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Dominant energy system influence on burnout in college female athletes: A follow up study

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Abstract
The purpose of this study was to identify the relationships between burnout scores on the Maslach Burnout Inventory (MBI) and the dominant energy system utilized in sports competition and training. Participants included 115 female athletes at a Division I institution in the southeastern United States who were current member of the basketball, cross country, golf, soccer, softball, tennis, track and field, and volleyball teams. Participants were categorized as predominantly using the ATP-CP energy system, anaerobic glycolytic system, or oxidative energy system. Burnout was assessed using participant scores on the MBI subscales of Emotional Exhaustion (EE), Depersonalization (DP), and Personal Accomplishment (PA). Prior study results indicated athletes in the oxidative dominant system experienced higher levels of DP and PA while the current study did not reveal any significant differences. However, future research should explore the current finding of higher burnout levels on EE for team sport versus individual sport athletes.

Keywords: Energy systems, burnout, turnover, athletes

1. Introduction
The term "burnout" first appeared regularly in the literature when referring to individuals who worked in the human services industry in the 1970s (Maslach, Schaufeli, & Leiter, 2001) [16]. The initial goal of researchers was to define the phenomenon of burnout and show it was not an uncommon response in human populations (Maslach *et al*. 2001) [16]. Research on burnout in the 1980s became more quantitative and systematic in nature. That is, survey methodology and studying larger populations became the norm and during this time period the Maslach Burnout Inventory (MBI) was developed (Maslach & Jackson, 1986) [14]. The MBI was, and still is, considered the leading instrument on the assessment of burnout (Maslach *et al*. 2001) [16]. Research on burnout continued in the 1990s and included the use of advanced statistical tools and methodologies, such as Analysis of Variance (ANOVA) and Multivariate Analysis of Variance (MANOVA). The use of enhanced methodologies and statistical tools yielded empirical findings which led to the use of structural models in burnout research (Maslach *et al*. 2001) [16]. Moreover, the 1990s marked the beginnings of research examining the phenomenon and impact of burnout within the athletic arena, and this research continues today.

1.1 Research Problem
Athlete burnout is a phenomenon concentrated on the health and well-being of an athlete, as burnout has been shown to negatively influence the quality of sport experiences, lead to decreased performance, and ultimately result in cessation of sport participation (Raedeke & Smith, 2004) [21]. It has been accepted that burnout is a consequence of chronic stress (Cordes & Dougherty, 1993; Raedeke & Smith, 2004; Shaufeli, Maslach and Marek, 1993; Smith, 1986) [5, 21, 22, 23] and stress is viewed as a mismatch between the perceived demands of a situation and one's perceived capabilities and resources for meeting those demands (Lazarus, 1990; Smith, 1986) [12, 23]. Thus, when the demands of an individual's circumstances outweigh the ability to handle the situation, the result could lead to maladaptive stress patterns (Kelley & Gill, 1993) [9].

Furthermore, prior research has been conducted on athlete burnout and determined that athletes are likely to experience burnout if they are participating in sports for reasons other than the attraction to sport (Bradford & Keshock, 2010; Coakley, 1992; Lemyre, Treasure, & Roberts, 2006; Raedeke, Lunney, & Venables, 2002) [2, 4, 13, 20]. Moreover, Coakley (1992) [4] found burnout could be related to control and identity issues that entrap athletes into sport (Coakley, 1992) [4]. Additionally, results from a survey of 88 Division I female athletes revealed the most frequently cited factors associated with attrition among female collegiate athletes were lack of free time and a feeling of being overextended, lack of playing time, injuries, and sport participation ceasing to be fun (Bradford & Keshock, 2010) [2].

Kroshus and De Freese (2017) [11] offered athlete burnout prevention strategies based on the results of a study conducted with 933 collegiate soccer coaches. Recommended prevention strategies include managing physical stressors through reduction of stressors not specifically related to their sport, and promoting autonomy among players. These findings might inform coaching training and educational programs to reduce the incidence of athlete burnout although Kroshus and De Freese did not explore how physical demands of sport might also influence burnout levels.

Holden, Keshock, Norrell, Gurchiek, and Heiman (2013) [8] completed a study on 99 female Division I athletes and identified the dominant energy system utilized in their sport for training and for competition. Results of the study determined athletes who participated sports in which the dominant energy systems was the oxidative energy experienced significantly higher levels of burnout on the MBI subscales of PA and DP. Results also revealed softball players reported the highest mean score on the MBI subscale of EE (M=27.2), golfers had the highest mean score on the DP subscale (M=11), and cross country runners had the lowest sense of PA (M=41) from their sport. The lowest levels of experienced burnout on the EE subscale was experienced by the track and field athletes (M=21.2). Cross country runners experienced the lowest level of DP (M=2.3), and soccer had the highest sense of PA (M=29.8) from their sport which means they were classified as having a low (1) level of burnout (Holden *et al*. 2013) [8]. However, researchers identified a key limitation in this study. That is, researchers failed to identify each athlete's respective position(s) in their sport. This is an important omission as player position(s) potentially affects the energy system being utilized.

