining, nutrition, and hydration levels. Strength coaches will typically pre-test players, expose them to a new strength and conditioning program, and then post-test the athletes. These scores will then be compared to see what improvements were achieved and sometimes compared to previous programs to see which works best for the team and athlete. As coaches continue to pre and post-test athletes, and athlete continue to get bigger, stronger and faster, how much improvement can be seen in athletes from decade to decade?

Comparative Studies

Olson and Hunter (1985) conducted a study to determine if differences exist in collegiate football players from 1974 and 1984. Thirteen universities returned surveys from both years. Variables that were analyzed were height, weight, 1 RM bench press, 1 RM squat, 1 RM power clean and 40-yard dash. Players were divided into six positions for comparisons: (1) receivers and tight ends (WR/TE); (2) offensive line (OL); (3) offensive backs (OB); (4) defensive backs (DB); (5) linebackers (LB); (6) defensive line (DL). To investigate the relationship between height and weight of 1974 and 1984 athletes, a Ponderal Index Reciprocal was used. A lower index indicates that more weight is carried in respect to height. It should be noted no statistical analysis was
conducted to determine significant differences between the years and that no measures of body composition were reported.

The ponderal index revealed that 1974 athletes carried more weight for positions of WR, DB, LB, and DL, while 1984 athletes carried more weight at the OL and OB positions. Offensive linemen and defensive linemen (1984) had the lowest ponderal index reciprocal of 11.90 and 11.92, respectively. Mean values for all players were very similar. Results of the 40-yard dash, bench press, squat and power clean revealed that all positions improved between decades. Mean values report 1984 athletes became faster by .16s. Absolute strength measures showed an improvement of 52.0, 82.9, and 35.0 pounds in the bench press, squat and power clean, respectively. Relative strength measures indicate that the OL and DL recorded the highest improvement between decades.

Surprisingly, the OL group of 1984, had the lowest ponderal index score, but showed the highest improvement in speed, absolute and relative strength. This is the only study that has assessed long-term changes in physical and performance variables of collegiate football players.

Wang, Perko, Downey, and Yesalis (1993) performed a similar study of Hunter and Olson (1985), but examined the change in Body Mass Index (BMI) of high school football players from 1963 - 1989. Data was collected on the best offensive linemen each year from 1963-1989 from Parade Magazine. Physical data collected included the height and weight of each player. BMI was determined by dividing weight (kg) by height (m).

BMI results showed that increase over the 26-year duration. In 1963, the average height was 73 in and average weight was 213 lb. In 1989, average height was 77 in and
weight was 268 lb. The BMI increased from 27.7 to 32.0 over 26 years. Wang et al. (1993) noted that from 1963 - 1971 significant differences were not evident however, from 1972- 1989, significant positive correlation ($R^2 = .59$) between year and BMI $p < .001$. Results were also consistent to Olson and Hunter (1985) BMI between 1973-1983. Proper nutrition, adherence to proper training techniques and the use of legal or illegal ergogenic aids could influence the proposed explanation for these results.

In conclusion, comparative studies over decades have shown improvement in performance and physical characteristics. However, these are the only studies that have looked at the changes over time of football players, and these data are out of date.

Summary

The popularity of football at all levels has resulted in many studies. The previous reviewed research has shown that as football players continue to get bigger, stronger and faster then previously reported players. As the players have improved, they have been compared to previous players, Berg et al. (1990) compared 1990 collegiate football players to those reported by Hunter and Olson (1985). The 1990 players were similar to 1985 however, but still showed improved results in the height, weight, speed and strength. The literature has also shown offensive lineman are heavier, fatter, slower, and stronger then offensive and defensive backs, while the backs are faster, leaner, more powerful then the linemen. Linebackers and tight-ends fall in between most categories due to the nature of their position. Although these trends are evident, more work needs to be done. Some of the problems with the literature include small sample size, no
statistical analysis, and inconsistent comparisons between previous studies and with in studies. The only study that investigated changes between decades in collegiate football is now outdated. No study has assessed the changes from 1985 to the present.
Chapter III – Methods

Preliminary Procedures

Surveys were sent to strength and conditioning coaches of 115 NCAA Division I-A universities offering football programs. Data were collected on the projected starters for all positions (n=22), excluding kickers for the fall 2000 football season. The Institutional Review Board (IRB) of the University of Nebraska at Omaha approved this study before surveys and data analysis commenced.

