DIETARY INTAKE AND RECOVERY STATUS AMONG DIVISION III BASEBALL PLAYERS DURING THE FALL COLLEGIATE BASEBALL SEASON

A master’s thesis submitted to the Kent State University College of Education, Health, and Human Services in partial fulfillment of the requirements for the degree of Master of Science

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The purpose of this study was to examine the dietary intake and recovery status of Division III baseball players during the fall collegiate baseball season. Dietary intake was evaluated using three 24-hour dietary records, while recovery status was evaluated using three Total Quality Recovery (TQR) logs on home, away and non-competition days. The participants in this study were 23 male (mean ± SD: age = 18.6 ± 0.9 years) NCAA Division III baseball student-athletes from a northeast Ohio university.

Participants completed the 24-hour dietary records and TQR logs. Dietary intake was analyzed using ESHA food processor software (Elizabeth Stewart Hands and Associates, Salem, OR). The findings of this study were assessed by a One-way repeated measures Analysis of Variance (ANOVA) and Bonferroni post hoc (SPSS, version 12). Statistical analysis revealed significant differences between home (2,514 ± 159.56 kcals) and non-competition energy intake (2,104.96 ± 114.99 kcals) (P = 0.004) and home (258.76 ± 118.22 g) and non-competition carbohydrate intake (201.33 ± 71.49 g) (P = 0.015).

Recovery status was classified as poor (≤14 points) during home (13.69 ± 3.00), away (13.96 ± 2.76) and non-competition (14.04 ± 3.22) days. Division III baseball players did not achieve sport-specific, bodyweight-dependent nutrition recommendations for energy, carbohydrate, fat or fluids. These data suggest Division III baseball players consume
suboptimal dietary intakes and experience poor recovery during the fall collegiate baseball season.
ACKNOWLEDGMENTS

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# TABLE OF CONTENTS

ACKNOWLEDGEMENTS ........................................................................................................ iii

LIST OF TABLES .................................................................................................................. vi

CHAPTER

I. INTRODUCTION ............................................................................................................... 1
  Problem Statement ............................................................................................... 3
  Purpose Statement ............................................................................................. 5
  Hypotheses ........................................................................................................... 5
  Operational Definitions ..................................................................................... 5

II. REVIEW OF LITERATURE ............................................................................................ 6
  Overview of Energy Metabolism ................................................................. 6
  Anaerobic Metabolism .................................................................................... 6
  Aerobic Metabolism ......................................................................................... 8
  Classification of Sport-Specific Energy Systems ..................................... 11
    Very High-Intensity Sports ................................................................. 11
    High-Intensity, Short-Duration Sports .................................................. 11
    Intermittent, High-Intensity Sports ....................................................... 12
    Endurance Sports ....................................................................................... 12
    Weight- and Body-Focused Sports ........................................................ 12
    Low-Endurance, Precision Skill Sports .............................................. 13
    Baseball-Specific Energy Systems ......................................................... 13
  Energy and Macronutrient Guidelines for College-Aged Males ........ 13
    Guidelines for Baseball ........................................................................... 15
    Carbohydrate Intake Guidelines .......................................................... 16
    Carbohydrate Intake Guidelines: Sports Nutrition ............................... 17
      Pre-exercise ............................................................................................ 19
      Intra-exercise ......................................................................................... 21
      Post-exercise ......................................................................................... 24
      Guidelines for baseball ....................................................................... 24
    Protein Intake Guidelines ......................................................................... 25
    Protein Intake Guidelines: Sports Nutrition ........................................... 25
      Guidelines for baseball ....................................................................... 26
    Fat Intake Guidelines ................................................................................ 26
    Fat Intake Guidelines: Sports Nutrition ................................................. 27
      Guidelines for baseball ....................................................................... 27
    Fluid Intake Guidelines ............................................................................ 27
      Guidelines for baseball ....................................................................... 28
  Assessing Current Dietary Intake ................................................................. 28
Dietary Intake of Collegiate Male Athletes .................................................................29
Overview of Recovery ...............................................................................................31
Nutrition and Hydration ............................................................................................31
Carbohydrate ............................................................................................................32
Protein ..........................................................................................................................32
Fluids .............................................................................................................................33
Sleep and Rest ..............................................................................................................33
Relaxation and Emotional Support ...........................................................................34
Stretching and Active Rest ........................................................................................35
Total Quality Recovery (TQR) Questionnaires .........................................................35
Practical Applications of TQR Questionnaires ..........................................................38
Overview of National Collegiate Athletic Association (NCAA) Policy ......................40
Division III Nutrition-Related Policy .........................................................................40
Meal allowance limitation ..........................................................................................41
Meals related to institutional committee service .......................................................41
Meals in conjunction with home competition ...........................................................41

III. METHODOLOGY ..................................................................................................42
Participants ..................................................................................................................42
Instrument of Measure ...............................................................................................43
Procedure ...................................................................................................................44
Statistical Analysis ......................................................................................................46

IV. JOURNAL ARTICLE .............................................................................................47
Introduction ................................................................................................................47
Methods .......................................................................................................................50
Participants ..................................................................................................................50
Instrument of Measure ...............................................................................................51
Procedure ....................................................................................................................52
Statistical Analysis .......................................................................................................53
Results ..........................................................................................................................54
Discussion ....................................................................................................................59
Limitations ...................................................................................................................65
Applications ..................................................................................................................67
Conclusion ....................................................................................................................69

APPENDICES ..........................................................................................................70
APPENDIX A. LETTER OF CONSENT ...................................................................71
APPENDIX B. SPORTS NUTRITION QUESTIONNAIRE ...................................75
APPENDIX C. TOTAL QUALITY RECOVERY (TQR) QUESTIONNAIRE ......78
APPENDIX D. 24-DIETARY RECORD .................................................................83

REFERENCES .........................................................................................................87
# LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Summary of Guidelines for Carbohydrate Intake by Athletes</td>
<td>18</td>
</tr>
<tr>
<td>3. Acute Fueling Strategies</td>
<td>20</td>
</tr>
<tr>
<td>4. Sports Nutrition Resources Provided to Division III Baseball Players as Frequencies (ƒ) and Percentages (%) (n=18)</td>
<td>55</td>
</tr>
<tr>
<td>5. Means ((\bar{X})) and Standard Deviations (±SD) of 24-Hour Dietary Record Carbohydrate, Protein, Fat and Energy Intakes and Recovery on Home, Away and Non-Competition Days in Division III Baseball Players (n=23)</td>
<td>56</td>
</tr>
<tr>
<td>6. Dietary Intake of Division III Baseball Players for Carbohydrates (g/kg), Protein (g/kg), Fat (g/kg), Fluid (ml/kcal), and Energy (kcal/kg) Using Current Baseball-Specific, Bodyweight-Dependent Sports Nutrition Recommendations</td>
<td>58</td>
</tr>
</tbody>
</table>
CHAPTER I
INTRODUCTION

Organizations such as the Academy of Nutrition and Dietetics, Dietitians of Canada, and the American College of Sports Medicine agree that the energy, carbohydrate, and protein requirements for athletes should be conveyed in grams per kilogram of body mass (g/kg), rather than a proportion of energy intake, to accommodate various body sizes of athletes (Thomas, Erdman, & Burke, 2016). Male athletes who participate in National Collegiate Athletic Association (NCAA) athletics require altered macronutrient standards (Burke, Hawley, Wong, & Jeukendrup, 2011; Hinton, Yakushko, Beck, Sanford, & Davidson, 2004; Hull et al., 2016; Thomas et al., 2016). Dietary recommendations for collegiate baseball players are as follows: Energy: ≥35 kcals/kg, Carbohydrates: 5-7 g/kg/day, Protein: 1.2-1.7 g/kg/day, Fat: ~1.0 g/kg/day, Fluid: 1 ml/kcal (Macedonio & Dunford, 2009; Popkin, D’Anci, & Rosenberg, 2010; Rosenbloom & Coleman, 2012).

According to the National Collegiate Athletic Association’s (NCAA) 2015 GOALS (Growth, Opportunities, Aspirations and Learning of Students in college) Study, Division III baseball players report spending 34 hours per week on in-season athletic activities. Additionally, Division III baseball players report spending 36 hours per week on in-season academic activities. In total, Division III baseball players report spending 70 hours per week towards in-season athletic and academic activities. Off-season athletic and academic time commitments may exceed in-season demands of Division III baseball players. According to the NCAA’s 2015 GOALS study, 64% of Division III baseball
players report spending as much or more time on athletic activities during the off-season than during in-season. With rigorous in-season and off-season athletic and academic demands, NCAA college baseball players may struggle with overall energy balance. Energy balance occurs when total energy intake (EI) equals total energy expenditure (TEE), which in turn consists of the summation of basal metabolic rate (BMR), the thermic effect of food (TEF), and the thermic effect of activity (TEA) (Thomas et al., 2016).

Energy balance is crucial for athletic performance, recovery, and body composition maintenance, and Division III baseball players may be at a higher risk of not achieving energy balance than their Division I and II counterparts. Competition nutrition focuses on providing an athlete with adequate energy substrates to meet the energy cost and cognitive demands of a specific event (Thomas et al., 2016). Various low-endurance, precision skill sports, such as baseball, require fine motor control, coordination, and reaction time as well as anaerobic power and general fitness conditioning (Rosenbloom & Coleman, 2012). Although low-endurance, precision skill athletes do not usually require significant energy or macronutrient increases compared to other types of athletes (Rosenbloom & Coleman, 2012), inadequate dietary intakes decrease athletic performance and recovery (Currell & Jeukendrup, 2008; Hottenrott et al., 2012; Position of the ADA, Dietitians of Canada & ACSM, 2009; Thomas et al., 2016; Wierniuk & Włodarek, 2013).

The Collegiate and Professional Sports Dietitian Association (CPSDA) currently reports 66 universities from major Division I college conferences who employ at least
one full-time registered sports dietitian (RD). In addition to a sports RD, many Division I programs utilize training tables and/or fueling stations to potentially provide food and beverages to multiple men’s and women’s athletic teams. However, due to variations in NCAA policy, finances, staffing and resources, Division III programs typically lack the capacity to provide such options. This key difference among upper- and lower-divisions poses a concern for a lack of nutrition accessibility in lower-division collegiate baseball programs.

Frequent travel and variability in athletic schedules presents additional nutrition and recovery challenges to collegiate baseball players. Due to financial circumstances of collegiate programs and players, fast food and 24-hour diners are common sources of meals on the road (Rosenbloom & Coleman, 2012). The sport of baseball does not have a time limit, so time between meals may exceed several hours. Players typically report to the clubhouse four to five hours prior to game time for home competitions. Food may be provided in the clubhouse, however, it may not necessarily be nutritionally sound (Rosenbloom & Coleman, 2012). Many confounding factors influence home and away competition nutrition and recovery. Therefore, energy balance and recovery differences could exist in Division III baseball players.

**Problem Statement**

The deregulation of feeding in collegiate athletics, implemented by the National Collegiate Athletic Association (NCAA), allows an institution to provide meals and snacks to scholarship and non-scholarship student-athletes at the discretion of the institution (NCAA, 2016). This policy broadens the potential nutrition services and
nutrition options available to the student-athlete. By increasing nutrition accessibility through the deregulation of feeding, student-athletes may better achieve their dietary requirements while enduring rigorous academic and athletic schedules. However, this policy does not apply to the Division III student-athlete and poses a nutrition risk for this population.

Consensus among the scientific literature, exercise and nutrition organizations, and sports nutrition professionals recognize that athletes require specific bodyweight-dependent dietary needs to help increase athletic performance, support energy balance, and promote recovery (Currell & Jeukendrup, 2008; Hottenrott, 2012; Position of the ADA, Dietitians of Canada & ACSM, 2009; Rosenbloom & Coleman, 2012; Thomas et al., 2016). Low-endurance, precision skilled sports, such as baseball, typically exert less energy than other sports (Rosenbloom & Coleman, 2012). Because of this, nutrition is often overlooked at the collegiate level of baseball and among the scientific literature. Collegiate athletes continue to struggle to meet the recommended dietary intake levels (Cole et al., 2005; Hull et al., 2017; Webber et al., 2015; Wierniuk & Włodarek, 2013). Proper nutrition plays an integral role in the recovery process (Heaton et al., 2017; Jäger et al., 2017; American College of Sports Medicine et al., 2007; Thomas et al., 2016).

The game of baseball presents many nutrition and recovery related barriers to its athletes. Baseball does not have a specific time limit which may create long duration layovers between meal times. Home and away competitions present a set of financial, food source, and meal timing challenges to Division III programs. Many confounding
factors influence nutrition and recovery, therefore, dietary intake and recovery
differences could exist in Division III baseball players.

**Purpose Statement**

The purpose of this study is to examine the dietary intake and recovery status of
Division III baseball players during the collegiate fall baseball season at a northeast Ohio
university. Additionally, comparison between home competition, away competition and
non-competition dietary intake and recovery status surveys will be investigated.

**Hypotheses**

H₁: Dietary intake will be different between home, away and non-competition days.

H₂: Recovery status will be different between home, away and non-competition days.

**Operational Definitions**

Dietary Intake: Total energy (kilocalories or kcals), carbohydrate, protein, fat, and fluid

Recovery Status: ≤14 = poor recovery; 15-16 = good recovery; 17-20 = optimal recovery

(Total Quality Recovery (TQR) Questionnaire summation of scores) (Berdejo-del-Fresno
& Laupheimer, 2014; Freitas, Nakamura, Miloski, Samulski, & Bara-Filho, 2014; Jones,
CHAPTER II

REVIEW OF LITERATURE

Overview of Energy Metabolism

The following section outlines the anaerobic and aerobic energy pathways.