1.2 Energy Systems

In general, during athletic competition, one of three energy systems will predominate. The first, and most immediate energy system, is termed the phosphocreatine system (ATP-PCr) and is associated with recruitment of Type II muscle fibers. The ATP-PCr system is the only system to store adenosine tri-phosphate (ATP) and fuels exercise events lasting less than 15 seconds. The second energy system to be utilized is referred to as anaerobic glycolysis and is also associated with the recruitment of Type II muscle fibers. Anaerobic glycolysis fuels exercise events lasting typically between 30-90 seconds and can only use carbohydrate as a fuel substrate to synthesize ATP. Overall, these two energy systems are referred to as anaerobic, as they do not require the presence of oxygen to synthesize ATP (Brooks, Fahey, & Baldwin, 2005) [3]. In contrast, the final energy system can utilize a variety of fuel substrates, including carbohydrate, fat, protein, and lactate (Brooks *et al*. 2005) [3]. Aerobic oxidation requires the presence of oxygen to break down fuel substrate in the process of ATP synthesis. Aerobic oxidation fuels exercise events lasting longer than two minutes and is associated with the recruitment of Type I muscle fiber. It is important to note that while one energy system may predominate during competition, the other two systems have the potential to contribute to energy production. In other words, these energy systems do not turn "off" and "on." Instead, as one system turns down, another system begins to turn up. Regardless, the determination of the primary energy system to be utilized during athletic competition is a function of both intensity and duration (Brooks *et al*. 2005) [3].

Soccer is a sport in which player position will affect the predominant energy system used during a typical match. For example, during competition, center defenders have been shown to cover distances of 4.40±.26 miles at speeds between 1 to 6.84 miles per hour (mph), respectively. This range of speed falls on a continuum from walking to moderate speed running, which would suggest a greater reliance on aerobic oxidation during competition. Furthermore, center midfielders and outside/external midfielders cover a game distance of 1.35±.23 and 1.29±.26 miles at moderate running speeds between 8.76 to 11.8 mph and would be associated primarily with a reliance on anaerobic glycolysis for the synthesis of adenosine tri-phosphate (ATP). Conversely, outside/external defenders, outside/external midfielders, and forwards cover approximately .25 miles at fast running speeds of greater than 15 mph during a typical soccer match. Exercise of this manner would suggest a high reliance on anaerobic pathways for energy, particularly the phosphocreatine system (Di Salvo, Baron, Tschan, Calderon Montero, Bachi, & Pigozzi, 2007; [6]. Overall, soccer is a sport relies on all three energy systems to provide the necessary ATP, but again, the predominance of a specific energy system is dependent on player position.

1.3 Objectives

Therefore, the purpose of the current study was to replicate the study of Holden *et al*. (2013) [8], and identify the relationships between burnout scores on the Maslach Burnout Inventory (MBI) and the dominant energy system utilized in sports competition and training, and compare current results of the two studies. Moreover, the current study took into consideration sport participation as well as the athlete's event (s) and position (s) within their sport. This was identified on the demographic portion of the instrument. Researchers also sought to determine burnout levels of the athletes based upon sport participation and type (individual or team sport).

2. Methods and Materials

2.1 Participants

Eligible participants for this research included female athletes at a Division I institution in the southeastern United States. Participation was voluntary, and a total of 115 athletes, ranging in age from 19 to 24 (M = 19.8; SD = 1.0) completed the survey. Participants were current members of the women's basketball, cross country, golf, soccer, softball, tennis, track and field, and volleyball teams. Of the participants, 58 (50.4%) were identified as predominantly using the ATP-CP energy system, 45 (39.1%) mainly used the anaerobic glycolytic system, and 12 (10.4%) relied most on the oxidative energy system.

2.2 Instrument

Athlete burnout was assessed based on participant scores on the Maslach Burnout Inventory (MBI). Researchers received permission to use the MBI instrument from the publisher, Consulting Psychologist Press (CPP). Descriptive data questions such as age, year in school, whether or not the athlete was on an athletic scholarship, sport team, and sport position were asked of participants before they completed the instrument.