Operational Procedures

A cover letter, data collection form, and instructions were provided to the strength and conditioning coaches. The data collection forms requested that the coaches indicate the methods used to assess selected variables (e.g., electronically timed 40-yard dash or stopwatch timed 40-yard dash). Physical data from each player included height (cm), weight (kg), and percent body fat (%). Performance data from each player included 40-yard dash (s), 1-RM bench press and squat (lb), and vertical jump (cm). By dividing strength variables by body weight, bench press and squat were assessed per body weight as a percent. Vertical jump height was converted to power (kgm·s⁻¹) by converting inches to centimeters and applying the Lewis Nomogram Equation (Fox, 1981). To facilitate data analysis, positions were grouped into the following categories: (1) quarterbacks (QB), (2) offensive backs (RB), (3) tight ends (TE), (4) wide receivers (R), (5) offensive tackles, guards and centers (OL), (6) defensive linemen (DL), (7) linebackers (LB), and (8) defensive backs (DB).
Initial surveys were sent out following the 2000 football season, winter of 2001 with completed returns at seven. Follow up surveys (reminder surveys) were sent out approximately six weeks later with a return of five during spring 2001. Due to limited sample size, these surveys were pooled, with permission of Marcus Garstecki, with surveys collected from a thesis by Marcus Garstecki, (2001), A comparison of Selected Physical Fitness and Performance Variables between Division I and Division II Football Players. The data collection instruments from both studies requested the same data and were distributed within the same time period. To ensure university anonymity, each university was assigned a code number. Code numbers remained private to the primary investigator and were not shared. Total combined returned surveys equaled thirty-seven.

Statistical Analysis

Data analysis was computed using Minitab 13.20 and included calculations of descriptive statistics (mean and standard deviations of each variable) and independent t-tests to make comparisons between 1987 (Berg et al., 1990) and present football players. An alpha level of .01 was selected to reduce the probability of making a type I error.
Chapter IV – Results and Discussion

Results

Hypothesis 1 was not accepted because present WR, DB, and LB's had significantly less body fat while present OL had significantly more body fat.

Hypothesis 2 was accepted because present LB's were significantly faster than previous LB's.

Hypothesis 3 was accepted because present LB's had significantly more vertical jump power than previous LB's.

Hypothesis 4 was not accepted because there was no difference in speed between the two DL groups.

Hypothesis 5 was accepted because present DL have significantly greater vertical jump power than previous DL.

Table 1 lists the universities that responded to the survey. Thirty-seven universities responded to the present survey and data were compared to 40 universities from the previous study. One unique finding revealed football players in the present study across all position had significantly greater vertical jump power than previous football players.

Test performance comparisons by position between present and previous NCAA division I football player’s are presented in Tables 2 through 9. Table 2 summarizes a comparison of present and previous quarterbacks. Significant differences (p<.01) (Figure 1) were found on 6 of the 11 variables: body mass, vertical jump height, bench press, relative bench press, power and fat-free mass. Present quarterbacks were taller, jumped
Table 1. Universities Responding to Survey

<table>
<thead>
<tr>
<th>Present Survey* (n=37)</th>
<th>Berg et al. Survey** (n=40)</th>
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</thead>
<tbody>
<tr>
<td>Air Force</td>
<td>Air Force</td>
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<tr>
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<td>Arizona</td>
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<tr>
<td>Clemson</td>
<td>Arizona State</td>
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<tr>
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<td>Eastern Michigan</td>
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<td>Temple</td>
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<td>Illinois</td>
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<td>Indiana</td>
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<td>Iowa State</td>
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<td>Utah State</td>
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<tr>
<td>United States Military Academy</td>
<td>Nebraska</td>
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</tr>
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<td>Oklahoma State</td>
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<tr>
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<td></td>
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<td>South Carolina</td>
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<td>West Virginia</td>
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<tr>
<td></td>
<td>Wyoming</td>
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* Fifteen universities requested to remain anonymous from the present study
** Four universities requested to remain anonymous from the Berg et al. (1990) study.
<table>
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<tr>
<th>Weight (lbs.)</th>
<th>Range</th>
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<th>SD</th>
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<th>Being at Study</th>
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<tr>
<td>192.0-206.0</td>
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<td>0.4</td>
<td>202.0-212.0</td>
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<tr>
<td>196.0-207.0</td>
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<td>0.6</td>
<td>210.0-218.0</td>
<td>3.5</td>
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Table 2: Descriptive and Comparative Statistics for Quarterbacks.
Significant Variables