Anaerobic Metabolism

The phosphagen system (ATP-PCr) utilizes adenosine triphosphate (ATP) and phosphocreatine (PCr) for short duration bouts of exercise lasting approximately 10 seconds (Thomas et al., 2016). ATP is the energy currency of the cell (Rosenbloom & Coleman, 2012) and PCr is an intracellular high-phosphate compound used to resynthesize ATP in the absence of oxygen. ATP resynthesis occurs when the chemical energy bond in the PCr is donated directly to adenosine diphosphate (ADP) through an enzyme-mediated reaction using creatine kinase (McArdle, Katch, & Katch, 2010; Rosenbloom & Coleman, 2012). Both ATP and PCr stores are limited in the human body. However, the amount of PCr stored in the body greatly exceeds that of ATP (Williams, Anderson, & Rawson, 2013). Stores of PCr are limited and supplies must be replenished if used. The ATP-PCr system powers high-output, short-duration, maximal effort movements needed to perform in various sporting events. This includes, but is not limited to, events like weightlifting, sprints and throws in track and field, a swing in golf or baseball, and a serve in tennis (Rosenbloom & Coleman, 2012). When exercise persists greater than 10 seconds and demands for energy exceed the capacity of the ATP-PCr system, ATP synthesis relies on the anaerobic glycolysis system (McArdle et al., 2010; Rosenbloom & Coleman, 2012)
Anaerobic glycolysis specializes in fueling high-intensity exercise lasting 10 to 180 seconds (Thomas et al., 2016). Anaerobic glycolysis yields energy at a slower rate than the ATP-PCr system, which limits its capacity for power and exercise-intensity sustainability (Rosenbloom & Coleman, 2012). Anaerobic glycolysis utilizes glucose degradation to rapidly replenish ATP during high-intensity bouts of exercise when the working muscles are under the conditions of insufficient levels of oxygen. Glucose may enter the working muscle via the bloodstream or by the breakdown of muscle and/or liver glycogen. Glycogen is the storage form of glucose in human liver and skeletal muscle tissues. Saturated glycogen stores are limited to approximately 100 grams in the adult liver and 375 grams in skeletal muscle tissue or approximately 1,000 to 2,000 kilocalories (kcals) of stored carbohydrate energy (Rosenbloom & Coleman, 2012).

Glycolysis is exclusively powered by glucose. The breakdown of one molecule of glucose to two molecules of pyruvate generates a net gain of two ATP’s. Under the conditions of high-intensity workloads, hydrogen ions accumulate and often exceed the oxidizing capacity of the electron transport chain. The excess hydrogen ions combine with pyruvate to form lactate, which is released into the bloodstream and metabolized by tissues like skeletal and heart muscle (Rosenbloom & Coleman, 2012). A linear relationship exists between exercise intensity and lactate formation, and athletic performance and fatigue rely heavily on lactate clearance.

When blood lactate levels exceed the clearance capacity of the liver, intracellular acidity increases within the muscle cell (McArdle et al., 2010; Rosenbloom & Coleman, 2012). The point at which blood lactate production exceeds lactate clearance at a certain
exercise intensity is known as the lactate threshold. Excess lactate accumulation mediates fatigue and diminishes athletic performance by inhibiting enzymatic activity in energy transfer (McArdle et al., 2010; Rosenbloom & Coleman, 2012). Well-trained athletes experience the onset of lactate threshold at approximately 70 to 80% of their maximum aerobic capacity while untrained individuals experience the onset considerably sooner at 50 to 60% of their maximum aerobic capacity (Rosenbloom & Coleman, 2012). As the duration of exercise proceeds, oxygen delivery increases to the working muscles and the aerobic system fuels ATP production.

**Aerobic Metabolism**

The aerobic system requires oxygen to metabolize carbohydrates, as glucose and liver/muscle glycogen, fats, as adipose tissue and intramuscular triglycerides, and proteins, as amino acids from muscle, blood, liver, and the gut (Thomas et al., 2016). The aerobic system is comprised of the Krebs cycle, also referred to as the Citric acid cycle and/or Tricarboxylic acid (TCA) cycle, and the electron transport chain (ETC). Figure 1 illustrates the aerobic system (Rosenbloom & Coleman, 2012).

Carbohydrates contribute to the aerobic system via aerobic glycolysis. The breakdown of one glucose molecule yields two pyruvate molecules in glycolysis. In the presence of oxygen, pyruvate converts to acetyl-coA and enters the mitochondrion to feed the Citric acid cycle. The ETC utilizes a hydrogen gradient to harness additional ATP from electron carrier nicotinamide adenine dinucleotide (NAD) and flavin adenine dinucleotide (FAD). The total yield of ATP from a single molecule of glucose equals 38
Fatty acids contribute to the aerobic system via lipolysis, or the breakdown, mobilization and delivery of fatty acids to skeletal muscle. Lipid metabolism is achieved by the following process: 1) breakdown of triacylglycerol to free fatty acids (FFA); 2) transport of FFA in the blood; 3) muscle uptake of FFA from blood; 4) preparation of catabolism; 5) entry into muscle mitochondria; 6) breakdown to acetyl-coA and reducing equivalents; 7) oxidation in Citric acid cycle and ETC (McArdle et al., 2010). Energy stored as adipose tissue may represent 50,000 to 120,000 kcals (McArdle et al., 2010; Rosenbloom & Coleman, 2012) while intramuscular triglycerides may include 2,000 to 3,000 kcals (McArdle et al., 2010). A single lipid molecule yields approximately 460 ATP molecules in aerobic metabolism (McArdle et al., 2010).

The aerobic system may also utilize protein as a contributor to generate ATP. Proteins are broken down into amino acids. Before the amino acids can be used, the nitrogen group must be removed. Once removed, amino acids enter aerobic metabolism as pyruvate, acetyl-coA or directly into the Krebs cycle as an intermediate. Pyruvate yielding amino acids include, threonine, serine, cysteine, and glycine. Acetyl-coA yielding amino acids include isoleucine, leucine, lysine, tyrosine, phenylalanine and tryptophan. Citric acid intermediate yielding amino acids include arginine, asparagine, aspartate, glutamate, glutamine, histidine, isoleucine, methionine, phenylalanine, proline, threonine, tyrosine and valine (McArdle et al., 2010).
Due to the metabolic cost to remove each nitrogen group as well as the physiological cost of muscle protein, amino acids are not a preferred fuel source among athletes. Amino acids can generate up to 15 ATP and contribute approximately 2% to 6% of aerobic energy demands (Rosenbloom & Coleman, 2012). Although the aerobic system is outweighed by both the phosphagen and anaerobic system in the rate of ATP resynthesis capacity, its ability to generate large quantities of ATP is far superior than any other system.
Classification of Sport-Specific Energy Systems

Individual and team sports require a magnitude of physiological demands which influence the utilization of different energy systems. Because of this, sports may be categorized based primarily on their energy systems. This not only allows athletes, coaches and practitioners the ability to personalize training programs, it allows for personalized nutrition guidelines to optimize energy-specific events and team sports. The Academy of Nutrition and Dietetics (ACEND) Sports Nutrition Manual categorizes sports into the following groups: very high-intensity sports; high-intensity, short-duration sports; intermittent, high-intensity sports; endurance sports; weight- and body-focused sports; low-endurance, precision skill sports (Rosenbloom & Coleman, 2012). The distribution and proportion of energy system usage in sports heavily influences nutrition guidelines for athletes to optimize athletic performance, fuel training, and promote recovery.

Very High-Intensity Sports

Very high-intensity (less than 30 seconds) sports rely exclusively on ATP-PCr and anaerobic metabolism to power maximal effort performances. Sports like track and field (sprints, hurdles, jumps & throws), cycling sprints, swimming sprints, Olympic weightlifting and powerlifting, gymnastics, and team sports with sprints (football & baseball) fall into this category (Rosenbloom & Coleman, 2012).

High-Intensity, Short-Duration Sports

High-intensity, short-duration sports last approximately one and half to 30 minutes and require both anaerobic and aerobic metabolism. Sports like running and
swimming (200 to 1,500 meters), rowing, and short-distance cycling and mountain biking fall into this category (Rosenbloom & Coleman, 2012).

**Interruption, High-Intensity Sports**

The Academy of Nutrition and Dietetics’ Sports Nutrition Manual defines intermittent, high-intensity sports as activities that require short periods of all-out effort, punctuated with periods of less-intense effort, and low-intensity effort. Many team sports such as football, volleyball, basketball, soccer, and ice hockey remain in this category (Rosenbloom & Coleman, 2012). Due to the multi-movement, stop-and-start nature of this category, anaerobic and aerobic metabolism is utilized throughout the duration of these sports.

**Endurance Sports**

Endurance sports include a variety of events such as many long-distance running events like marathons and ultra runs, triathlons, long-distance cycling and swimming, and adventure races. Endurance sports typically last a few hours, however, ultra-endurance races may span across multiple days to weeks, such as the 21-stage Tour de France. Endurance sports rely minimally on anaerobic metabolism and predominantly on aerobic metabolism (Rosenbloom & Coleman, 2012).

**Weight- and Body-Focused Sports**

Weight- and body-focused sports rely heavily on aesthetics and body composition. Sports such as wrestling, gymnastics, martial arts, body building and figure skating fall into this category. Athletes participating in these sports predominantly rely on both anaerobic and aerobic metabolism to support brief, explosive movements as well
as recovery between bouts. Specific movements within each respective sport influence the distribution of energy system utilization (Rosenbloom & Coleman, 2012).

**Low-Endurance, Precision Skill Sports**

According to the Academy of Nutrition and Dietetics’ Sports Nutrition Manual, low-endurance, precision skill sports, like baseball and golf, require fine motor control, coordination, and quick reaction time. Athletes participating in low-endurance, precision skill sports rely predominantly on the anaerobic system to power brief, explosive movements, like swinging a bat or club, sprinting the bases or throwing the ball (Rosenbloom & Coleman, 2012).

**Baseball-Specific Energy Systems**

Baseball falls within the category of low-endurance, precision skill sports. Baseball players predominantly utilize the anaerobic system (ATP-PCr & anaerobic glycolysis) to power various sport-specific movements (Rosenbloom & Coleman, 2012; Szymanski, 2009). Baseball-specific movements, such as throwing a baseball or swinging a bat, are brief, explosive activities that require great amounts of power. The PCr system supplies large quantities of ATP and power to the short-term, high-intensity movements. Additionally, running the bases and sprinting on defense requires ATP generation supplied by anaerobic glycolysis.

**Energy and Macronutrient Guidelines for College-Aged Males**

The Dietary Guidelines for Americans (DGA) 2015-2020 and Food and Nutrition Board of the Institute of Medicine (IOM), National Academies, provide energy and nutrient standards for the general healthy population in the United States. The DGA and
IOM include Dietary Reference Intakes (DRIs) and Acceptable Macronutrient Distribution Ranges (AMDRs) for healthy individuals. Current adult AMDRs for daily intake of carbohydrates, protein and fat is 45-65%, 10-35% and 20-35%, respectively, of one’s total energy (calorie) intake (National Academy of Medicine, 2017; United States Department of Health and Human Services and United States Department of Agriculture, 2015). Energy (calorie) intake recommendations vary among age-sex groups. Additional factors, such as physical activity, influence energy guidelines as well. The current energy recommendations for college-aged males is outlined in Table 1.

Table 1

*Dietary Guidelines for Americans 2015-2020: Appendix 7. Daily Nutritional Goals for Age-Sex Groups*

<table>
<thead>
<tr>
<th>Guidelines</th>
<th>Males</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>14-18</td>
</tr>
<tr>
<td>Calories (kcal)</td>
<td>2,200</td>
</tr>
<tr>
<td></td>
<td>2,800</td>
</tr>
<tr>
<td></td>
<td>3,200</td>
</tr>
<tr>
<td>Protein, g</td>
<td>52</td>
</tr>
<tr>
<td>Protein, % kcal</td>
<td>10-30</td>
</tr>
<tr>
<td>Carbohydrate, g</td>
<td>130</td>
</tr>
<tr>
<td>Carbohydrate, % kcal</td>
<td>45-65</td>
</tr>
<tr>
<td>Total fat, % kcal</td>
<td>25-35</td>
</tr>
</tbody>
</table>

Guidelines for Baseball

Compared to other sport groups, low-endurance, precision skill sports, like baseball, are relatively low-energy expenditure sporting events (Rosenbloom & Coleman, 2012). Although overall energy demands remain relatively low in baseball players, energy balance is crucial for athletic performance, recovery, and body composition maintenance. Energy balance occurs when total energy intake (EI) equals total energy expenditure (TEE), which in turn consists of the summation of basal metabolic rate (BMR), the thermic effect of food (TEF), and the thermic effect of activity (TEA) (Thomas et al., 2016).

Baseball players typically endure events lasting several hours of the day. According to the National Collegiate Athletic Association (NCAA), the average length of a collegiate nine-inning game increased from two hours, 53 minutes in 2012 to three hours, 19 minutes in 2015 (Johnson, 2015). It is typical for collegiate baseball players to report to the clubhouse four to five hours prior to competition (Rosenbloom & Coleman, 2012). According to the NCAA’s 2015 GOALS (Growth, Opportunities, Aspirations and Learning of Students in college) Study, Division I, II, and III baseball players report spending 40, 37 and 34 hours per week, respectively, on in-season athletic activities. Additionally, Division I, II, and III baseball players report spending 34, 34, and 36 hours per week, respectively, on in-season academic activities. In total, Division I, II, and III baseball players report spending 74, 71 and 70 hours per week, respectively, towards in-season athletic and academic activities. Due to the lengthy nature of the sport and
academic responsibilities, baseball players may experience compromised athletic performance due to their suboptimal fuel intake (Rosenbloom & Coleman, 2012).

According to the Academy of Nutrition and Dietetics’ Sports Nutrition Manual, specific energy recommendations for baseball players remains undefined. However, this manual state that a well-balanced diet adequate in energy will likely meet most if not all of these athletes’ nutritional needs (Rosenbloom & Coleman, 2012). Individualized energy guidelines depend on baseball player position, body size and composition, and in-season workload demands including competitions, practices, strength and conditioning training sessions, and coursework. Macedonio and Dunford (2009) recommend male athletes participating in moderate-intensity exercise three to five days per week or low-intensity and short-duration training daily, including baseball players, consume an estimated 38 kcals/kg/day. Sedentary male athletes require an estimated 31 kcals/kg/day. Therefore, a conservative energy factor of 35 kcals/kg/day may appropriately represent the male collegiate baseball player (Macedonio & Dunford, 2009).

**Carbohydrate Intake Guidelines**

The DGA recommends college-aged males consume at least 130 grams of carbohydrates per day. Carbohydrate distribution is recommended at 45-65% of total kcals per day. Carbohydrate ranges may vary considerably depending on the caloric range and percent of total kcals per day. Table 1 displays caloric recommendations ranging from 2,200 to 3,200 kcals for college-age males. For example, a carbohydrate distribution of 45% total kcals of a 2,200 kcal energy intake equals 247.5 grams of carbohydrate while a carbohydrate distribution of 65% total kcals of a 3,200-kcal energy
intake equals 520 grams of carbohydrate. General, flexible carbohydrate recommendations provided by the DGA allow healthy college-aged males the ability to match his appropriate recommendation to his lifestyle. However, general carbohydrate recommendations vary considerably to current sport-specific carbohydrate guidelines.

