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Various Studies on the Relationship among Physical Performance and Team Presentation in Elite Soccer Players

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Abstract – Monitoring soccer players is important for evaluating individual and collective team behavior during training sessions and games, in addition to informing recovery strategies and load management. Modern micro-technology allows assessment of physical, technical and tactical performance parameters in "realworld" conditions. However, physical testing performed either in laboratories or on the pitch is required for individual training prescription, and to develop performance benchmarks for playing standards and playing positions. Anaerobic actions precede the majority of goals, and a large number of linear or repeated sprint tests with or without direction changes have been used in order to assess soccer players' ability to create or close a gap.

To investigate the relationship between physical fitness and team success in soccer, and to test for differences in physical fitness between different player positions. Participants were 306 male soccer players from 17 teams in the two highest divisions in Iceland. Just before the start of the 1999 soccer season, the following variables were tested: height and weight, body composition, flexibility, leg extension power, jump height, and peak O2 uptake. Injuries and player participation in matches and training were recorded through the 4-month competitive season. Team average physical fitness was compared with team success (final league standing) using a linear regression model. Physical fitness was also compared between players in different playing positions. Coaches and medical support teams should pay more attention to jump and power training, as well as preventive measures and adequate rehabilitation of previous injuries to increase team success.

Player activities in soccer matches are influenced by the match result and match venue. It is not known if injury rates are influenced by these factors. The odds of two or more injury occurrences in professional soccer was higher in matches lost and drawn compared with matches won, while the odds of injury occurrences was lower in matches played away compared with home matches. The rate of moderate and severe injuries increased with the importance of the match.

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INTRODUCTION:-

Soccer is the world`s most popular sport: approximately 265 million players and 5 million referees and officials are actively involved, or 4% of the world population, according to FIFA, the International Federation of Association Soccer. The game is intermittent in nature and involves multiple motor skills, such as running, dribbling, kicking, jumping and tackling. Performance depends upon a variety of individual skills and their interaction and integration among different players within the team. Technical and tactical skills are considered to be predominant factors. For example, pass completion, frequency of forward and total passes, balls received and average touches per possession are higher among successful teams compared to less successful teams (Bradley et al., 2013; Dellal et al., 2011). However, individual physical and physiological capabilities (both aerobic and anaerobic) must also reach a certain level for players to be successful (Haugen et al., 2014).

Teams from the best European leagues have tight game schedules, long seasons and relatively short pre-season periods, limiting the possibilities for long-term physical conditioning planning (Carling et al., 2015). As long as each player does his/her "job" satisfactorily on the field, all other physical and physiological considerations are secondary (Delgado-Bordonau and Mendez-Villanueva, 2012). In such settings, the main focus is to recover and prepare for the next game. Underperforming players may be replaced by other players in the short term, while they risk being sold to other clubs in the longer term. In contrast, academies and reserve teams prepare for

future careers by developing soccer-specific motor skills and physiological capacity to an elite level. Key skills are developed to a high level, while other capabilities merely need to meet a minimum requirement.

Many physical tests have been implemented in clubs and academies over the years to evaluate physical performance in soccer players. This long list includes linear sprinting, agility, repeated sprint ability, VO2max, and Yo-Yo intermittent tests. However, in the last decade semi-automatic computerized player tracking technologies and global positioning systems (GPS) with integrated accelerometers have been extensively implemented in the best European soccer leagues for match analysis. This technology allows assessment of physical, technical and tactical performance parameters during training sessions and games. The advantage with such technology is obvious, as a large range of performance data can be assessed quickly and accurately in real-world conditions.

The introduction of this technology has initiated a debate among professional practitioners and scientists regarding the value and usefulness of traditional off-field testing. Are soccer-related fitness tests still necessary? Is it reasonable to assume that future soccer laboratories will consist of micro-technology and purpose-built software only, replacing timing gates, force platforms and metabolic gas analyzers? Our goal with this presentation is to identify pros and cons with today's available physical performance assessment tools and present reasonable arguments regarding what information is needed to prescribe training and thereby enhance soccer performance.