Christina Maslach developed the MBI and is recognized as one of the leading researchers on burnout (Kelley & Gill, 1993; Nelson, 2005) [9, 18]. The MBI uses a Likert-type scale, is comprised of 22 items, and is separated into three subscales: Emotional Exhaustion (EE), Depersonalization (DP), and Personal Accomplishment (PA). MBI scores on the three subscales are used to determine participant's level of burnout. Participants receive a separate score on each of the subscales of burnout (EE, DP, and PA) and scores are not combined into one, single, aggregate score. Thus, the three scores are coded as low, moderate, or high based upon the cutoff points listed on the MBI scoring key (Zalaquett & Wood, 1997) [25]. The subscale total scores are 54 for EE, 30 for DP, and 48 for PA. Maslach and Jackson determined the level of burnout was high if EE was ≥ 27, DP was ≥ 13, and PA was ≤ 21; moderate if EE was 17-26, DP was 7-12, and PA was 38-22; and low if EE was ≤ 16, DP was ≤ 6, and PA was ≥ 39 (Malsach & Jackson, 1986) [14].

Scoring on EE subscale is based on nine items outlined on the scoring key (see Zalaquett & Wood, 1997) [25]. The DP subscale score is based on five items, and eight items make up the PA subscale score. Higher scores for the EE and DP subscales suggest higher degrees of experienced burnout of participants while lower mean scores on the PA subscale represent higher degrees of burnout experienced (Maslach, Jackson, & Leiter, 1996; Zalaquett & Wood, 1997) [15, 25].

According to Maslach *et al*. (1996) [15] EE refers to a tired fatigued feeling that develops as an individual's emotional energies are drained over time. Depersonalization (DP) is characterized by a decrease in positive feelings in the workplace such as when athlete's, display signs of a cold or distant attitude, or emotionally distance themselves from their coaches and/or teammates (Maslach *et al*. 1996) [15]. The PA subscale scores refers to feelings of low personal accomplishment from one's job or competitive sport (Maslach *et al*. 1996) [15]. An example is when a player determines they are no longer contributing to individual or team success and development, a feeling of profound disappointment can occur.

2.3 Procedure of Data Collection

The Institutional Review Board (IRB) from the investigators' institution of higher learning granted permission to conduct this study. Athletes who participated were members of the women's basketball, cross country, golf, soccer, softball, track and field, and volleyball teams at a Division I university in the southeastern United States. Head coaches of each sport where contacted prior to the study to request their team's participation. Researchers met with each team individually and were responsible for monitoring the completion the instrument and demographic questionnaire. All participants were informed that completion of the inventory was voluntary and results would remain confidential and anonymous.

2.4 Statistical Analysis

Descriptive and inferential statistics were calculated with R version 3.1.1 (2013, R Core Team) and the packages gmodels (MVN (Korkmaz & Goksuluk, 2014) [10]. Researchers coded participants to indicate team or individual sport. Participants were also coded to indicate energy system used based on position as well as sport, following the process described in the methods section. Given three dependent variables derived from participants' scores on each of the three subscales of the inventory and two independent variables of interest (team versus individual, primary energy system used), a factorial multivariate analysis of variance (MANOVA) model is an appropriate approach.

3. Results

Initial cross tabulation to assess observations per cell revealed that all athletes primarily classified as using the oxidative energy system were individual sport participants. Because MANOVA requires a minimum more participants than dependent variables in each cell (Hair, Black, Babin, & Anderson, 2010) [7], and collapsing or combining categories would have confounded the energy system variable, these 12 participants were eliminated from the analysis. Visual assessment of boxplots for each dependent variable indicated presence of six outliers; these observations were also deleted leaving a final sample of 98. After removal of outliers, results of Shapiro-Wilks test for univariate normality suggested that scores for the dependent variables emotional exhaustion (EE; W = .98; p = .198) and personal accomplishment (PA; W = .979; p = .11) were normally distributed. The third dependent variable, depersonalization (DP) was moderately skewed to the right (skewness = .85). The results of the Henze-Zirkler test (HZ = 1.73, $p<.0001$) suggested that the data did not meet the assumption of multivariate normality. Table 1 shows participant by sport; Table 2 shows cross tabulation for individual versus team and primary energy system used.

Table 1: Participants by sport

Sport	Number of participants
Basketball	13
Cross Country and Track	3
Softball	17
Soccer	26
Tennis	3
Track	19
Volleyball	17

Note. N= 98.

Table 2: Primary energy system used

Primary System	Individual	Team
ATP	15	43
LA	10	32

MANOVA of burnout scores on the independent variables energy system (system) and team versus individual sport (type) indicated no significant interaction and no significant main effects for system. Results from Pillai, Wilks, Hotelling-Lawley, and Roy's tests are shown in Table 3. Results of follow up analysis of variance (ANOVA) indicated that there was a statistically significant difference in type for the burnout subscale EE (F = 11.07; df = 1, p = 0.001). Mean EE score for team sports participants was 20 while mean EE score for individual sports participants was 13.72 (p = .0013).