**Carbohydrate Intake Guidelines: Sports Nutrition**

Carbohydrate is a primary and versatile substrate in energy metabolism due to its ability to yield ATP in both the aerobic and anaerobic energy systems (Thomas et al., 2016). Due to carbohydrate’s relatively low storage capacity in the human body (muscle & liver glycogen) adequate intake is imperative for optimal athletic performance, maintaining and refueling glycogen stores, and recovery (Burke et al., 2011; Jeukendrup, 2014; Rosenbloom & Coleman, 2012; Thomas et al., 2016).

Contrary to the DGA’s carbohydrate guidelines for the general, healthy individual, sports nutrition carbohydrate guidelines are provided in grams per bodyweight (kilogram; kg) rather than a percent of total energy intake. Carbohydrate intake is dependent on many factors like body mass, training duration and exercise type and intensity (Burke et al., 2011). According to the Academy of Nutrition and Dietetics Sports Nutrition Manual, recommended daily carbohydrate intake for most trained athletes is five to 10 g/kg, five to seven g/kg for general training needs, seven to 10 g/kg for endurance athletes, and greater than 11 g/kg for ultra-endurance athletes. Furthermore, guidelines for carbohydrate intake by athletes is outlined in Table 2 (Burke et al., 2011). Burke et al. (2011), provides carbohydrate recommendations based on exercise intensity (light, moderate, high, very high) and situation with specific gram per
kilogram carbohydrate targets. Additional comments on both type and timing of carbohydrate intake is provided to further personalize the guidelines towards athletic populations.

Table 2

<table>
<thead>
<tr>
<th>Situation</th>
<th>Carbohydrate targets</th>
<th>Comments on type of timing of carbohydrate intake</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light</td>
<td>Low-intensity or skill-based activities</td>
<td>3-5 g/kg/day</td>
</tr>
<tr>
<td>Moderate</td>
<td>Moderate exercise program (i.e. ~1 hr/day)</td>
<td>5-7 g/kg/day</td>
</tr>
<tr>
<td>High</td>
<td>Endurance program (i.e. moderate-to-high intensity exercise 1-3 hr/day)</td>
<td>6-10 g/kg/day</td>
</tr>
<tr>
<td>Very high</td>
<td>Extreme commitment (i.e. moderate-to-high intensity exercise of &gt;4-5 hr/day)</td>
<td>8-12 g/kg/day</td>
</tr>
</tbody>
</table>


Current carbohydrate guidelines for athletes range from three to 12 grams per kilogram and remain non-specific to some under-researched athletic populations.

Carbohydrate guidelines depend largely on the type, intensity and duration of exercise
(Burke et al., 2011; Jeukendrup, 2014; Rosenbloom & Coleman, 2012; Thomas et al., 2016). Much research on the impact of pre-, intra- and post-exercise carbohydrate ingestion on athletic performance and recovery continues to drive personalized, sport-specific fueling guidelines (Burke et al., 2011). Overall, daily carbohydrate guidelines for athletes should aim to achieve adequate fueling for optimal sport performance (training, exercise, competition) as well as provide sufficient carbohydrate for glycogen maintenance (Burke et al., 2011; Jeukendrup, 2014; Rosenbloom & Coleman, 2012; Thomas et al., 2016).

**Pre-exercise.** Athletes typically utilize pre-exercise carbohydrate strategies beginning from hours to days leading up to an athletic event (Burke et al., 2011). Acute and sub-acute carbohydrate fueling strategies used to optimize sport performance are outlined in Table 3. Pre-exercise carbohydrate fueling is situationally dependent on the sporting event, timing, and type of carbohydrate source.

General fueling guidelines for an athlete preparing for an event lasting less than 90 minutes is seven to 12 g/kg per 24 hours as for daily fuel needs. Carbohydrate loading guidelines for an athlete preparing for an event lasting greater than 90 minutes of sustained and/or intermittent exercise is 10-12 g/kg per 24 hours for 36-48 hours leading up to the event. When an athlete has less than eight hours of recovery between two fuel demanding sessions, they may adhere to the speedy refueling guidelines. Speedy refueling recommends an athlete ingest 1.0-1.2 g/kg/h of carbohydrate for the first four hours after the initial session, then daily fuel needs resume thereafter. This carbohydrate fueling strategy may benefit an athlete participating in tournament style play. Collegiate
athletes with a schedule, for example, of an early morning training session, followed by several hours of class, concluded by an afternoon practice may benefit from this technique as well. Pre-event fueling prior to exercise lasting greater than 60 minutes is one to four g/kg carbohydrate consumed one to four hours before exercise. Essentially, pre-event fueling follows a one to one ratio of grams per kilogram of carbohydrate to time before exercise (Burke et al., 2011; Rosenbloom & Coleman, 2012).

Table 3

**Acute Fueling Strategies**

<table>
<thead>
<tr>
<th>Situation</th>
<th>Carbohydrate targets</th>
<th>Comments on type of timing of carbohydrate intake</th>
</tr>
</thead>
<tbody>
<tr>
<td>General fueling up</td>
<td>Preparing for events &lt; 90 min exercise</td>
<td>7-12 g/kg per 24 h as for daily fuel needs</td>
</tr>
<tr>
<td>Carbohydrate Loading</td>
<td>Preparing for events &gt; 90 min of sustained/intermittent exercise</td>
<td>36-48 h of 10-12 g/kg body mass per 24 h</td>
</tr>
<tr>
<td>Speedy Refueling</td>
<td>&lt; 8 h recovery between two fuel demanding sessions</td>
<td>1.0-1.2 g/kg/h for first 4 h then resume daily fuel needs</td>
</tr>
<tr>
<td>Pre-event Fueling</td>
<td>Before exercise &gt; 60 min</td>
<td>1-4 g/kg consumed 1-4 h before exercise</td>
</tr>
</tbody>
</table>
Choices high in fat/protein/fiber may need to be avoided to reduce risk of gastrointestinal issues during the event.

Low Glycemic Index choices may provide a more sustained source of fuel for situations where carbohydrate cannot be consumed during exercise.


The purpose of pre-exercise carbohydrate fueling is to top off glycogen stores, avoid post-prandial hyperinsulinemia and hypoglycemia, avoid gastrointestinal disturbances, and prevent overall hunger (Burke et al., 2011; Jeukendrup, 2014; Rosenbloom & Coleman, 2012; Thomas et al., 2016; Wright, Sherman, & Dernbach, 1991). The general fueling guidelines among the literature act as a foundation for athletes and coaches to further personalize and fine-tune down to an individual basis for optimal sport performance. Athletes should experiment with low-, medium-, and high-glycemic index foods during training to further personalize these guidelines (Rosenbloom & Coleman, 2012).

**Intra-exercise.** Recent developments by Jeukendrup (2014) establish the importance of carbohydrate intake during exercise. These guidelines are displayed in Figure 2. Carbohydrate intake during prolonged exercise (>2 hours) prevents hypoglycemia, maintains carbohydrate oxidation rates and increases endurance capacity.
(Jeukendrup, 2014). Jeukendrup (2014) indicates carbohydrate ingestion is imperative to shorter duration, high-intensity exercise performance as well. Synergistic interactions between pre-exercise and intra-exercise carbohydrate ingestion may improve athletic performance. Wright, Sherman and Dernbach (1991) demonstrated the additive benefits to pre- plus intra-exercise carbohydrate consumption by examining the effects of no carbohydrate, pre-exercise carbohydrate, intra-exercise carbohydrate or a combination of pre- and intra-exercise carbohydrate in well-trained cyclists. Cyclists consuming both pre- and intra-exercise carbohydrate significantly improved exercise performance and time to exhaustion compared to the no carbohydrate placebo group. Cyclist who received the combination of both pre-exercise and intra-exercise carbohydrate could significantly outperform all other modalities in cycling performance and time to exhaustion (Wright, Sherman, & Dernbach, 1991).

According to the Academy of Nutrition and Dietetics Sports Nutrition Manual, carbohydrate intake during exercise improves endurance performance as well as performance in stop-and-go sports. Although most intra-exercise carbohydrate research has studied endurance athletes performing continuous exercise, new insight on team sports have developed. Currell, Conway and Jeukendrup (2009) developed a simulated soccer protocol to measure carbohydrates impact on sport-specific skills. The 90-minute protocol measured skills such as agility, dribbling, shooting and heading. University soccer players performed three randomized trials with two placebo trials and one trial with a 7.5% maltodextrin solution. The soccer players experienced a significant increase
in agility, dribbling, and accuracy of shooting during the carbohydrate ingestion trial, however, heading was not affected with carbohydrate ingestion (Currell et al., 2009).

Figure 2. Carbohydrate intake recommendations during exercise. Figure 2 depicts current carbohydrate recommendations during exercise. Carbohydrate dosages increase proportionally as duration of exercise increases and recommendations are bodyweight dependent (g/kg). Carbohydrate sources vary among time-points. Figure 2 retrieved from Jeukendrup, A. (2014). A step towards personalized sports nutrition: Carbohydrate intake during exercise. *Sports Medicine* (Auckland, N.Z.), 44 Suppl 1S25-S33. doi:10.1007/s40279-014-0148-z.
Although most intra-exercise carbohydrate research remains predominantly endurance athlete focused, team sport research is expanding (Currell et al., 2009; Jeukendrup, 2014). Current guidelines provided by the Academy of Nutrition and Dietetics Sports Nutrition Manual promote carbohydrate intake during exercise for both endurance and stop-and-go athletes. There has yet to be research published examining the effect of intra-exercise carbohydrate ingestion on baseball-specific movements such as swinging, pitching, or fielding.

**Post-exercise.** Glycogen restoration remains a primary goal of post-exercise carbohydrate ingestion (Thomas et al., 2016). Delayed carbohydrate intake post-exercise may reduce muscle glycogen restoration and impair recovery, while adequate carbohydrate and energy intake post-exercise optimizes muscle glycogen stores (Rosenbloom & Coleman, 2012). According to the Academy of Nutrition and Dietetics Sports Nutrition Manual, recommended carbohydrate intake after hard exercise (> 90 minutes) is 1.5 g/kg immediately after exercise and an additional 1.5 g/kg two hours later.

**Guidelines for baseball.** According to the Academy of Nutrition and Dietetics Sports Nutrition Manual, specific carbohydrate guidelines have not been established for baseball players, therefore, general recommendations are applied to these athletes. The acceptable carbohydrate range to properly fuel baseball players is five to seven grams per kilogram (Rosenbloom & Coleman, 2012). These guidelines coincide with the moderate carbohydrate category provided in Table 2.

Baseball players may utilize pre-exercise carbohydrate fueling guidelines provided in Table 3. Due to the nature of a collegiate baseball schedule, players typically
participate in many tournament style competitions or double-headers (back-to-back baseball games with a brief intermission between play). Although limited research exists on carbohydrate ingestion and baseball performance, baseball players should adhere to current sports nutrition guidelines relating to pre-, intra- and post-exercise carbohydrate ingestion (Rosenbloom & Coleman, 2012).

**Protein Intake Guidelines**

The DGA recommends college-aged males consume at least 52 and 56 grams of protein per day for ages 14-18 and 19-30, respectively. Protein distribution is recommended at 10-35% of total kcals per day. The current Dietary Reference Intake for protein is 0.8 g/kg/day for individuals older than 18 years of age (National Academy of Medicine, 2017; Rosenbloom & Coleman, 2012; United States Department of Health and Human Services and United States Department of Agriculture, 2015). General, flexible protein recommendations provided by the DGA allow healthy college-aged males the ability to match his appropriate recommendation to his lifestyle. However, general protein recommendations vary considerably to current sport-specific protein guidelines and athletes, both strength and endurance, require additional dietary protein for recovery (Rosenbloom & Coleman, 2012; Thomas et al., 2016).

**Protein Intake Guidelines: Sports Nutrition**

In a recent joint position statement endorsed by the Academy of Nutrition and Dietetics (ACEND), Dietitians of Canada (DC), and American College of Sports Medicine (ACSM), protein requirements for athletes typically range from 1.2-2.0 g/kg/day (Thomas et al., 2016). Endurance athletes should generally aim towards the
lower end of the recommendation range while strength-trained athletes should aim towards the upper end (Rosenbloom & Coleman, 2012). Additionally, a position publication by the International Society of Sports Nutrition (ISSN) on protein and exercise identifies a range of 1.4-2.0 g/kg of protein per day for most exercising individuals (Jäger et al., 2017).

During hypocaloric periods, athletes may require higher protein needs upwards of 2.3-3.1 g/kg of protein per day to preserve lean body mass (Jäger et al., 2017). The ISSN recommends a dose of 20-40 grams of high quality protein post-exercise for athletes to maximize muscle protein synthesis (MPS). Not only should protein be utilized post-exercise, ideally, high quality protein should be consumed in modest amounts (0.3 g/kg) throughout the day with equal spacing to support MPS (Jäger et al., 2017; Thomas et al., 2016).

**Guidelines for baseball.** According to the Academy of Nutrition and Dietetics Sports Nutrition Manual, baseball players require 1.2 to 1.7 g/kg of protein per day. Baseball players should follow nutrient timing guidelines provided by the ISSN, ACEND, DC, and ACSM to maximize recovery and MPS. General recommendations to consume 20-40 grams of protein post-exercise and consumption of modest amounts of high quality protein evenly throughout the day may be applied by baseball players to enhance recovery, increase MPS, and preserve lean body mass (Jäger et al., 2017; Thomas et al., 2016).

**Fat Intake Guidelines**
The DGA recommends college-aged males consume fat between 25-35% and 20-35% of total energy intake for ages 14-18 and 19-30 years old, respectively. Unlike carbohydrate and protein recommendations provided by the DGA, fat is exclusively recommended as a percent of total energy intake. Recommended fat intake by the DGA is not listed in a gram amount for college-aged males. General, flexible fat recommendations provided by the DGA allow healthy college-aged males the ability to match his appropriate recommendation to his lifestyle. Sports nutrition guidelines do not vary significantly from the general guidelines as well.