Soccer is one of the most widely played sports in the world and is a sport characterized by short sprints, rapid acceleration or deceleration, turning, jumping, kicking, and tackling. It is generally assumed that through the years, the game has developed to become faster, with more intensity and aggressive play than seen previously (29). Elite soccer is a complex sport, and performance depends on a number of factors, such as physical fitness, psychological factors, player technique, and team tactics. Injuries and sequelae from previous injuries can also affect the players' ability to perform.

During a 90-min soccer match an elite player covers on the average between 10 and 11 km per game. Although the distance covered by different players in the same position varies, studies have shown that midfielders travel farther than defenders or attackers, probably because of their linking role in the team. Among the defensive players, the fullbacks usually cover more distance than centerbacks, since they are usually more involved during the attacking phase. Although most of the movement for all players is at low or submaximal intensity, it has been estimated that the mean work rate is about 70–75% of maximum oxygen uptake and close to the anaerobic threshold. Midfield players cover a greater percentage of their distance at lower intensity, whereas attackers cover a greater proportion at a sprint. This indicates that there may be a difference in the requirements between different playing positions, but whether this is reflected by differences in fitness is not clear.

Studies on the physical performance of elite soccer players indicate that the average maximal O2 uptake ranges between 56.8 and 67.6 mL·kg_1·min_1, whereas mean body fat (%) is between 8.6 and 11.2%. Muscular power has mainly been reported as jump height, using different tests. Some studies have found a vertical jump of 55.6–63.4 cm, whereas other studies reported a countermovement jump height of 41.4–41.6 cm and a standing jump height of 38.5–39.0 cm. Flexibility, muscle strength and hamstring to quadriceps strength ratios among soccer players have also been reported in several studies, but methodological differences (test type, speed, joint angle, etc.) make direct comparisons difficult.

Although one might expect team success to be strongly correlated to physical fitness, there is limited evidence for such a relationship. One study found a correlation between the amount of training and the training to match ratio on one side and team success on the other (12). Wisloff et al. (1998) compared the fitness of one team at the top and another at the bottom of the Norwegian elite division and found that the best team had significantly higher test values for maximal O2 uptake and 1-RM squat. However, an obvious limitation of this study was that only two teams were compared, and we therefore wanted to expand their approach by including the teams of two divisions in Icelandic soccer. The aim was to study the relationship between physical fitness and team performance by comparing various indices of physical fitness between and within divisions with final league standing. We also wanted to test for differences in physical fitness between different player positions.

PHYSICAL FITNESS AMONG INDOOR AND OUTDOOR ELITE MALE SOCCER PLAYERS

Five-a-side indoor soccer (IS) (oYcial name: Futsal), the indoor version of outdoor soccer (OS), is an intermittent high-intensity strenuous team sport played worldwide (12 million players in more than 100 countries) that places heavy emphasis on running speed and endurance and requires substantial strength levels to kick, tackle, turn, change pace and sprint during game actions. IS is played on a 38–42 m £ 18–25 m pitch during two 20-min clock time halves, with the clock stopped for some events that can result in a total duration game of 70–80 min. Teams can request one time-out (1 min) in each half and there is a break of 10 min between halves. An IS team comprises the players and an unlimited number of

substitutions are permitted (Barbero-Alvarez et al. 2008).

As in the case of IS, OS is also an intermittent highintensity strenuous team sport that places heavy emphasis on strength, running speed and endurance. However, some signiWcant diVerences exist between IS and OS soccer because OS is played on a bigger surface (100–110 m £ 64–75 m) for a longer time (two 45-min periods) and with the clock stopped for very few events, which can result in a game whose total duration can be between 90 and 100 min. Teams cannot request a time-out during the game and there is a break of 15 min between halves. In addition, an OS team comprises 11 players and only three substitutions are allowed throughout the game.