Figure 1: Significant Differences between Present Quarterbacks and Previous Quarterbacks.
higher, were stronger in the bench press and relative, possessed more fat-free mass, and had greater vertical jump power than previous quarterbacks.

Comparisons of present and previous running backs are reported in Table 3. Significant differences ($p<.01$) (Figure 2) were found on 6 of the 11 variables: body mass, vertical jump height, bench press, squat, vertical jump power and fat-free mass. Present running backs were heavier, stronger in the bench press and squat, had more fat-free mass, and had greater vertical jump power than previous running backs.

Table 4 summarizes a comparison of present and previous tight ends. Significant differences ($p<.01$) (Figure 3) were found for 5 of the 11 variables: body mass, bench press, relative bench press, power and fat-free mass. Present tight ends were heavier and stronger in bench press, scored lower in relative bench press, had more fat-free mass, and had greater vertical jump power than previous tight ends.

Table 5 summarizes a comparison of present and previous receivers. Significant differences ($p<.01$) (Figure 4) were found on 6 of the 11 variables: 40 yard dash, vertical jump height, body fat, bench press, squat, and power. Present receivers were faster, jumped higher, had less body fat, were stronger in the bench press and squat, and had greater vertical jump power than previous receivers. A comparison of present and previous offensive linemen is reported in Table 6. Significant differences ($p<.01$) (Figure 5) were found on 6 of the 11 variables: body mass, vertical jump height, body fat, relative squat, power, and fat-free mass. Present offensive linemen were heavier, jumped higher, had more body fat, scored lower in relative squat, had more fat-free mass, and had greater vertical jump power than previous offensive linemen.
<table>
<thead>
<tr>
<th>Weight (kg)</th>
<th>Height (cm)</th>
<th>Vertical Jump (cm)</th>
<th>40 Yard Dash (s)</th>
<th>Bench Press (kg)</th>
<th>Squat Press (kg)</th>
<th>Sitting (kg)</th>
<th>Power (kg.m.s⁻¹)</th>
<th>Speed (m)</th>
<th>SD</th>
<th>Present Study</th>
<th>Berg et al. Study</th>
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Table 3. Descriptive and Comparative Statistics for Running Backs.
Significant Variables

Figure 2: Differences between Present and Previous Runningbacks.

Data Values

- Weight, kg
- Vertical Jump, cm
- Bench Press, kg
- Squat, kg
- Power, kgm/s
- Fat-Free Mass, kg
Table 4.

<table>
<thead>
<tr>
<th>Variable</th>
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<th>M</th>
<th>SD</th>
<th>Range</th>
<th>Diff</th>
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<tr>
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<td>6.1</td>
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<tr>
<td>Power (Kg.m/s)</td>
<td>38</td>
<td>224.4</td>
<td>15.7</td>
<td>193.4-258.0</td>
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</tr>
<tr>
<td>Sagittal ML (°)</td>
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<td>199.5</td>
<td>32.4</td>
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<tr>
<td>CoM (mg)</td>
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<td>131.4</td>
<td>17.4</td>
<td>107.9-189.6</td>
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</tr>
<tr>
<td>Bench press (Kg)</td>
<td>36</td>
<td>167.7</td>
<td>20.9</td>
<td>120.5-213.6</td>
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</tbody>
</table>

Average Vertical Jump (cm) | 39 | 78.9 | 7.9 | 66.0-99.1 |

40 Yard Dash (s) | 34 | 4.80 | 0.14 | 4.00-5.15 |

Weight (Kg) | 38 | 114.2 | 6.9 | 96.4-122.7 |

Height (cm) | 36 | 191.7 | 3.6 | 185.4-198.1 |
Figure 3.