**Fat Intake Guidelines: Sports Nutrition**

The joint position statement endorsed by the Academy of Nutrition and Dietetics (ACEND), Dietitians of Canada (DC), and American College of Sports Medicine (ACSM), recommends most athletes consume fat between a range of 20-35% of total energy intake. Contrary to adjusted carbohydrate and protein sports nutrition guidelines for athletes, the recommendations for daily fat consumption in athletes generally coincides with the general recommendations for healthy individuals. It is well-supported among the current literature that fat restricted (<20% of total energy intake) and high-fat, low-carbohydrate diets do not provide performance benefits to athletes (Thomas et al., 2016).

**Guidelines for baseball.** According to the Academy of Nutrition and Dietetics Sports Nutrition Manual, baseball players should aim for ~1 g/kg of fat per day. Baseball players may follow the fat intake guidelines provided by the joint position statement by the ACEND, DC, and ACSM.
**Fluid Intake Guidelines**

According to the position of the ACSM, athletes should utilize fluids pre-, intra- and post-exercise to ensure optimal performance and hydration status. The ACSM recommend athletes drink ~5-7 mL/kg of fluid at least four hours prior to exercise. An additional ~3-5 mL/kg may be needed if the individual does not produce urine, or if the urine is dark or highly concentrated (ACSM et al., 2007). Because the predicted sweat rate of athletes may vary from ~0.4 to ~1.8 L/hour, intra-exercise guidelines aim to prevent excessive dehydration (>2% bodyweight loss from water deficit) (ACSM et al., 2007). The ACSM recommends athletes monitor his/her weight fluctuations to create a more personalized fluid replacement strategy during exercise. Fluid replacement post-exercise aims to replenish fluid and electrolyte losses due to exercise. The ACSM recommends the consumption or normal meals and beverages post-exercise to replenish losses. Rapid recovery from excessive dehydration requires ~1.5 L of fluid for each kilogram of bodyweight lost (ACSM et al., 2007).

**Guidelines for baseball.** Currently, the Academy of Nutrition and Dietetics Sports Nutrition Manual does not provide specific fluid or hydration guidelines specific to baseball players. Therefore, general fluid guidelines and hydration techniques should be followed by this group of athletes. Baseball players may also utilize the position stand by the ACSM discussing exercise and fluid replacement guidelines for athletes.

**Assessing Current Dietary Intake**

Methods for measuring dietary intake vary among populations. Popular techniques include, but are not limited to, 24-hour recalls or records, food frequency
questionnaires, semi quantitative food frequency questionnaires, Burke-type dietary histories, and photographic or videotape records. A 24-hour recall requires a respondent to recall and describe all foods and beverages consumed over the past 24 hours (Rosenbloom & Coleman, 2012) while a 24-hour record requires immediate documentation of food and beverage items as consumed. Food frequency questionnaires allow respondents to record or describe their usual intakes as a list of different foods over the course of daily, weekly or monthly frequencies (Rosenbloom & Coleman, 2012). Semi quantitative food frequency questionnaires are like food frequency questionnaires, however, portion sizes are specified on semi quantitative food frequency questionnaires (Rosenbloom & Coleman, 2012). Burke-type dietary histories require respondents to orally report food and beverage consumption on a usual day, then interviewers inquire about food frequency and amount. Lastly, photographic or videotape recordings document all foods to be eaten from a standardized distance (Rosenbloom & Coleman, 2012).

**Dietary Intake of Collegiate Male Athletes**

Wierniuk & Włodarek (2013) assessed the energy and nutrient intake in young men practicing aerobic sport. The researchers observed and analyzed the diets of 25 college-aged (19-25 years) males who participated in aerobic sport or exercise across two universities. Overall energy (kcals), total protein, total fat, saturated fat, polyunsaturated fat, cholesterol, total carbohydrate, and fiber were compared to dietary recommendations. Eighty-eight percent of the male athletes consumed lower than the recommended amount of energy (kcals), 40% consumed lower than the recommended amount of protein, 84%
consumed lower than the recommended amount of carbohydrate, and 76% consumed lower than the recommended amount of fiber. Conversely, 56% consumed higher than the recommended amount of total protein, 32% consumed higher than the recommended amount of total fat, and 64% consumed higher than the recommended amount of cholesterol. The athletes among this study consumed both adequate and inadequate amounts of nutrients.

Webber et al. (2015) assessed the diet quality of 138 male and female student-athletes using the Block 2005 Food Frequency Questionnaire. Dietary analysis indicated that student-athletes’ diets were adequate in calcium, iron and vitamin C but inadequate in fiber, fruits and vegetables (Webber et al., 2015). Significant differences between male and female caloric intake were reported. Female athletes consumed 1,866.9 ± 976.8 calories while males consumed 3,615.8 ± 2238.4 calories. Caloric comparison to dietary recommendations revealed female athletes under consuming and male athletes over consuming calories. Cole et al. (2005) monitored the dietary practices of 30 Division I college football players. Three-day dietary records were evaluated on two separate occasions. The researchers analyzed overall energy, carbohydrate, protein, and fat intake. Subjects consumed an average of 3,288 calories, 392 grams of carbohydrates, 169 grams of protein, and 103 grams of fat. All of which, fell significantly short (inadequate) of the calculated 5,300 calories, 795 grams of carbohydrates, 198 grams of protein, and 147 grams of fat (Cole et al., 2005).

Very little research is published on the dietary intake of collegiate baseball players. A recent study by Hull et al. (2017) examined the availability of a sports
dietitian and the impact on performance and recovery of Division I baseball athletes.
Although the composition of an athletes’ dietary intake was not specifically analyzed, the study identified key dietary habits and nutrient timing practices of collegiate baseball players. In the presence of a sports dietitian, collegiate baseball players were more likely to consume less high calorie/low nutrient dense items, eat prior to exercise, and consume healthier foods post-exercise (Hull et al., 2017).

**Overview of Recovery**

The following section outlines components of recovery including, nutrition and hydration, sleep and rest, relaxation and emotional support, and stretching and active rest, and methods of tracking the various components of recovery.

**Nutrition and Hydration**

Nutrition and hydration strategies play an integral role in the recovery from exercise and sport-related activities. Recovery begins upon the completion of competition, training, and/or sport-related activities. Heaton et al. (2017), describes recovery initiation as an athlete entering a metabolic recovery phase and mechanical recovery phase. Metabolic recovery restores an athlete’s fuel levels while mechanical recovery repairs damaged musculoskeletal tissues (Heaton et al., 2017). Many nutrition and hydration strategies promote recovery and preparedness for subsequent competition or training. These strategies support muscle glycogen restoration, muscle regeneration, fatigue reduction, and immune system support (Burke et al., 2011; Heaton et al., 2017; Phillips & Van Loon, 2011). While many strategies exist, current literature focuses on carbohydrate and protein ingestion, as well as fluid replacement for optimal recovery.
(Beck, Thomson, Swift, & von Hurst, 2015; Beelen, Burke, Gibala, & van Loon, 2010; Burke & Mujika, 2014; Heaton et al., 2017).

**Carbohydrate.** Muscle and liver glycogen restoration remains a priority post-exercise (Heaton et al., 2017; Thomas et al., 2016). Carbohydrate guidelines and refueling strategies can be found in Table 3 and Figure 2. Glycogen resynthesis occurs at a rate of ~5% per hour post-exercise (Burke, Kiens, & Ivy, 2004; Thomas et al., 2016) and may take up to 72 hours to achieve complete restoration despite following current carbohydrate replacement protocols (Burke et al., 1996; Hausswirth, Meur, 2011; Heaton et al., 2017). Refueling techniques are especially important when subsequent competition (tournament style) or multiple training sessions occur during a short period of time. The application of carbohydrate replacement guidelines remains less important in low to moderate exercise intensity sports (<90 min) when adequate time (>8 hours) exists between competition or training sessions (Heaton et al., 2017;). Glycogen repletion occurs faster post-exercise due to an increased blood flow to the muscles and an increased sensitivity to the effects of insulin (Rosenbloom & Coleman, 2012). Therefore, carbohydrate ingestion immediately after and during the hours following exercise or competition contributes to an athlete’s overall recovery by restoring muscle and glycogen stores.

**Protein.** Protein ingestion post-exercise supports muscle repair, muscle remodeling, immune function (Heaton et al., 2017) and accelerates glycogen resynthesis (Thomas et al., 2016). Protein supports these components in part by stimulating muscle protein synthesis (MPS). A high-quality protein dose of 0.25 to 0.3 g/kg, or
approximately 15 to 25 grams, providing ~10 grams of essential amino acids immediately following exercise (0-2 hours) optimizes MPS (Beelan et al., 2010; Burke & Mujika, 2014; Heaton et al., 2017; Moore et al., 2009; Phillips, 2012; Thomas et al., 2016). There is evidence that exercise may stimulate MPS for 24-hours post-exercise (Areta et al., 2013; Thomas et al., 2016) and protein should be distributed evenly throughout the day to maximize these time points (Heaton et al., 2017; Mamerow et al., 2014).

**Fluids.** Fluid replacement is not only important for rehydration, electrolyte homeostasis and fluid status post-exercise, it often acts as a delivery method for carbohydrate and protein ingestion as well. Like carbohydrate replacement, fluid replacement is especially important for athletes with subsequent competition or training sessions with a short period of time between activities (Heaton et al., 2017;). Many rehydration solutions contain carbohydrates and sodium. Rehydration solutions comprised of sodium increase thirst, and fluid retention, including extracellular fluids and plasma volume (Heaton et al., 2017; ACSM et al., 2007; Thomas et al., 2016). Post-exercise rehydration replaces fluid-electrolyte deficits and returns an athlete to a euhydrated state important for recovery and future athletic performance.

**Sleep and Rest**

Sleep deprivation has been associated with decreased athletic performance, particularly decreased psychomotor and cognitive function (Halson, 2008; Rae et al., 2017). Sleep deprivation may exacerbate immune and endocrine system impairments and, therefore, impair the overall recovery process and adaptation to exercise (Halson, 2008; Reilly & Edwards, 2007). Adequate sleep has been recognized as one of the most
beneficial components of recovery for athletes (Halson, 2008; Romyn, Robey, Dimmock, Halson, & Peeling, 2016) by contributing restorative effects both physiologically and psychologically (Leeder, Glaister, Pizzoferrro, Dawson, & Pedlar, 2012). Athletes commonly prioritize sleep as the number one recovery modality (Venter, 2014). Napping (approximately 30 minutes) has also been shown to increase cognitive and athletic performance after a night of sleep deprivation (Halson, 2014). Due to the complex schedules of collegiate athletes, supplemental sleep, in the form of naps, may help fill the void during times of heavy travel, competition, and training.

**Relaxation and Emotional Support**

Athletes not only face challenges regarding recovery from a physical standpoint, but also from a mental readiness aspect to perform during the next competition or training session (Heaton et al., 2017). Collegiate athletes face many daily athletic, academic, social, and psychological stressors that may affect athletic performance. Stress induces the release of cortisol in the body, which in turn, leads to physical symptoms of stress and anxiety (muscle tension, increased heart rate, distracting thoughts) (Walsh, 2011). Relaxation approaches aim to reduce overall stress and anxiety by facilitating a sense of calm and relaxation. These approaches may include, but are not limited to, repeating a meaningful word, phrase, sound or prayer for approximately ten minutes as well as controlled, rhythmic breathing (Walsh, 2011). Mental relaxation techniques promote recovery by limiting the stimulation and release of catabolic stress hormones like cortisol. Activities such as yoga have become popular among athletic populations to help combat every day stressors and support emotional well-being.
Stretching and Active Rest

Stretching is one of the most common recovery modalities used by team sports and individual athletes. Self-myofascial release, via foam rolling or roller massage, is an emerging technique used to promote joint range of motion, muscle recovery and performance (Cheatham, Kolber, Cain, & Lee, 2015). A systemic review by Cheatham et al. (2015) determined self-myofascial release using foam rolling or roller massage demonstrated an increase in joint range of motion without compromising muscle performance. Foam rolling and roller massage may help reduce the magnitude of delayed onset of muscle soreness (DOMS) (Cheatham et al., 2015; Pearcey et al., 2015) and fatigue post-exercise (Healey, Harfield, Blanpied, Dorfman, & Riebe, 2014).

Total Quality Recovery (TQR) Questionnaires

Total Quality Recovery (TQR) questionnaires were developed by Göran Kenttä and Peter Hassmén at Stockholm University in the late 1990’s. The TQR questionnaire was designed to allow coaches and athletes the ability to monitor and evaluate an individual’s recovery versus an individual’s training output. With this concept in mind, the researchers adapted many principles from Borg’s Ratings of Perceived Exertion (RPE) scale. The Borg Scale ranges from 6 to 20 and can be used to denote heart rate ranges from 60 to 200 beats per minute (Borg, 1982). The synergistic approach to the Borg Scale and TQR questionnaire is depicted in Figure 3. Kenttä and Hassmén (1998) suggest that by structuring the TQR scale around the RPE scale, the recovery process can be monitored and matched against the breakdown (training) process (TQR versus RPE). The TQR scale emphasizes both the athlete’s perception of recovery and the importance
of active measures to improve the recovery process and allows an athlete to match their recovery process to their stressors and exercise/training stimulus (Kenttä & Hassmén, 1998).

<table>
<thead>
<tr>
<th>Ratings of perceived exertion (RPE)</th>
<th>Total quality recovery (TQR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>6 Very, very poor recovery</td>
</tr>
<tr>
<td>7 Very, very light</td>
<td>7 Very, very poor recovery</td>
</tr>
<tr>
<td>8</td>
<td>8 Very poor recovery</td>
</tr>
<tr>
<td>9 Very light</td>
<td>9 Very poor recovery</td>
</tr>
<tr>
<td>10</td>
<td>10 Poor recovery</td>
</tr>
<tr>
<td>11 Fairly light</td>
<td>11 Poor recovery</td>
</tr>
<tr>
<td>12</td>
<td>12 Reasonable recovery</td>
</tr>
<tr>
<td>13 Somewhat hard</td>
<td>13 Reasonable recovery</td>
</tr>
<tr>
<td>14</td>
<td>14 Good recovery</td>
</tr>
<tr>
<td>15 Hard</td>
<td>15 Good recovery</td>
</tr>
<tr>
<td>16</td>
<td>16 Very good recovery</td>
</tr>
<tr>
<td>17 Very hard</td>
<td>17 Very good recovery</td>
</tr>
<tr>
<td>18</td>
<td>18 Very, very good recovery</td>
</tr>
<tr>
<td>19 Very, very hard</td>
<td>19 Very, very good recovery</td>
</tr>
<tr>
<td>20</td>
<td>20 Very, very good recovery</td>
</tr>
</tbody>
</table>

*Figure 3.* Rate of Perceived Exertion (RPE) and Total Quality Recovery (TQR). Figure 3 depicts the relationship between RPE and TQR for matching recovery to training stimulus or output. Figure 3 retrieved from Kenttä, G., Hassmén, P. (1998). Overtraining and recovery. A conceptual model. *Sports Medicine (Auckland, N.Z.)*, 26(1), 1-16.