As a consequence of the diVerent characteristics of IS and OS, it has been argued that diVerent physical Wtness and anthropometric characteristics should exist between IS and OS players. Only a few studies have analyzed some anthropometric and aerobic power (Castagna et al. 2008) characteristics of elite IS players. Despite its popularity, it is somewhat surprising to Wnd no information concerning the strength, muscle power and aerobic capacity characteristics of current world class elite IS players. The majority of the great number of studies that have analyzed anthropometric and physical Wtness characteristics of OS players have found that elite OS players must possess superior strength, power and endurance characteristics (Stolen et al. 2005). In addition, the main physical diVerences in elite compared with lower level OS players seem to be a faster sprint velocity and higher leg extensor power (Arnason et al. 2004).

To our knowledge no studies have analyzed if some differences exist in physical fitness and anthropometric characteristics among IS and OS players. Knowledge of the anthropometric and physiological characteristics of elite IS players is of great importance because: (1) little is known at present about these characteristics in this population, and (2) this knowledge should allow indoor coaches to verify and modify strength/power and endurance training programs to adapt their players to the physiological requirements of their sports.

Considering that IS and OS soccer places heavy emphasis on strength and power-related actions, data were collected to test the following hypothesis. First, taking into account the physiological characteristics of players competing in relatively similar playing areas and competition times in sports such as basketball and handball (Gorostiaga et al. 2005), we hypothesized that elite IS players should present lower endurance capacity and higher strength and muscle power values compared to elite OS players. Second, as has been observed in elite OS players and other team sports players, associations between lower extremity muscle power and sprint running performance should be observed in elite IS players. Third, considering that anthropometric profile is an important selective factor for success in sport (Rienzi et al. 2000), it was hypothesized that low levels of body fat should be associated with higher physical fitness values in both groups of soccer players.

INJURIES AFFECT TEAM PERFORMANCE NEGATIVELY IN PROFESSIONAL SOCCER

Injuries are common in international and professional soccer, and injuries are the most common reason for player unavailability in training and matches. Injuries during a season or a tournament could thus have a considerable impact on a team's performance.

In one study of the Swedish men's national team over six years, the injury incidence was higher during matches lost or tied compared to matches won. This finding was not repeated, however, in a study on nine men's (senior, under-21, under-19, and under-17) and three women's (under-19) European Championships between 2006 and 2008, where no difference in injury incidence was seen based on match results.

In the women's European Championship in 2005, teams that were eliminated in the group stage of the tournament had a higher match injury incidence than teams that advanced to the semi-finals, while no such association was found in the men's tournament 2004 or in the men's under-19 tournament in 2005. No difference in total injury incidence between teams that were eliminated in the group stage and those that qualified for the final stage of the tournament was reported in the previously mentioned study on 12 European Championships.

In club level soccer, three studies have correlated injury figures with team performance in the league play. In one study including 17 teams in the Icelandic top two male divisions during one season, a relationship, although non-significant ($p=0.092$), between the number of injury days per team and the final league ranking was found, indicating that teams with fewer injury days had a better chance of success. In another study on a French professional team followed over 15 seasons, no correlation between the team's final league ranking and total injury incidence in a season was observed.

Finally, in a study on the Qatari professional league, strong correlations between injury incidence and a high league ranking, more games won, more goals scored, greater goal difference, and total number of points in a season, were reported.

METHODOLOGY

Of 20 soccer teams that participated in the Icelandic elite and first division during the 1999 season, 17 accepted an invitation to participate in this study (nine from the elite and eight from the first division). At the end of the season, the three teams that declined to participate finished third in the elite division, and 9th and 10th in the first division. The Icelandic soccer season lasts from mid-May until mid-September.

The teams played a double round-robin competition format, home and away, and the final league standing was determined based on the total number of points won. For each game, a team was awarded 3 points for a win, 1 point for a draw, and 0 points for a loss. Each coach selected the 18 best players from his team to participate (N = 306). Just before the start of the season, players were tested to estimate peak O2 uptake (226 of the players completed this test), body composition (N = 228), leg extensor power (N = 215), jumping ability (N = 217), and flexibility (N = 249).