Significant Differences between Present Tight Ends and Previous Tight Ends.
<table>
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<th>SD</th>
<th>Range</th>
<th>M</th>
<th>SD</th>
<th>Range</th>
<th>M</th>
<th>SD</th>
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<td>Berg et al. Study</td>
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<td></td>
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<td></td>
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Table 5.
Figure 4.
Significant Differences between Present Receivers and Previous Receivers.
<table>
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<td>SD</td>
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</table>

Descriptive and Comparative Statistics for Offensive Linemen.

Table 6.
Significant Variables

Weight, kg  Vertical Jump, cm  %  Body Fat, %  Squat/1t, %  Power, kgm.s⁻¹  Fat-Free Mass, kg

Figure 5.
Table 7 summarizes a comparison of present and previous defensive linemen (DL). Significant differences (p<.01) (Figure 6) were found on 7 of the 11 variables: height, body mass, vertical jump height, bench press, squat, vertical jump power and fat-free mass. Present defensive linemen were shorter, heavier, jumped higher, were stronger in bench press and squat, had more fat-free mass, and had greater vertical jump power then previous defensive linemen.

Table 8 summarizes a comparison of present and previous linebackers (LB). Significant differences (p<.01) (Figure 7) were found on 7 of the 11 variables: height, 40 yard dash, vertical jump height, body fat, squat, vertical jump power and fat-free mass. Present linebackers were shorter, faster, jumped higher, possessed less body fat, were stronger in the squat, had more fat-free mass, and had greater vertical jump power than previous linebackers.

Table 9 summarizes a comparison of present and previous defensive backs. Significant differences (p<.01) (Figure 8) were found on 7 of the 11 variables: height, 40 yard dash, vertical jump height, body fat, squat, relative squat, and vertical jump power. Present defensive backs were shorter, slower, jumped higher, had less body fat, were stronger in squat and relative squat, and had greater vertical jump power then previous defensive backs.
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<th>Variable</th>
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<th>SD</th>
<th>Range n M</th>
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</thead>
<tbody>
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Table 7. Descriptive and Comparative Statistics for Defensive Linemen.
Figure 6: Significant Differences between Present Defensive Linemen and Previous Defensive Linemen
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<td>Power (Kgm/s)</td>
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<td>Squat/Wm. (%)</td>
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<td>Bench Max (%)</td>
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<td>Squat (kg)</td>
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<td>% Fat (%)</td>
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<td>102</td>
<td>1.0</td>
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<td>% Vertical Jump (cm)</td>
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<td>40 Yard Dash (s)</td>
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<td>Height (cm)</td>
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<td>43</td>
<td>9.6</td>
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</table>

Table 8. Descriptive and Comparative Statistics for Linebackers.
Figure 7. Significant Differences between Present Linebackers and Previous Linebackers.
Table 9. Descriptive and Comparative Statistics for Defensive Backs.
Figure 8. Significant Differences between Present Defensive Backs and Previous Defensive Backs.
Discussion

This study made over 80 statistical comparisons. Sampling error might explain much of the differences in all variables. Table 10 reports the magnitude of the changes in percentages for all positions. The quarterback (Table 2), running back (Table 3), and receiver (Table 5) positions showed positive improvements in selected physical and performance variables from previous football players to the present football players. Present QB improved in bench press, bench press/body weight and power by 23%, 12% and 11% compared to previous QB. Present RB improved in bench press, power and vertical jump by 11%, 9% and 7.7% compared to previous RB. Present WR improved in % body fat, bench press and vertical jump by -19.9%, 15%, and 12.7% compared to previous WR.

The present tight ends (Table 4) (Table 10) are less strong than previous tight ends in the bench press relative to body mass by 7.9%. However, present tight ends weigh 8.0 kg (5%) more, bench press 16 kg (11%) more, and have 10.5% greater vertical jump power than previous tight ends. All other significant differences favored the present tight ends.

Present offensive linemen (OL) (Table 6) (Table 10) have increased body mass (8.8%), vertical jump (3.6%), vertical jump power (6.2%) and fat-free mass (5.7%) in comparison with previous OL. Present OL are higher in percent body fat (15.2%) and less strong in squat relative to body mass (6.8%) compared to previous OL. However, body mass of OL increased 10.9 kg and fat-free mass increased 5.9 kg from the previous to the present OL. Power is influenced by body mass and the data showed that although
<table>
<thead>
<tr>
<th>Positions</th>
<th>Variables</th>
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</tr>
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Table 10.