The TQR questionnaire was designed into two sub-scales of TQR perceived (TQRper) and TQR action (TQRact). These sub-scales create one subjective (TQRper)
and one objective (TQRact) scale. Together, the sub-scales combine both qualitative and quantitative components to the recovery process. The TQRper sub-scale was designed to evaluate an athlete’s perceived feeling of overall recovery. An athlete rates their previous 24 hours of psychophysiological recovery by cognitively recalling cues such as mood states, bodily signals like muscle soreness and heaviness, and the previous night’s sleep (Kenttä & Hassmén, 1998). The researchers note that by directing an athlete’s attention to his or her psychophysiological cues, it accomplishes a corresponding goal as in RPE, by increasing self-awareness (Kenttä & Hassmén, 1998).

The TQRact sub-scale is divided into four categories of recovery. This includes nutrition and hydration, sleep and rest, relaxation and emotional support, and stretching and active rest. Nutrition and hydration allows the accumulation of a maximum of 10 recovery points; sleep and rest a maximum of 4 points; relaxation and emotional support a maximum of 3 points; and stretching and active rest a maximum of 3 points (Kenttä & Hassmén, 1998). The maximum score an athlete can accrue in the TQRact sub-scale is 20 points, which corresponds to the maximum RPE score. A general practical recommendation for ensuring that an athlete’s recovery is adequate is that both the TQRact and TQRper ratings should, preferably, be at least equivalent to the actual training stress (RPE rating) (Kenttä & Hassmén, 1998). For example, if an athlete reports an overall training stimulus of 15 on Borg’s RPE scale, then adequate recovery would be determined as greater than or equal to 15 on the athlete’s TQR accumulation of points. The TQR questionnaire is easily adapted to fit various sports and athletes (Kenttä & Hassmén, 1998).
Practical Applications of TQR Questionnaires

Berdejo-del-Fresno and Laupheimer (2014) implemented the use of TQR questionnaires while monitoring the recovery and regeneration behaviors in elite English futsal players. Futsal is a modified version of soccer or football, making it a high-intensity, intermittent sport where accelerations and short sprints are performed at maximal or almost maximal intensity (Berdejo-del-Fresno & Laupheimer, 2014). TQR questionnaires assessed the nutrition and hydration, sleep and rest, relaxation and emotional status, and cool-down/stretching of 20 elite male futsal players. Individuals were monitored during a one week period where athletes logged three days out of camp, one traveling day, and three days in camp.

Statistical analysis determined a significant difference among in and out of camp days. Athletes achieved a mean score of 12.36, 12.39, and 12.13 on days one, two, and three, respectively, and achieved a mean score of 16.08, 16.85, and 15.42 on days five, six, and seven, respectively. Furthermore, the athletes achieved their lowest mean score of 9.57 on day four, their traveling day. The researchers concluded that the TQR questionnaire might be a good method to give feedback to the players about the categories they need to improve on and use it as a tool to educate the players about their needs to recover and regenerate properly (Berdejo-del-Fresno & Laupheimer, 2014).

Similarly, Freitas et al. (2014) used TQR questionnaires to analyze the sensitivity of physiological and psychological markers to training load intensification in 16 male volleyball players playing at a high-level Brazilian team. The 16 male volleyball players were separated into two groups by the head coach based on the likelihood to start in the
championship game. The athletes of lower skill, termed the intensification (IT) group, underwent an 11-day training load with deliberate increases in intensification followed by a 14-day period of reduction. The higher skilled athletes, termed the normal training (NT) group, followed the same procedure except during the 14-day period training loads were normalized, instead of reduced, like the IT group. Overall, all athletes completed pre- and post-recovery (TQR) questionnaires over the course of four total micro cycles.

Statistical analysis determined that the TQR questionnaires were sensitive in identifying changes in stress and recovery after the intensification of training loads (Freitas et al., 2014). Freitas et al. (2014) concluded that coaches and physical trainers can use TQR’s to monitor and control the stress and recovery in their athletes, and that this psychometric tool is simple, valid, and practical for monitoring effects of training loads.

Furthermore, Jones et al. (2013) used TQR questionnaires to investigate the effects of different recovery interventions following a repeated rugby union game simulated protocol in ten male Premiership Level Rugby Union players. Athletes were instructed to run a sprint interval course known as Sevens Test. All participants performed one bout of Sevens Test, immediately performed three-laps of active recovery of slow laps around the field, and finally passively rested indoors with snacks that are provided at traditional rugby matches (bananas, granola bars, chewy sweets). Next, athletes performed a second bout of the Sevens Test. Athletes were randomly assigned post-recovery groups that included passive recovery (PR), active recovery (AR), cold water immersion (CWI), or combined recovery (COMB) (CWI then AR).
Statistical analysis reported a significantly lower recovery status among the post-workout PR group compared to post-AR, -CWI, and -COMB groups. Essentially, athletes reported a significantly lower perceived perception of their recovery when their second bout of exercise was followed with PR as the recovery modality. TQR responses revealed that subjects perceived AR to increase perceived recovery compared to PR, but no differently than CWI or COMB recovery (Jones et al., 2013).

**Overview of National Collegiate Athletic Association (NCAA) Policy**

Division I, II, and III student-athletes share many similarities, however, significant variances among divisions may impact student-athletes and potential access to nutrition-related services. Differences exist within NCAA athletic policy regarding the regulation of feeding. According to the 2015 NCAA Regional Rules Seminar, deregulation of feeding in Division I went into effect on August 14, 2014 and deregulation of feeding in Division II went into effect on August 1, 2015. This policy allows an institution to provide meals and snacks to all scholarship and non-scholarship student-athletes at its discretion as a benefit incidental to participation in intercollegiate athletics (NCAA, 2016). This policy does not apply to Division III student-athletes. Therefore, the deregulation of feeding at the Division I and II levels may provide these student-athletes with significantly greater meal and snack options than Division III student-athletes. The 2016-2017 NCAA Division III August Manual provides the most current information applicable to Division III student-athletes and NCAA rule and regulations.

**Division III Nutrition-Related Policy**
Current nutrition-related policy regarding Division III student-athletes.

**Meal-allowance limitation.** All student-athletes on the same team must receive identical meal allowances on intercollegiate trips and during vacation periods when student-athletes are required to remain on the institution’s campus for organized practice sessions or competition. Such allowances may not exceed the amount provided by the institution to institutional staff members on away-from-campus trips and may not be provided for a particular meal if the student-athlete receives that meal (or its equivalent) from another source (p.121).

**Meals related to institutional committee service.** A student-athlete who serves on an institutional committee may receive expenses to cover the cost of a meal missed as a result of a committee meeting that occurs when regular institutional dining facilities are open (p.120).

**Meals in conjunction with home competition.** The institution may provide meals to student-athletes at the institution’s discretion on the day(s) of competition until they are released by institutional personnel. An institution shall not provide cash to student-athletes in lieu of meals during this time period. An institution, at its discretion, may provide a meal or cash, but not both, to student-athletes at the time of their release by institutional personnel (p.120).
CHAPTER III

METHODOLOGY

The purpose of this study was to examine the dietary intake and recovery status of Division III baseball players during the fall collegiate baseball season at one northeast Ohio university. The following experimental hypotheses were assessed for this repeated measure multifactorial design investigation. \( H_1 \): Dietary intake will be different between home, away and non-competition days; \( H_2 \): Recovery status will be different between home, away and non-competition days. Adequate dietary intake was defined as energy \( \geq 35 \) kcals/kg, carbohydrates 5-7 g/kg/day, protein 1.2-1.7 g/kg/day, fat \( \sim 1.0 \) g/kg/day, and fluid 1 ml/kcal (Macedonio & Dunford, 2009; Popkin, D’Anci, & Rosenberg, 2010; Rosenbloom & Coleman, 2012). Adequate recovery status was defined as \( \geq 15 \) summation points of TQR scores. Dependent variables included time for home, away and non-competition days and independent variables included dietary intake and recovery status.

Participants

A convenience sample of college-aged males participating in Division III National Collegiate Athletic Association (NCAA) baseball at one northeast Ohio university were recruited to participate in this investigation during the fall baseball season. A total of approximately 35 dress list players were eligible to participate in this study. A total of 23 participants were used for the study. Participants who had musculoskeletal damage or injury, metabolic disorder, and/or chronic illness were excluded from this study to eliminate the possibility of unreliable data. This study was
approved by the Kent State University Institutional Review Board (IRB) and all participants read and signed an informed consent form (Appendix A).

**Instrument of Measure**

Participants completed one Sports Nutrition Questionnaire (Appendix B), three Total Quality Recovery (TQR) Questionnaires (Appendix C) and three 24-Hour Dietary Records (Appendix D). The TQR Questionnaire was recreated with permission by the original authors (Berdejo-del-Fresno & Laupheimer, 2014). Adherence to Kenttä and Hassmén's (1998) TQR Manual was followed in the production of the TQR Questionnaire.

The Sports Nutrition Questionnaire was developed by the researcher and contained three sections. The first section assessed background information including age, height, current weight and athletic class. The second section assessed athletic information including baseball position and primary position. The third section assessed nine yes or no sports nutrition related questions regarding pre- and post-workout/practice/game nutrition options, home and away nutrition options and access to training tables, a strength and conditioning coach and a sports dietitian.

Total Quality Recovery (TQR) Questionnaires assessed recovery status. The TQR Questionnaire analyzed five recovery strategy categories including nutrition, hydration, sleep and rest, relaxation and stress, and cooldown/stretching. Each individual recovery strategy was allotted a numerical value based on its significance in the recovery process (Kenttä & Hassmén, 1998). Nutrition equaled eight possible points, hydration equaled two possible points, sleep and rest equaled four possible points, relaxation and
stress equaled three possible points, and cooldown/stretching equaled three possible points. Scoring adjustments for partial point values were listed for each recovery strategy. A total of 20 points were possible. Three identical TQR Questionnaires were used for one home, away and non-competition day.

The standardized 24-Hour Dietary Record was obtained with permission from the Kent State University Nutrition and Dietetics Department. The 24-Hour Dietary Record assessed dietary intake and was comprised of eight columns including time, food item, ingredient, amount, cooking method, brand name and food preparation. Three identical 24-Hour Dietary Records were used for one home, away and non-competition day.

**Procedure**

Original procedure of this research study called for data collection materials to be distributed to Division I and Division III collegiate baseball players during the 2017 Spring collegiate baseball season. Due to a lack of commitment via the prospective Division I university, this component was terminated. Once this occurred, the 2017 Division III baseball season had concluded and data could not be obtained from the Division III university. Therefore, data collection occurred during the 2017 Fall collegiate baseball season.

This study was approved by the Institutional Review Board (IRB) at Kent State University. Verbal and written permission to conduct this study was obtained from the Head Baseball Coach at the University of Mount Union. All data collection materials were provided to the Head Baseball Coach via email. The Head Baseball Coach distributed the data collection materials to the dress list baseball players with instruction
to complete all documents on selected home, away, and non-competition days. The baseball players self-reported all three sections of the Sports Nutrition Questionnaire. Self-reported bodyweights were used to calculate an individual’s gram per kilogram carbohydrate, protein and fat requirements, gram per kilocalorie energy requirements, and milliliter per kilocalorie fluid requirements.

Three separate TQR Questionnaires were self-scored on a home, away and non-competition day. Baseball players scored each recovery strategy (nutrition, hydration, sleep & rest, relaxation & stress, cooldown/stretching) based on the fulfillment of each strategy over the past 24 hours. Scoring adjustments identified partial point values for each recovery strategy. The recovery strategy point values were summated and categorized by the researcher. The summation of recovery strategy points determined an athlete’s recovery status. Categorization of the recovery status ranges (≤14 = poor recovery; 15-16 = good recovery; 17-20 = optimal recovery) were completed by the researcher to avoid athlete bias during the completion process.

Three separate 24-Hour Dietary Records were self-reported on the same home, away and non-competition days. Baseball players recorded the time, food item, ingredient, amount, cooking method, brand name and food preparation for all food and beverage items consumed over the course of 24 hours. Dietary intake was assessed by the researcher using the ESHA Food Processor Software (Elizabeth Stewart Hands and Associates, Salem, OR). Total energy (kcals), carbohydrate (grams), protein (grams), fat (grams) and fluid (milliliters) was obtained for home, away, and non-competition days.
All documents were returned to the head coach via email and forwarded to the primary researcher.

**Statistical Analysis**

Data was analyzed using the Statistical Package for the Social Sciences software (SPSS, version 12). Food and fluid intakes from the 24-hour dietary records were assessed using the ESHA Food Processor software (Elizabeth Stewart Hands and Associates, Salem, OR) provided by the Nutrition and Dietetics department at Kent State University. Adequate dietary intake was defined as: total energy (kilocalories) ≥35 kcals/kg; Carbohydrates 5-7 g/kg; Protein 1.2-1.7 g/kg; Fat: ~ 1.0 g/kg/day; Fluid: 1 ml/kcal (Macedonio & Dunford, 2009; Popkin et al., 2010; Rosenbloom & Coleman, 2012). The summation of an individual’s TQR values were assessed using standardized ranges from existing literature. Ranges were defined as: <14 points equaled poor recovery status, 15-16 points equaled good recovery status, and 17-20 points equaled optimal recovery status (Berdejo-del-Fresno & Laupheimer, 2014; Freitas et al., 2014; Jones et al., 2013; Kenttä & Hassmén, 1998). The findings of this study were assessed by a One-way repeated measures Analysis of Variance (ANOVA). Results from the nine sports nutrition questions, located in the Sports Nutrition Information section of the Sports Nutrition Questionnaire, were reported as descriptive statistics as frequencies. For significance to be accepted, an alpha level of P < 0.05 was set. A Bonferroni Post Hoc was performed for all significant values for repeated measures.
CHAPTER IV

JOURNAL ARTICLE

Introduction

The National Collegiate Athletic Association (NCAA) is constructed of men’s and women’s sports at the Division I, II, and III level. The deregulation of feeding allows an institution to provide meals and snacks to all scholarship and non-scholarship student-athletes at its discretion (NCAA, 2016). However, this policy does not apply to Division III student-athletes as it currently encompasses Division I and Division II student-athletes only. According to the NCAA’s 2015 GOALS (Growth, Opportunities, Aspirations and Learning of Students in college) Study, Division III baseball players report spending 34 hours per week on in-season athletic activities. Additionally, Division III baseball players report spending 36 hours per week on in-season academic activities. In total, Division III baseball players report spending 70 hours per week towards in-season athletic and academic activities. Off-season athletic and academic time commitments of Division III baseball players may exceed in-season demands. According to the NCAA’s 2015 GOALS study, 64% of Division III baseball players report spending as much or more time on athletic activities during the off-season than during in-season. With such substantial time commitment towards athletic and academic activities by Division III baseball players, dietary intakes and nutritional strategies may be compromised during times of heightened training, practice, academics and competition.