Endurance tests and power/jump tests were conducted on separate days. A total of 153 players (50%) participated in all of the tests, and 301 (98%) took part in at least one of the tests (mean age 24, range 16–38). These 301 players were included in the analyses. The project was reviewed and approved by the National Bioethics Committee and Data Protection Authority in Iceland, and written informed consent was obtained.

During the soccer season, the team physical therapists recorded injuries on a special form. This form included information about the type and location of the injury, prior similar injuries, injury mechanism, duration of the injury, and the exact diagnosis. A player was defined as injured if he was unable to participate in a match or a training session because of an injury that occurred in a soccer match or during training, and classified as injured until he was able to comply fully with all instructions given by the coach (3).

During the same time period, the coaches recorded individual match and training exposure, that is, player participation for every training session (including the duration of each session). Detailed information on injury incidence, injury types, and risk factors for injury is reported separately (2).

Body composition- Skinfold measurements were taken from six different areas: triceps brachii, subscapular, pectoralis major, iliac chest, abdomen and, anterior thigh (Lange Skinfold Caliper, Cambridge Scientific Industries Inc., Cambridge, MD). The results were calculated using four different formulas, and the average was used as the final result for body composition (% body fat) (14,16,17,26). Body mass index (BMI, $kg \cdot m^{-2}$) was calculated as the mass (kg) divided by the squared height (m).

Jump testing- Jump tests were performed right after the power test on a contact mat (PE, TapeSwitch Corp., Farmingdale, NY) connected to the MuscleLab unit, which measures the height of rise of the center of gravity above the ground (h, cm) based on the flight time (t_f, s) with the formula: $h = t_f^2 \cdot g \cdot 8^{-1}$. The players were instructed to jump and land in exactly the same place with the body in an erect position during the jump until landing. The better of two outcomes was used as the final result.

Statistical methods. SPSS (version 10.0; SPSS Inc., Chicago, IL) was used for the statistical analysis. Independent samples t-tests were used to compare test results between all players in the elite and first divisions. However, in order to compare the teams, the team average was also calculated for each test variable, and independent samples t-tests were used to compare team averages between divisions.

To test for a possible relationship within divisions between team averages (independent variable) and the final league standing of the teams (dependent variable), the common slope for both divisions corrected for division was calculated using linear regression. Unstandardized regression coefficients (B) were used to describe the slope.

Players in the study were classified as attackers, midfielders, defenders, and goalkeepers. The most common playing formation was 4-4-2 (four defenders, four midfielders, and two attackers), although 4-5-1 and 3-5-2 were also seen. A one-way ANOVA was used to test for possible differences in test variables between different player positions (goalkeepers, defenders, midfielders, and strikers). The same method was also used to test for differences between goalkeepers and field players, and between the three different positions of field players using Bonferroni correction for multiple comparisons. P values $\leq$ 0.05 were considered as statistically significant.

CONCLUSION

The main finding of the present study was that surprisingly few differences were observed in the team average test values between or within the two highest male soccer divisions in Iceland. Moreover, the relationship between team average performance on the various tests and team success expressed as final league standing was generally weak.

Finally, goalkeepers appeared to have a different fitness profile than the other player positions, whereas the three groups of outfield players were similar in their performance on the tests.

Elite soccer is a complex sport, and performance is assumed to depend on a number of factors, including psychological factors, player technique, team tactics, and physical fitness. We therefore expected to find

substantial differences in the results from the various fitness tests between and within divisions, with the best results in the elite division, and with a gradient from better to lower performance from the top to the bottom teams in each league. Few other studies have been found that compare physical fitness between different levels of soccer players (9,23,24). Some indicate that soccer players playing at a higher level have a significantly higher vertical jump than players at a lower level (13,23), but not all studies have confirmed this finding (9,30).

The relationships observed in the present study between certain anthropometric and physical fitness characteristics in the whole group of soccer players suggest that those with higher sprint running or vertical jump height performances tend to have lower endurance running capacities. These relationships also suggest that soccer players with higher values of percent body fat may achieve lower strength, sprint and endurance running performances versus those with lower percent body fat values.

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