Percent Differences between Present and Previous Positions for Each Variable

(Negative scores indicate a decrease in the variable)

Table 10.

Percent Differences between Present and Previous Positions for Each Variable

( Negative scores indicate a decrease in the variable)
body mass and percent body fat increased between the previous and present OL, fat-free mass and vertical jump power increased as well.

Height was the only variable with a lower score in the present defensive linemen (Table 7) and linebackers (Table 8) then the previous defensive linemen and linebackers by less than 1% in both groups (Table 10). All other variables indicate present DL and LB's scored higher. Present DL are 10.8%, 9%, and 6.9% greater than previous DL in power, vertical jump and squat. Present LB (Table 10) were -15.5%, 12.5%, and 7.3% improved in % body fat, vertical jump and vertical jump power compared to previous LB. Present defensive backs (DB) (Table 9) were slower than previous DB's by less than 1% (Table 10). Speed scores could be attributed to different running surfaces (grass, astro-turf, and field turf). All other variables showed increased scores and the 40-yard dash time was only .03 s slower. Present DB improved in % body fat, vertical jump and vertical jump power by -20.9%, 10%, and 7.9% compared to previous DB.

These changes may be attributed to factors such as intensive strength training and conditioning programs at the high school and university level. Nutrition, supplements, anabolic steroids at all levels may explain some of these changes (Swirzinki, Latin, Berg, & Grandjean, 2000). At the collegiate level, universities provide meals (training table) which offer the athletes better nutritional choices. Possible influences from or role modeling of the National Football League or other professional leagues could provide incentive for the athlete to improve. The surveys were sent out during off-season training. This could also influence some of the results. The emphasis during spring training would emphasize improvements in body mass and strength rather than speed and
agility. This could explain the lack of improvements in the 40-yard dash and more improvements in weight and strength variables. The type of running surfaces: grass, astro-turf and field turf could also affect speed times. These factors help explain the overall improving trends in physical and performance variables. The overall improvements in body size, strength, speed and power from previous athletes to present athletes suggest that strength and conditioning programs have had a positive effect on college football players.
Chapter V - Summary, Conclusions and Recommendations

Summary

Strength development and conditioning have become a more significant element for the collegiate football player who participates in year round training and conditioning to enhance athletic performance. Research is abundant with regards to short duration improvements in training performance. However, little research has assessed the performance progress over time. The purpose of this study was to collect normative data from Division I NCAA football teams and to make comparisons to 1987 Division I football teams using Berg et al.'s. (1990) data.

Comparisons included height (cm), weight (kg), bench press and squat strength (kg), bench press and squat strength / body weight (%), vertical jump (cm), vertical jump power (kgm s⁻¹), 40-yard dash speed (s) and body composition (%) between present Division I football players and previous Division I football players. The players were divided into the following positions for analysis: quarterbacks, running backs, wide receivers, tight ends, offensive linemen, defensive linemen, linebackers and defensive backs.

Surveys were sent to each Division I football program's strength coach requesting data physical and performance data on current or projected starters at positions excluding kickers. All returned surveys were then compared to previous data from Berg et al. (1990) using descriptive statistics and independent t-tests. Alpha level was set at .01.
Results showed that overall, present football players compared to previous football players weighed more, were stronger, jumped higher, were faster, had more vertical jump power, had more fat-free mass.

Conclusions

The following conclusions are warranted from the results of the study:

1. Present linebackers are faster than previous linebackers.
2. There is no difference in speed between present and previous defensive linemen.
3. All present athletes possessed greater vertical jump power than previous athletes.