Baseball is a low-endurance, precision skilled sport consisting of brief, explosive movements such as throwing, sprinting, and swinging a bat (Rosenbloom & Coleman,
Baseball players predominantly utilize anaerobic metabolism, including the anaerobic glycolysis system and phosphagen system, to power sport-specific movements (Rosenbloom & Coleman, 2012; Szymanski, 2009). Baseball demands less involvement of aerobic metabolism than other sports. Because baseball is a low-energy expenditure sport, nutrition is often overlooked at the NCAA level.

The importance of pre-, intra- and post-exercise nutrition is well-documented among the scientific literature (Burke, Hawley, Wong, & Jeukendrup, 2011; Jäger et al., 2017; Jeukendrup, 2014; Rosenbloom & Coleman, 2012; Thomas, Erdman, & Burke, 2016; Wright, Sherman, & Dernbach, 1991). The purpose of pre-exercise fueling is to top off glycogen stores, avoid post-prandial hyperinsulinemia and hypoglycemia, avoid gastrointestinal disturbances, and prevent overall hunger (Burke et al., 2011; Jeukendrup, 2014; Rosenbloom & Coleman, 2012; Thomas et al., 2016; Wright et al., 1991). Intra-exercise fueling maintains oxidation rates, increases endurance capacity and increases high-intensity, stop-and-go exercise performance (Jeukendrup, 2014). Post-exercise nutrition restores glycogen (Thomas et al., 2016), stimulates muscle protein synthesis (MPS) (Jäger et al., 2017; Thomas et al., 2016), rehydrates and restores electrolyte homeostasis (ACSM et al., 2007), and improves recovery (Heaton et al., 2017).

Sports nutrition guidelines and recommendations have evolved into a personalized approach encompassing the requirements of both the individual sport and individual athlete (Burke et al., 2011; Jäger et al., 2017; Jeukendrup, 2014; Rosenbloom & Coleman, 2012; Thomas et al., 2016; Wright et al., 1991). Male athletes who
participate in NCAA athletics require altered macronutrient standards to fuel athletic performance, cognition, and recovery (Burke et al., 2011; Hinton, Yakushko, Beck, Sanford, & Davidson, 2004; Hull et al., 2016; Thomas et al., 2016). Although a plethora of knowledge on proper sports nutrition exists, collegiate athletes continue to struggle to meet the recommended intake levels (Cole et al., 2005; Hull et al., 2017; Webber et al., 2015; Wierniuk & Włodarek, 2013).

Frequent travel and variability in athletic schedules presents additional nutrition and recovery challenges to collegiate baseball players. Due to financial circumstances of collegiate programs and players, fast food and 24-hour diners are common sources of meals on the road (Rosenbloom & Coleman, 2012). The sport of baseball does not have a time limit, so time between meals may exceed several hours. Players typically report to the clubhouse four to five hours prior to game time for home competitions. Food may be provided in the clubhouse; however, it may not necessarily be nutritionally sound (Rosenbloom & Coleman, 2012). Previous research analyzed the dietary intakes of collegiate athletes (Cole et al., 2005; Hull et al., 2017; Wierniuk & Włodarek, 2013; Webber et al., 2015), however, less is known about the dietary intakes of collegiate athletes on home, away, and non-competition days, particularly at the Division III level. Furthermore, research regarding how athletes recover on home, away, and non-competition days is also lacking. More research is warranted in these areas to better understand the dietary intake and recovery of lower division collegiate athletes.

The purpose of this study was to examine the dietary intake and recovery status of Division III baseball players during the collegiate fall baseball season at one northeast
Ohio university. Additionally, comparison between home competition, away competition and non-competition dietary intake and recovery status surveys were investigated. A secondary goal was to compare the baseball-specific bodyweight-dependent sports nutrition guidelines for energy (kcal/kg), carbohydrate (g/kg), protein (g/kg), fat (g/kg) and fluid (ml/kcal) to the dietary intakes of Division III baseball players. The hypotheses of this study were that dietary intake will be different between home, away, and non-competition days and recovery status will be different between home, away, and non-competition days.

**Methods**

The following methodology section outlines the subjects, instruments of measure, procedures, and statistical analyses applied in this research study.

**Participants**

Subjects were a total of 23 male (mean ± SD: age = 18.6 ± 0.9 years) NCAA Division III baseball student-athletes consisting of freshman (n = 16), sophomores (n = 4), juniors (n = 1), and seniors (n = 2), from one northeast Ohio university. Subjects consisted of outfielders (n = 5), infielders (n = 8), pitchers (n = 6), and catchers (n = 4). Participants who had musculoskeletal damage or injury, metabolic disorder, and/or chronic illness were excluded from this study to eliminate the possibility of unreliable data. This study complied with the requirements of the Kent State University Institutional Review Board (IRB) and all participants read and signed an informed consent form (Appendix A). Five of the 23 participants (n = 18) failed to respond to the nine sports nutrition questions on the Sports Nutrition Questionnaire.
**Instrument of Measure**

Participants completed one Sports Nutrition Questionnaire (Appendix B), three Total Quality Recovery (TQR) Questionnaires (Appendix C) and three 24-Hour Dietary Records (Appendix D). The TQR Questionnaire was recreated with permission by the original authors (Berdejo-del-Fresno & Laupheimer, 2014). Adherence to Kenttä and Hassmén's (1998) TQR Manual was followed in the production of the TQR Questionnaire.

The Sports Nutrition Questionnaire was developed by the researcher and contained three sections. The first section assessed background information including age, height, current weight and athletic class. The second section assessed athletic information including baseball position and primary position. The third section assessed nine yes or no sports nutrition related questions regarding pre- and post-workout/practice/game nutrition options, home and away nutrition options and access to training tables, a strength and conditioning coach and a sports dietitian.

Total Quality Recovery (TQR) Questionnaires assessed recovery status. The TQR Questionnaire analyzed five recovery strategy categories including nutrition, hydration, sleep and rest, relaxation and stress, and cooldown/stretching. Each individual recovery strategy was allotted a numerical value based on its significance in the recovery process (Kenttä & Hassmén, 1998). Nutrition equaled eight possible points, hydration equaled two possible points, sleep and rest equaled four possible points, relaxation and stress equaled three possible points, and cooldown/stretching equaled three possible points. Scoring adjustments for partial point values were listed for each recovery.
strategy. A total of 20 points were possible. Three identical TQR Questionnaires were used for one home, away and non-competition day.

The standardized 24-Hour Dietary Record was obtained with permission from the Kent State University Nutrition and Dietetics Department. The 24-Hour Dietary Record assessed dietary intake and was comprised of eight columns including time, food item, ingredient, amount, cooking method, brand name and food preparation. Three identical 24-Hour Dietary Records were used for one home, away and non-competition day.

**Procedure**

This study was approved by the Institutional Review Board (IRB) at Kent State University. Verbal and written permission to conduct this study was obtained from the Head Baseball Coach at the University of Mount Union. All data collection materials were provided to the Head Baseball Coach via email. The Head Baseball Coach distributed the data collection materials to the dress list baseball players with instruction to complete all documents on selected home, away, and non-competition day. The baseball players self-reported all three sections of the Sports Nutrition Questionnaire. Self-reported bodyweights were used to calculate an individual’s gram per kilogram carbohydrate, protein and fat requirements, gram per kilocalorie energy requirements, and milliliter per kilocalorie fluid requirements.

Three separate TQR Questionnaires were self-scored on a home, away and non-competition day. Baseball players scored each recovery strategy (nutrition, hydration, sleep & rest, relaxation & stress, cooldown/stretching) based on the fulfillment of each strategy over the past 24 hours. Scoring adjustments identified partial point values for
each recovery strategy. The recovery strategy point values were summated and categorized by the researcher. The summation of recovery strategy points determined an athlete’s recovery status. Categorization of the recovery status ranges (≤14 = poor recovery; 15-16 = good recovery; 17-20 = optimal recovery) were completed by the researcher to avoid athlete bias during the completion process.

Three separate 24-Hour Dietary Records were self-reported on the same home, away and non-competition day. Baseball players recorded the time, food item, ingredient, amount, cooking method, brand name and food preparation for all food and beverage items consumed over the course of 24 hours. Dietary intake was assessed by the researcher using the ESHA Food Processor Software (Elizabeth Stewart Hands and Associates, Salem, OR). Total energy (kcals), carbohydrate (grams), protein (grams), fat (grams) and fluid (milliliters) was obtained for home, away, and non-competition days. All documents were returned to the head coach via email and forwarded to the primary researcher.

**Statistical Analysis**

Statistical analysis was completed using SPSS (version 12). The findings of this study were assessed by a one-way Analysis of Variance (ANOVA) for repeated measures. Food and fluid intakes from the 24-hour dietary records were assessed using the ESHA Food Processor Software (Elizabeth Stewart Hands and Associates, Salem, OR) provided by the Nutrition and Dietetics department at Kent State University. Adequate dietary intake was defined as: total energy (kilocalories) ≥35 kcals/kg; Carbohydrates 5-7 g/kg; Protein 1.2-1.7 g/kg; Fat: ~ 1.0 g/kg/day; Fluid: 1 ml/kcal
The summation of an individual’s TQR values were assessed using standardized ranges from existing literature. Ranges were defined as: <14 points equaled poor recovery status, 15-16 points equaled good recovery status, and 17-20 points equaled optimal recovery status (Berdejo-del-Fresno & Laupheimer, 2014; Freitas et al., 2014; Jones et al., 2013; Kenttä & Hassmén, 1998). The findings of this study were assessed by a One-way repeated measures Analysis of Variance (ANOVA). Results from the nine sports nutrition questions, located in the Sports Nutrition Information section of the Sports Nutrition Questionnaire, were reported as descriptive statistics as frequencies. For significance to be accepted, an alpha level of P < 0.05 was set. A Bonferroni Post Hoc was performed for all significant values for repeated measures.

**Results**

Of the 23 total participants, 18 completed the series of nine sports nutrition questions on the sports nutrition questionnaire for a response rate of 78.3%. Table 4 summarizes the sports nutrition questionnaire responses as frequencies and percentages for each individual question. Descriptive data in Table 4 provides insight regarding nutrition strategies, food availability, and nutrition related-resources provided by the athletic department of the investigated university.

Table 5 summarizes the means and standard deviations of carbohydrate, protein, fat, and energy intakes from the 24-Hour Dietary Records and recovery from the Total Quality Recovery scores on home, away, and non-competition days.
Table 4

*Sports Nutrition Resources Provided to Division III Baseball Players as Frequencies (f) and Percentages (%) (n=18)*

<table>
<thead>
<tr>
<th>Question</th>
<th>Response</th>
<th>f</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Does your athletic team provide pre-workout/practice nutrition options? (n=18)</td>
<td>Yes</td>
<td>2</td>
<td>8.7</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>16</td>
<td>78.3</td>
</tr>
<tr>
<td>Does your athletic team provide post-workout/practice nutrition options? (n=18)</td>
<td>Yes</td>
<td>1</td>
<td>4.3</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>17</td>
<td>73.9</td>
</tr>
<tr>
<td>Does your athletic team provide pre-game nutrition options? (n=18)</td>
<td>Yes</td>
<td>4</td>
<td>17.4</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>14</td>
<td>60.9</td>
</tr>
<tr>
<td>Does your athletic team provide post-game nutrition options? (n=18)</td>
<td>Yes</td>
<td>3</td>
<td>13.0</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>15</td>
<td>65.2</td>
</tr>
<tr>
<td>Does your athletic team provide nutrition options in the dugout during home games? (n=18)</td>
<td>Yes</td>
<td>6</td>
<td>26.1</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>12</td>
<td>52.2</td>
</tr>
<tr>
<td>Does your athletic team provide nutrition options in the dugout during away games? (n=18)</td>
<td>Yes</td>
<td>6</td>
<td>26.1</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>12</td>
<td>52.2</td>
</tr>
<tr>
<td>Does your athletic department provide “Training Tables” to your team? (n=18)</td>
<td>Yes</td>
<td>10</td>
<td>43.5</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>8</td>
<td>34.8</td>
</tr>
<tr>
<td>Does your team have access to a Strength and Conditioning Coach? (n=18)</td>
<td>Yes</td>
<td>12</td>
<td>52.2</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>6</td>
<td>26.1</td>
</tr>
</tbody>
</table>
Does your team have access to a Sports Dietitian? (n=18)

<table>
<thead>
<tr>
<th>Access</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>Percentage</td>
<td>26.1</td>
<td>52.2</td>
</tr>
</tbody>
</table>

Significant differences were observed between home competition carbohydrate intake (258.76 ± 118.22 g) and non-competition carbohydrate intake (201.33 ± 71.49 g) (P = 0.015). No significant differences were observed within subjects for protein, fat, and recovery on home, away, and non-competition days. Significant differences were observed between home competition energy intake (2,514 ± 159.56 kcals) and non-competition energy intake (2,104.96 ± 114.99 kcals) (P = 0.004).

Fluid intake from the 24-Hour Dietary Records for home, away and non-competition days were reported as descriptive statistics. Division III baseball players consumed 932.87 ± 949.30 milliliters of fluid on home competition days, 791.27 ± 772.92 milliliters of fluid on away competition days and 693.06 ± 547.75 milliliters of fluid on non-competition days.