Table 3: Manova results

Variable	Test	Result
Type * system	Pillai (.049)	F = 1.61; df = 3, 92; p = .193
	Wilks (.951)	F = 1.85; df = 3, 92; p = .193
	Hotelling-Lawley (.051)	F = 1.85; df = 3, 92; p = .193
	Roy (.051)	F = 1.85; df = 3, 92; p = .193
Type	Pillai (.119)	f = 4.17; df = 3, 92; p = .008
	Wilks (.880)	F = 4.17; df = 3, 92; p = .008
	Hotelling-Lawley (.136)	F = 4.17; df = 3, 92; p = .008
	Roy (.136)	F = 4.17; df = 3, 92; p = .008
System	Pillai (.06)	F = 1.96; df = 3, 92; p = 0.126
	Wilks (.94)	F = 1.96; df = 3, 92; p = 0.126
	Hotelling-Lawley (.064)	F = 1.96; df = 3, 92; p = 0.126
	Roy (.064)	F = 1.96, df = 3, 92; p = 0.126

When analyzing means scores for the entire sample (N=115), results indicate a mean EE subscale score of 19.3, DP of 4.9, and PA of 34.3. When comparing the mean scores to the cutoff points determined by the mean EE perceived burnout level for the sample was moderate, DP was low, and PA was moderate. Mean scores based upon team affiliation can be seen in Table 4.

Table 4: Mean MBI scores by team

Sport	Number of participants	EE level	DP level	PA level
Basketball	15	27.2	8.5	32.6
Cross Country and Track	8	18.8	3.8	35.0
Golf	7	12.7	2.7	31.1
Softball	17	17.4	3.4	34.8
Soccer	29	23.3	5.9	33.5
Tennis	3	20.3	6.3	26.3
Track	19	12.7	3.7	35.9
Volleyball	17	17.6	3.9	37.6

Note. N=115.

Results based upon sport participation determined the mean EE score of the women's basketball players was highest (M=27.2), while the golf and track participants were labeled as experiencing the lowest level of burnout in the sample (M= 12.7; M=12.7). None of the sports teams represented experience high levels of burnout on the DP subscale. However, the cross country/track and field, golf, softball, soccer, track and volleyball means scores indicated a low level of burnout on the DP subscale. Finally, the mean scores for the PA subscale did not determine any team in the sample had a low sense of personal accomplishment from their sport. In fact, mean scores for all teams fell into the moderate range on the MBI subscale of PA.

3.1 Limitations

Failure of the data to meet multivariate normality tests suggests that hypothesis testing results should be approached with caution, since test statistics are calculated based on a normal distribution. Moreover, researchers limited their participants to females so they were unable to survey the men's basketball, baseball, and football teams. Therefore, results cannot be generalized to these sports teams or males. Finally, participants in this study were also limited to one Division I university in the southeastern United States. Consequently, the findings in the current study may not be representative to other parts of the country or other levels (NCAA Division II, III, National Association of Intercollegiate Athletics (NAIA) or National Junior College Athletic Association (NJCAA)) of competition.

4. Discussion

Much prior research has been conducted on athlete burnout. However, there is limited research on burnout as it relates to the physical demands of the sport. More specifically, only one study has examined the relationship between athlete burnout and the predominate energy system utilized in sport participation. Results of the previous study indicated participants in the oxidative dominant system experienced higher levels of DP and PA using three separate one –way ANOVAs while the current study did not reveal any significant differences. However, the current study did reveal team sport participants experienced higher levels of burnout on the EE subscale as compared to individual sport participants. Future research should explore this finding through examination of theories such as commitment and entrapment.

Moreover, when examining mean MBI subscale scores based upon sport participation, results of the current study differ greatly from Holden *et al.*'s 2013 [8] study. Teams with the highest level and lowest level of perceived burnout on the EE, DP, and PA subscales of the MBI differed in each of the studies. It should also be noted that mean scores for each study were not coded as experiencing a high level of burnout in any of the subscales (EE, DP, or PA). However, there were individual scores on the subscales in both studies that were coded as high which is concerning and leads to the fact that more research is needed in order to educate and prepare collegiate athletes to cope with the many demands of their sport.

5. Conclusion

Clearly additional, larger-scale investigation is required to further assess the role of overall and position-specific physical demands on athletes and its relationship to burnout. Along with this, additional efforts are warranted to educate and prepare collegiate athletes, and their coaches and trainers, to better understand the role of the energy systems on burnout. While Kroshus and De Freese (2017) [11] offered athlete burnout prevention strategies based on the results of their research of collegiate soccer coaches, it is not clear whether these results might be generalizable to athletes participating in other team or individual sports, especially given our findings that point to the possibility for by-position variation in experienced and reported stress. Assuming further study supports the energy system-burnout relationship, future researchers should also incorporate investigation of dietary intake to ensure that athlete's diets provide the necessary substrate intake for the synthesis of ATP. If timing and type of macronutrients are not appropriate, an athlete may be at even higher risk for burnout.

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