Recommendations

Improvements in performance variables by Division I football players over the last 10 or so years suggest that strength and conditioning programs have had a positive impact on the physical characteristics, strength, speed and power. However, this study did not look at the improvements over a Division I college football player's eligibility period. To investigate the impact high school strength training, a study could collect normative data on incoming scholarship athletes on physical and performance variables.
Appendix A - Institutional Review Board Approval

October 27, 2000

Craig Secora
HPER
UNO - VIA COURIER

IRB # 425-00-EP


SECONDARY INVESTIGATORS: Kris Berg, EdD; Jeffrey French, PhD; Richard Latin, PhD; John Noble, PhD

DATE OF FULL BOARD REVIEW _________ DATE OF EXPEDITED REVIEW 09-28-00

DATE OF FINAL APPROVAL 10-27-00 VALID UNTIL 09-28-01

EXPEDITED CATEGORY OF REVIEW: 45CFR46.110; 21CFR56.110, Category 5

The Institutional Review Board (IRB) for the Protection of Human Subjects has completed its review of the above-titled protocol and informed consent document(s), including any revised material submitted in response to the IRB's review. The Board has expressed it as their opinion that you are in compliance with HHS Regulations (45 CFR 46) and applicable FDA Regulations (21 CFR 50.56) and you have provided adequate safeguards for protecting the rights and welfare of the subjects to be involved in this study. The IRB has, therefore, granted unconditional approval of your research project. This letter constitutes official notification of the final approval and release of your project by the IRB, and you are authorized to implement this study as of the above date of final approval.

Please be advised that only the IRB approved and stamped consent/assent form can be used to make copies to enroll subjects. Also, at the time of consent all subjects/representatives must be given a copy of the rights of research participants. The IRB wishes to remind you that the PI or Co-PI, is responsible for ensuring that ethically and legally effective informed consent has been obtained from all research subjects.

Finally, under the provisions of this institution's Multiple Project Assurance (MPA #1509), the PI/Co-PI is directly responsible for submitting to the IRB any proposed change in the research or the consent document(s). In addition, any unanticipated adverse events involving risk to the subject or others must be promptly reported to the IRB. This project is subject to periodic review and surveillance by the IRB and, as part of their surveillance, the IRB may request periodic reports of progress and results. For projects which continue beyond one year, it is the responsibility of the principal investigator to initiate a request to the IRB for continuing review and update of the research project.

Sincerely,

Ernest D. Prentice, Ph.D.
Co-Chair, IRB

EDP/kje
Appendix B - Survey Cover Letter

Date

First Name
Strength and Conditioning Coach
University
Address
City, State Zip Code

Dear Coach,

I am currently conducting a study examining the changes in Division I football players' physical and performance traits from 1987 and 2000. I am conducting this study for the completion of my Masters Degree in Exercise Science. This study is being supervised by Dr. Richard Latin at the University of Nebraska at Omaha. This study will assist both strength and conditioning coaches and football coaches by comparing the strengths and weaknesses of your own players to those throughout the country.

I realize that this is a busy time of the year for strength and conditioning coaches. I hope you will take the time to fill out the enclosed form. This study will help to expand the knowledge in our field. I will be pleased to share the results of this study with you.

Please follow the instructions on the questionnaire. When determining the starter at each position, please use the player who has started the most games at that position or the projected starter if the previous criterion does not apply. Data will be kept anonymous. With your approval, I would like to use the name of your institution in a scientific publication as having participated in the study. However, scores will be reported by position only not of individuals and scores of a given universities athletes will remain confidential.

Finally, please notify each subject that their data will be used in a study conducted at the University of Nebraska at Omaha. If anyone objects with the use of this data, this information will not be shared with investigators at the University of Nebraska at Omaha.

Thank you for your time and good luck through this season.

Sincerely,

Craig A. Secora
Graduate Student
University of Nebraska at Omaha
<table>
<thead>
<tr>
<th>Appendix C - Survey Worksheet</th>
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</thead>
</table>

**Question:** May we use the name of your school in a scientific publication?

- [ ] Yes
- [ ] No

**Electrode Position:**

- [ ] Hand
- [ ] Foot

**Body Fat:**

- [ ] %

**Date of Data Collection:**

- [ ] May 20

**University:**

- [ ]...

**Strength Coach:**

- [ ]...

**Date:**

- [ ]...

**DATA WILL BE ANONYMOUS:**

- [ ]

**If the offensive and defensive positions do not match with your scheme, please correct the column heading:**

- [ ]

**If you did not perform a particular test leave it blank:**

- [ ]

**Please fill out survey for testing data on the starting or projected starters for each position listed below:**

<table>
<thead>
<tr>
<th>Position</th>
<th>Value</th>
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</tr>
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<tr>
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References