Table 5

Means (\(\bar{X}\)) and Standard Deviations (±SD) of 24-Hour Dietary Record Carbohydrate, Protein, Fat and Energy Intakes and Recovery on Home, Away and Non-Competition Days in Division III Baseball Players (n=23)

<table>
<thead>
<tr>
<th>Category</th>
<th>(\bar{X}) ± SD</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbohydrate (g)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Home</td>
<td>258.76 ± 118.22</td>
<td></td>
</tr>
<tr>
<td>Away</td>
<td>255.59 ± 123.32</td>
<td>0.015*</td>
</tr>
<tr>
<td>Non</td>
<td>201.33 ± 71.49</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Home</td>
<td>Away</td>
</tr>
<tr>
<td>------------------</td>
<td>-----------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>Protein (g)</td>
<td>128.46 ± 50.43</td>
<td>110.30 ± 42.45</td>
</tr>
<tr>
<td>Fat (g)</td>
<td>107.57 ± 37.01</td>
<td>110.84 ± 54.21</td>
</tr>
<tr>
<td>Energy (kcals)</td>
<td>2,514.00 ± 159.56</td>
<td>2,328.45 ± 219.50</td>
</tr>
<tr>
<td>Recovery***</td>
<td>13.69 ± 3.00</td>
<td>13.96 ± 2.76</td>
</tr>
</tbody>
</table>

* denotes a significant (P < 0.05) difference between home competition and non-competition carbohydrate intake; Bonferroni Post Hoc (P = 0.016).
** denotes a significant (P < 0.05) difference between home competition and non-competition energy intake; Bonferroni Post Hoc (P = 0.001).
*** Recovery scores determined by Total Quality Recovery (TQR) values.

A Bonferroni Post Hoc analysis was performed on the significant difference between home competition carbohydrate intake and non-competition carbohydrate intake (P = 0.016) and between home competition energy intake and non-competition energy intake (P = 0.001). No significant differences were observed between home, away and non-competition recovery status (P = 0.717). Recovery status was classified as poor (≤14 points) during home (13.69 ± 3), away (13.96 ± 2.76) and non-competition (14.04 ± 3.22) days.
Table 6 summarizes the current baseball-specific, bodyweight-dependent sports nutrition recommendations for carbohydrates (g/kg), protein (g/kg), fat (g/kg), fluid (ml/kcal), and energy (kcal/kg) (Macedonio & Dunford, 2009; Popkin et al., 2010; Rosenbloom & Coleman, 2012). Actual intakes are reported as means and standard deviations for home, away, and non-competition days. Division III baseball players consumed inadequate intakes of carbohydrates on home (3.24 ± 1.71), away (3.18 ± 1.74) and non-competition (2.51 ± 1.06) days compared to the 5-7 g/kg recommendation. Athletes achieved adequate intakes of protein on home (1.60 ± 0.72), away (1.35 ± 0.56) and non-competition (1.35 ± 0.47) days compared to the 1.2-1.7 g/kg recommendation. Division III baseball players exceeded fat recommendations of 1.0 g/kg on home (1.32 ± 0.51), away (1.37 ± 0.75) and non-competition (1.16 ± 0.41) days. Division III baseball players consumed inadequate fluids on home (0.42 ± 0.43), away (0.36 ± 0.35) and non-competition (0.31 ± 0.24) days compared to the 1 ml/kcal recommendation. Compared to the ≥35 kcals/kg recommendation for energy, Division III baseball players consumed inadequate intakes of energy on home (31.23 ± 11.64), away (28.95 ± 14.90) and non-competition (25.90 ± 8.02) days.

Table 6

<table>
<thead>
<tr>
<th>Category</th>
<th>Recommendations*</th>
<th>( \bar{X} ) ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbohydrates</td>
<td>5-7 g/kg</td>
<td>Actual g/kg</td>
</tr>
</tbody>
</table>
Home & Away Competition Dietary Intake and Recovery Status Survey

<table>
<thead>
<tr>
<th>Component</th>
<th>Requirement</th>
<th>Home</th>
<th>Away</th>
<th>Non</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein (g/kg)</td>
<td>1.2-1.7</td>
<td>1.60 ± 0.72</td>
<td>1.35 ± 0.56</td>
<td>1.35 ± 0.47</td>
</tr>
<tr>
<td>Fat (g/kg)</td>
<td>1.0</td>
<td>1.32 ± 0.51</td>
<td>1.37 ± 0.75</td>
<td>1.16 ± 0.41</td>
</tr>
<tr>
<td>Fluid (ml/kcal)</td>
<td>1</td>
<td>0.42 ± 0.43</td>
<td>0.36 ± 0.35</td>
<td>0.31 ± 0.24</td>
</tr>
<tr>
<td>Energy (kcals)</td>
<td>≥35</td>
<td>31.23 ± 11.64</td>
<td>28.95 ± 14.90</td>
<td>25.90 ± 8.02</td>
</tr>
</tbody>
</table>

Note. Dietary intake from 24-Hour Dietary Records *(Macedonio & Dunford, 2009; Popkin et al., 2010; Rosenbloom & Coleman, 2012)*

**Discussion**

The primary purpose of this study was to examine the dietary intake and recovery status of Division III baseball players during the collegiate fall baseball season at one northeast Ohio university. Additionally, comparison between home competition, away competition and non-competition dietary intake and recovery status surveys were
investigated. A secondary goal was to compare the baseball-specific, bodyweight-dependent sports nutrition guidelines for energy (kcal/kg), carbohydrate (g/kg), protein (g/kg), fat (g/kg) and fluid (ml/kcal) to the dietary intakes of Division III baseball players.

There was a significant statistical difference between home and non-competition carbohydrate and energy intakes. This data partially supports the researcher’s hypothesis that dietary intake will be different between home, away and non-competition days. These findings are supportive of similar research studies (Cole et al., 2005; Wierniuk & Włodarek, 2013). Cole et al., (2005) examined the dietary practices of 30 Division I football players using three-day dietary records. Actual dietary intake was compared to the recommended dietary intake for overall energy, carbohydrate, protein, and fat. Results indicated that subjects consumed an average of 3,288 calories, 392 grams of carbohydrates, 169 grams of protein, and 103 grams of fat. All of which, fell significantly short (inadequate) of the recommended 5,300 calories, 795 grams of carbohydrates, 198 grams of protein, and 147 grams of fat (Cole et al., 2005). Similarly, Wierniuk and Włodarek (2013) assessed the dietary intake of 25 college-aged males participating in aerobic sport or exercise. Results determined that 88% consumed lower than recommended energy, 40% consumed lower than recommended protein, and 84% consumed lower than recommended carbohydrate.

One possible reason why athletes may struggle with overall energy and carbohydrate consumption is due to athletic and academic schedules. According to the NCAA GOALS study, Division III baseball players report spending 70 hours per week towards in-season athletic and academic activities. With substantial time commitment to
sport and coursework, student-athletes face challenges regarding nutrition and meal-timing. However, this study found that non-competition energy and carbohydrate intakes were significantly lower than home competition intakes. This unexpected finding may be explained by the decrease in physical activity on non-competition days compared to home and away competition days. This may be better explained by energy balance. Energy balance occurs when total energy intake (EI) equals total energy expenditure (TEE), which in turn consists of the summation of basal metabolic rate (BMR), the thermic effect of food (TEF), and the thermic effect of activity (TEA) (Thomas et al., 2016). When TEA is decreased, less EI is required to achieve energy balance. Therefore, players may decrease overall energy and carbohydrate intakes to match his energy expenditure accordingly. Players may also sleep in on non-competition days. This may cause athletes to miss morning meals and snacks, like breakfast, and contribute to lower carbohydrate and energy intakes.

No significant differences were observed between home, away and non-competition recovery statuses and rejects the researcher’s hypothesis that recovery status will be different between home, away and non-competition days. Recovery status was classified as poor for home, away and non-competition days. These findings are supportive of previous research studies (Berdejo-del-Fresno & Laupheimer, 2014; Jones, Lander, & Brubaker, 2013). Jones et al. (2013) reported poor (< 14 points) recovery in rugby athletes using passive recovery compared to active recovery, cold water immersion and combined (active & cold water immersion) recovery methods following a simulated rugby protocol. Berdejo-del-Fresno and Laupheimer (2014) analyzed the recovery of 20
elite male futsal players during a week period of three days out of camp, one traveling
day, and three days in camp. Results indicated that athletes achieved mean recovery
scores of 12.36, 12.39, and 12.13 during the three out of camp days and mean scores of
16.08, 16.85, and 15.42 during the three in camp days. Furthermore, the athletes
achieved their lowest mean score of 9.57 during their traveling day.

These findings suggest Division III baseball players do not adhere to basic
recovery strategies. Many factors may contribute to the lack of recovery in collegiate
athletes. Nutrition is imperative for optimal recovery regarding muscle glycogen
restoration, muscle regeneration, fatigue reduction and immune system support (Burke et
al., 2011; Heaton et al., 2017; Phillips & Van Loon, 2011). Previously mentioned
academic and athletic schedules may contribute to missed meals, poor meal timing, a lack
of sleep and emotional and social stressors. The studied participants and its athletic team
may not participate in a structured pre- and post-exercise stretching protocol. All of
which, may potentially decrease one’s TQR score, and therefore, decrease overall
recovery. The lack of recovery in Division III baseball players questions the recovery
strategies used by this group. The mean age of the participants was 18.6 ± 0.9 years and
16 of the total 23 participants were freshman. Poor recovery in young athletes may
impair muscle repair and remodeling, immune function and mediating inflammation
(Heaton et al., 2017). All of which jeopardize the long-term health and wellness of an
individual.

This study identified that Division III baseball players consumed an inadequate
amount of carbohydrate (g/kg), energy (kcals/kg), and fluid (ml/kcal) compared to the
sport-specific bodyweight-dependent recommendations for baseball players. Excessive fat (g/kg) consumption on home, away and non-competition days was also observed. Protein intake was adequate for home, away and non-competition days in Division III baseball players during the fall collegiate baseball season. One of the 23 Division III baseball players met the recommended 5-7 g/kg carbohydrate recommendation for both home and away competitions. No players achieved this recommendation on non-competition days. A total of 10, 7 and 12 Division III baseball players achieved the 1.2-1.7 g/kg recommendation for protein on home, away and non-competition days, respectively. A total of 8, 5 and 9 Division III baseball players achieved the 1.0 g/kg recommendation for fat on home, away and non-competition days, respectively. A total of 2, 2 and 1 Division III baseball players achieved the 1.0 ml/kcal recommendation for fluid on home, away and non-competition days, respectively. A total of 5, 5 and 3 Division III baseball players achieved the ≥35 kcal/kg recommendation for energy on home, away and non-competition days, respectively.

These findings are supportive of previous research conducted by Shriver, Betts, and Wollenberg (2013). Shriver et al. (2013) examined the dietary intakes of female collegiate athletes using a three-day food record, a 24-hour dietary recall and a nutrition questionnaire. The researchers compared the female athletes’ dietary intakes to the minimum recommended bodyweight-dependent sports nutrition guidelines for energy, carbohydrate, protein and fat. Results indicated that only 9% of athletes met the minimum recommended amount of energy and 75% failed to consume an adequate amount of carbohydrate.
These findings and previous research (Shriver et al., 2013) suggest that collegiate athletes marginally achieve sport-specific, bodyweight-dependent dietary recommendations. These findings support the need to educate collegiate athletes and supporting athletic staff members on the existence of sport-specific, bodyweight-dependent dietary recommendations. Individuals at the Division III level may be unaware of these sport-specific recommendations because of the minimal presence of sports nutrition professionals, such as registered sports dietitians, at this level of collegiate athletics. Additionally, the practical application of sports nutrition recommendations in the collegiate athletic population may be of concern. Collegiate athletes continue to struggle to meet the recommended dietary intake levels (Cole et al., 2005; Hull et al., 2017; Webber et al., 2015; Wierniuk & Włodarek, 2013). However, collegiate athletes continue to perform at competitive levels. Current sports nutrition recommendations may require modification to appropriately encompass the collegiate athlete. Based on the current sports nutrition recommendations for baseball, a Division III baseball player is expected to achieve similar guidelines of a Major League Baseball player. With very few Division III baseball players continuing careers into professional sports, the focus of these sports nutrition recommendations may warrant an increased emphasis on general health and wellness to promote healthy lifestyles in an athlete’s post-athletic career. Structuring the sport-specific nutrition guidelines down to a youth, high school, collegiate and professional/elite level may better encompass the wide variety of age groups and skill levels.
The inconsistent responses to the nine sports nutrition questions in Table 4 supports the need for continuing education on sports-related terminology. All subjects used in this study participate in collegiate baseball at the same Division III university. Therefore, responses should be consistent for all nine questions. However, variable responses were observed. For example, the final two questions regarding access to a strength and conditioning coach and a sports dietitian yielded 12 yes and 6 no and 6 yes and 12 no responses, respectively. Players may perceive an assistant coach who is responsible for operating training sessions as a strength and conditioning coach. Likewise, a nutrition professor may be viewed as a sports dietitian. These findings suggest the need for education to promote distinction and clarity in this area.

**Limitations**

The primary limitation of this study was the associated error and accuracy related to the 24-hour dietary records. Although validated 24-hour dietary records are well-accepted among the scientific literature, under- and over-reporting remains an overall barrier. Additionally, many student-athletes utilize the dining services of their university. This also presents a concern regarding accuracy due to the difficulty of identifying all ingredients and serving sizes in various prepared dishes.

Only one Division III university was used for this study creating a limitation surrounding its sample size. Convenience sampling from one Division III university was used to recruit participants. The small sample size (n=23) was attributed to the relatively small size of eligible dress list players of approximately 35 players.
Another limitation of the study was the under-reporting of fluid intake. Many athletic teams provide their athletes fluids through team designated squirt bottles rather than individual bottles for each player. During a baseball game, an athlete is likely to take numerous squirts of fluid during his time in the dugout rather than consuming a known amount of fluid, such as a 16.9 fluid ounce plastic water bottle. Because of this, players experience a difficult time monitoring his intake over the course of a baseball game.

Limitations surrounding the recovery monitoring method used in this study include the subjective nature of the TQR logs. Athletes self-reported and scored their recovery strategies based on the fulfillment of various recovery criterion. The classification of recovery (poor, good, & optimal) was intentionally withheld from the participants to prevent bias.

Another limitation of this study was the timing of the study. Data was collected in the fall season of the collegiate baseball schedule and, therefore, does not necessarily represent the dietary intake and recovery status of Division III baseball players during the collegiate baseball season. Although differences exist among time points, collegiate fall baseball schedules often emulate that of the regular season. This study collected data during a week where student-athletes attended fall courses, participated in daily baseball practice, and participated in one home competition, one away competition and one non-competition day. Data was collected at a time that closely simulates the stressors and routine of a regular season of collegiate baseball.
The final limitation of this study was the self-reporting nature of its data collection materials. Participants self-reported three 24-hour dietary records and three subjective TQR logs. It is assumed that participants honestly self-reported their dietary and recovery information for the duration of this study.

**Applications**

It is important to evaluate if the dietary intakes of NCAA Division III baseball players concur with the current baseball-specific, bodyweight-dependent nutrition guidelines set by the Academy of Nutrition and Dietetics’ practice group, Sports, Cardiovascular, and Wellness Nutrition (Rosenbloom & Coleman, 2012). This study reinforces the challenges collegiate student-athletes face regarding proper sports nutrition and the ability to adhere to sport-specific recommendations. Division III collegiate baseball players, coaches, athletic trainers, and other supporting staff members would benefit from nutrition education intervention. Athletic coaches, athletic trainers, and strength and conditioning coaches would benefit from monitoring recovery status to assess current team recovery strategies and adjust practice and/or training loads to prevent impaired muscle repair and remodeling, immune function and inflammation mediation (Heaton et al., 2017).

This research study aimed to fill an existing gap within the scientific literature. Much research is known about the dietary intake of Division I athletes and less is known about lower-division athletes. Baseball is a low-endurance, precision skilled sport by nature, and therefore, requires less energy expenditure compared to other team sports (Rosenbloom & Coleman, 2012). Nutrition may often be overlooked in such sports with
minimal energy expenditure, however, the overall scope of the sport should be taken into consideration when conceptualizing future sports nutrition recommendations. Future research studies may focus on long-term investigation, for example, for the duration of the collegiate season, to better understand the practical application of sports nutrition recommendations.

This research study demonstrated similar findings to much of the current sports nutrition literature regarding collegiate athletes and dietary intake (Cole et al., 2005; Hull et al., 2017; Webber et al., 2015; Wierniuk & Włodarek, 2013). These findings provide continual support for the necessity of collegiate nutrition intervention programs and more specifically, at the Division III collegiate level. The deregulation of feeding in Division I and Division II athletics has changed the scope of collegiate athletics. Division I and II student-athletes now have more ways than ever to access meals and snacks ranging from simple fueling stations and training tables, to state-of-the-art facilities outfitted to serve the dietary needs of student-athletes. The deregulation rules also play an integral part in expanding the profession of nutrition and dietetics and the role of a registered sports dietitian. The Collegiate and Professional Sports Dietitian Association (CPSDA) currently reports 66 universities from major Division I college conferences who employ at least one full-time registered sports dietitian (RD). With an increasing number of Division I and II athletic departments utilizing the role of a sports nutrition program, the NCAA should consider the future deregulation of feeding in Division III athletics.

Since the inception of sports nutrition at the collegiate level remains relatively infantile, future research should aim to define the value of a sports nutrition program.
The scientific literature continues to support the need for sports nutrition related programs and education at the collegiate level. A strength of evidence and value surrounding such programs may drive future policy makers of the NCAA to evaluate the current regulation of feeding enforced at the Division III level.

According to the NCAA’s 2015 GOALS study, Division I, II and III men’s and women’s student-athletes identified both preparation for a career after college and proper nutrition for athletic performance as the top two topics they wished their coaches and athletics administrators talked about more frequently. Due to this, the NCAA and universities across all divisions should place a higher emphasis on educating athletes for life after athletics. Various universities currently offer a life after sports curriculum to its student-athlete population to better prepare this group for post-graduation and post-athletic lifestyle transitions. The NCAA may consider mandating a policy requiring such a curriculum be offered by all universities participating in NCAA athletics.

**Conclusion**

In conclusion, this research study found that Division III collegiate baseball players do not meet the current bodyweight-dependent sports nutrition recommendations, under consume carbohydrates and energy on non-competition days and recovery poorly on home, away, and non-competition days during the collegiate fall baseball season. These findings suggest Division III collegiate baseball players may experience inadequate dietary intake and poor recovery over the duration of the collegiate baseball season.
APPENDIX A

LETTER OF CONSENT
LETTER OF CONSENT

Informed Consent to Participate in a Research Study

Study Title: DIETARY INTAKE AND RECOVERY STATUS AMONG DIVISION III BASEBALL PLAYERS DURING THE COLLEGIATE BASEBALL SEASON

Principal Investigator: Dr. Natalie Caine-Bish & Sean Mohney (Co-investigator)

You are being invited to participate in a research study. This consent form will provide you with information on the research project, what you will need to do, and the associated risks and benefits of the research. Your participation is voluntary. Please read this form carefully. It is important that you ask questions and fully understand the research to make an informed decision. You will receive a copy of this document to take with you.

Purpose: The purpose of this study is to examine the dietary intake and recovery status of Division III baseball players during the fall collegiate baseball season at a northeast Ohio university. This study is designed to examine the dietary intake and recovery status of collegiate baseball players during home, away, and non-competition days during the fall collegiate baseball season. The literature on the topic of dietary intake and recovery status among National Collegiate Athletic Association (NCAA) baseball players is limited, therefore, further research in this specific area would be beneficial to collegiate baseball athletes, coaches, and programs, as well as the sports nutrition community.

Procedures
This study is designed to evaluate the dietary intake and recovery of NCAA baseball players. Each participant is required to complete one general background questionnaire which evaluates age, height, weight, class, athletic information and sports nutrition information. Each participant is required to complete three separate dietary intake records which coincide with one home, away, and non-competition day. Additionally, each participant is required to complete three Total Quality Recovery (TQR) questionnaires which coincide with each corresponding dietary intake record on one home, away, and non-competition day. Each dietary intake record is to be filled out during dietary consumption. This means that when the participant consumes food, liquid, supplement, etc., he records the item on the appropriate dietary intake record. Each TQR questionnaire is to be filled out at the end of each day, preferably before sleep. Once completed, each participant will individually send his documents to the head coach or
assistant coach. The co-investigator will collect all documents upon completion. All documents will be saved on a password protected computer locked in a designated office. The investigators of this study will report statistical findings at a later time and date.

**Benefits**
The potential benefits of participating in this study may include a personal gain in knowledge regarding one’s dietary intake and recovery status. This information may potentially be used to reinforce or modify dietary and/or recovery behaviors that contribute to overall athletic performance. This information may benefit NCAA baseball players, coaches, and programs. The literature on the topic of dietary intake and recovery status among NCAA baseball players is limited, therefore, research on this topic may contribute to the scientific community and scientific literature. No form of financial compensation for participation is available.

**Risks and Discomforts**
There are no anticipated risks beyond those encountered in everyday life. Reasonably expected risks, harms, and/or discomforts may include minimal risks of cognitive distress and/or social obligation. All efforts to minimize the occurrence of these risks will be taken. Participants may choose to opt out of this research study at any time.

**Privacy and Confidentiality.**
Your study related information will be kept confidential within the limits of the law. Any identifying information will be kept in a secure location and only the researchers will have access to the data. Research participants will not be identified in any publication or presentation of research results; only aggregate data will be used.

**Voluntary Participation**
Taking part in this research study is entirely up to you. You may choose not to participate or you may discontinue your participation at any time without penalty or loss of benefits to which you are otherwise entitled. You will be informed of any new, relevant information that may affect your health, welfare, or willingness to continue your study participation.

**Contact Information**
If you have any questions or concerns about this research, you may contact Dr. Natalie Caine-Bish at (330) 672-2148 or Sean Mohney at (330) 635-2599. This project has been approved by the Kent State University Institutional Review Board. If you have any questions about your rights as a research participant or complaints about the research, you may call the IRB at 330.672.2704.

**Consent Statement and Signature**
I have read this consent form and have had the opportunity to have my questions answered to my satisfaction. I voluntarily agree to participate in this study. I understand that a copy of this consent will be provided to me for future reference.
DIETARY INTAKE AND RECOVERY STATUS AMONG DIVISION III BASEBALL PLAYERS
DURING THE FALL COLLEGIATE BASEBALL SEASON
Appendix B

SPORTS NUTRITION QUESTIONNAIRE

Sports Nutrition Questionnaire  Date ________________

Directions: Please complete the following information to the best of your ability.

Background Information
Age: _______________
Height: _________ ft. _________ in.
Current Weight: ______________ lbs.
Athletic Class (Freshman, Sophomore, Junior, Senior): ________________

Athletic Information
Position(s) (Highlight all that apply): Infield  Outfield  Pitcher  Catcher
Primary Position (ex. SS, CF, P, etc.): ________________

Sports Nutrition Information (Please “X” YES or NO)

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Does your athletic team provide pre-workout/practice nutrition options?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Does your athletic team provide post-workout/practice nutrition options?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Does your athletic team provide pre-game nutrition options?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Does your athletic team provide post-game nutrition options?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Does your athletic team provide nutrition options in the dugout during HOME games?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Does your athletic team provide nutrition options in the dugout during AWAY games?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Does your athletic department provide “Training Tables” to you team?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Question</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------</td>
<td>-----</td>
<td>-----</td>
</tr>
<tr>
<td>Does your team have access to a Strength and Conditioning Coach?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Does your team have access to a Sports Dietitian?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX C

TOTAL QUALITY RECOVERY (TQR) QUESTIONNAIRE
APPENDIX C

TOTAL QUALITY RECOVERY (TQR) QUESTIONNAIRE

HOME RECOVERY

Total Quality Recovery (TQR) Questionnaire

**Directions:** Complete each TQR questionnaire at the end of each day before bed. Refer to each main “Recovery Strategy” and its total possible points. Score each subcategory with an “X” based on your recovery strategies. Refer to the “Scoring Adjustments” column for partial point values. Total all subcategories and record your value in the “Total” row located at the bottom.

<table>
<thead>
<tr>
<th>Recovery Strategy</th>
<th>Points Possible</th>
<th>Your Points</th>
<th>Scoring Adjustments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NUTRITION</strong></td>
<td>8</td>
<td></td>
<td>Assign ½ point for a less than full breakfast (&lt;50% usual intake) i.e. snack</td>
</tr>
<tr>
<td>Breakfast</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lunch</td>
<td>2</td>
<td></td>
<td>Give 1 point for a less than full lunch (&lt;50% usual intake)</td>
</tr>
<tr>
<td>Dinner</td>
<td>2</td>
<td></td>
<td>Give 1 point for a less than full lunch (&lt;50% usual intake)</td>
</tr>
<tr>
<td>Pre-workout/game snack</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post-workout/game refueling within 60 minutes</td>
<td>2</td>
<td></td>
<td>Give 1 point for after 60 minutes</td>
</tr>
<tr>
<td><strong>HYDRATION</strong></td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-workout/game urine: clear or light color</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post-workout/game urine: clear or light color</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>SLEEP &amp; REST</strong></td>
<td>4</td>
<td></td>
<td>Give 2 points for 7 to &lt;8 hours</td>
</tr>
<tr>
<td>8 hours of sleep</td>
<td>3</td>
<td></td>
<td>Give 1 point for 6 to 7 hours</td>
</tr>
<tr>
<td>Daytime nap</td>
<td>1</td>
<td></td>
<td>Give 0 for less than 6 hours</td>
</tr>
<tr>
<td><strong>RELAXATION &amp; STRESS</strong></td>
<td>3</td>
<td></td>
<td>Give 1 point for mild stress</td>
</tr>
<tr>
<td>Fully relaxed 60 minutes post-</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>workout/game or 30 minutes feet up</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>relaxation post-workout/game</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No daily psycho-social stress</td>
<td>2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
COOLDOWN/STRETCHING

<table>
<thead>
<tr>
<th>Recovery Strategy</th>
<th>Points Possible</th>
<th>Your Points</th>
<th>Scoring Adjustments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adequate cooldown post-workout/game</td>
<td>2</td>
<td></td>
<td>Give 1 point for partial cooldown</td>
</tr>
<tr>
<td>Stretching and foam roller for at least 10 minutes</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>20</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Total Quality Recovery (TQR) Questionnaire

**Directions:** Complete each TQR questionnaire at the end of each day before bed. Refer to each main “Recovery Strategy” and its total possible points. Score each subcategory with an “X” based on your recovery strategies. Refer to the “Scoring Adjustments” column for partial point values. Total all subcategories and record your value in the “Total” row located at the bottom.

<table>
<thead>
<tr>
<th>Recovery Strategy</th>
<th>Points Possible</th>
<th>Your Points</th>
<th>Scoring Adjustments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NUTRITION</strong></td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Breakfast</td>
<td>1</td>
<td></td>
<td>Assign ½ point for a less than full breakfast (&lt;50% usual intake) i.e. snack</td>
</tr>
<tr>
<td>Lunch</td>
<td>2</td>
<td></td>
<td>Give 1 point for a less than full lunch (&lt;50% usual intake)</td>
</tr>
<tr>
<td>Dinner</td>
<td>2</td>
<td></td>
<td>Give 1 point for a less than full lunch (&lt;50% usual intake)</td>
</tr>
<tr>
<td>Pre-workout/game snack</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post-workout/game refueling within 60 minutes</td>
<td>2</td>
<td>Give 1 point for after 60 minutes</td>
<td></td>
</tr>
</tbody>
</table>

**NON-COMPETITION RECOVERY**

**DATE____________________**
<table>
<thead>
<tr>
<th>HYDRATION</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-workout/game urine: clear or light color</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Post-workout/game urine: clear or light color</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>SLEEP &amp; REST</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>8 hours of sleep</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Daytime nap</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>RELAXATION &amp; STRESS</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Fully relaxed 60 minutes post-workout/game or 30 minutes feet up relaxation post-workout/game</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>No daily psycho-social stress</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Give 1 point for mild stress</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COOLDOWN/STRETCHING</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Adequate cooldown post-workout/game</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Give 1 point for partial cooldown</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stretching and foam roller for at least 10 minutes</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>20</td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX D

24-HOUR DIETARY RECORD
APPENDIX D

24-HOUR DIETARY RECORD

HOME 24-HOUR DIETARY RECORD

<table>
<thead>
<tr>
<th>Time (Time you began eating)</th>
<th>Meal/ Snack (M/S)</th>
<th>Food Item (“Official Name”, i.e. Cobb salad)</th>
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doi:10.1139/h2012-028


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doi:10.1186/s12970-017-0187-6


doi:10.1007/s40279-014-0148-z


National Collegiate Athletic Association. (2016). *Results from the 2015 GOALS study of*


Position of the American Dietetic Association, Dietitians of Canada, and the American...


