GENDER EFFECT ON TORQUE AND EXPLOSIVE CHARACTERISTICS AT KNEE EXTENSOR IN TRIATHLETES WITH HIGH AND LOW EATING ATTITUDES

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This study examined the impact of eating attitudes on the strength, agility, explosiveness, and endurance performance of 26 triathletes who were categorized into EAT-Better and EAT-Worse groups. Isometric knee extensor maximal voluntary contractions were conducted before and after cycling incremental VO2 max tests. Results showed that there were no significant between-group differences at baseline and there were gender differences in Peak Knee Extensor Joint Torque and Knee Extensor Joint Impulse. At fatigue status, only females exhibited a decrease in fatigue-induced Knee Joint Impulse. Although there were no significant between-group differences in fatigue status, EAT-Worse exhibited a more notable decrease than EAT-Better. Further exploration of eating attitudes' influence on triathletes' performance is needed.

KEYWORDS: triathlon, diet, fatigue, sport performance.

INTRODUCTION: In recent years, the number of participants in triathlon events has steadily increased. Triathlon, consisting of swimming, cycling, and running, is an endurance sport that involves long durations and high intensity of training and also requires high energy intake and nutritional demands (Devrim-Lanpir et al., 2021; Knechtle & Nikolaidis, 2018). Energy deficit poses significant concerns for both health and athletic performance, as it may reduce fat and skeletal muscle mass, especially in endurance events involving prolonged physical activity (Devrim-Lanpir et al., 2021; Nikolaidis et al., 2018). Some literature also suggests that eating disorders or nutritional deficiencies can adversely affect athletes' performance, causing a decrease in isometric muscle strength and aerobic capacity (Hausenblas & Carron, 1999; Quesnel et al., 2023). Given the importance of energy intake in triathlon, the eating attitude may affect sports performance, especially in muscle strength and aerobic capacity. Therefore, the study aimed to firstly investigate the interactive effect of gender and fatigue on torque exertion and explosive characteristics at knee extensor and secondly to investigate the dietary habits of recruited triathletes to divide them into good and poor Eating Attitude by using an Eating Attitude Test (Garner et al., 1982) to explore the effect of Eating Attitude on torque exertion and explosive characteristics at knee extensor in sports performance.

METHODS: There were 26 triathletes whose characteristics outlined in Table 1 participated in the current study. They were divided into two groups based on their scores on the Eating Attitudes Test: the EAT-Better group, consisting of those with lower scores, and the EAT-Worse group, comprising individuals with higher scores. The Eating Attitudes Test consists of 15 questions about Self-Perception of Body Shape, Dieting, Food Preoccupation, and Awareness of Food Content. This questionnaire uses a 6-point Likert scale, including "Always", "Usually", "Often", "Sometimes", "Rarely" and "Never". Participants' responses to the questionnaire are scored on a point scale, where choosing "Always" results in 3 points, "Usually" corresponds to 2 points, and "Often" corresponds to 1 point. Higher scores on the EAT indicate more problematic attitudes and behaviors related to eating. In this study, the highest score on the Eating Attitudes Test is 45, and the cut-off value for distinguishing between high and low levels of eating attitudes is based on a total score over or under 11. The rating of perceived exertion (RPE) was investigated before and after the incremental VO2max test.

All participants were well-recognized with comprehensive information about the research details, and they also signed the informed consent form before undergoing the experiment. The research has obtained approval from the Research Ethics Committee at National Taiwan University (Approval Number: 202212EM001), and all assessments were conducted within a laboratory setting.

Table 1: The information of the participants.

		EAT-Better (N = 15)	EAT-Worse (N = 11)	*p**
Age		33.73 ± 15.13	36.27 ± 8.06	.62
Gender	Male	9	7	.85
	Female	6	4	
Weight (kg)		61.65 ± 11.12	67.62 ± 7.47	.14
Height (cm)		167.13 ± 8.51	166.73± 6.45	.90

Note: Values are presented as mean ± standard deviation or numerical figures. Differences between subjects were analyzed using independent t-tests.

To quantify different aspects of isometric muscle strength before and after the incremental VO2max tests, the participants underwent the incremental VO2max tests using cycle ergometry (Monark®, LC6 Novo; Vansbro, Sweden), a set of three isometric knee extension maximal voluntary contractions, using the Biodex Multi-Joint System 4 Pro (Biodex Medical Systems Inc., USA), and electrophysiological examination to test Twitch force and Interpolated Twitch Technique to assess peripheral and central fatigue (Huang et al., 2010), while simultaneously monitoring RPE to ensure fatigue status. Before and after the incremental VO2max tests, Peak Knee Extension Joint Torque, Time to Peak Knee Extension Joint Torque, Slope of Peak Knee Extension Joint Torque, and Knee Extension Joint Impulse were obtained and analyzed (Figure 1). Research steps:

1. The Eating Attitudes Test: After signing the informed consent form, participants will also complete the Eating Attitudes Test.
2. Pre-measurements: Conduct a set of three isometric knee extension maximal voluntary contractions.
3. 10 minutes rest: Participants will have a 10-minute rest before the incremental VO2max test to ensure adequate rest.
4. Warm-up: Participants will perform a cycling warm-up.
5. The incremental VO2max test: Conduct an incremental VO2max test until the participant can no longer continue. Consider this condition as "Fatigue status".
6. Post-measurements: Following the incremental VO2max test, proceed directly to another set of three isometric knee extension maximal voluntary contractions.

Additionally, a Two-way mixed-model analysis of variance with one between-subject factor (Group effect: MALE AND FEMALE) and one within-subject factor (Fatigue effect: before and after incremental VO2max tests, namely Pre and Post-measurements) was conducted in triathletes with low and high eating attitudes to analyze the differences between all variables of Knee Extension Joint. The significance level was set at α = 0.05.

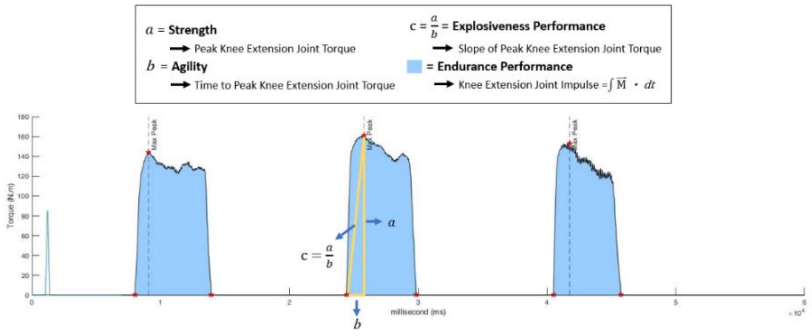

Figure 1: Variables calculated from the pattern of Extension Torque at the Knee.

RESULTS AND DISCUSSION: Scores of RPE showed significant pre-post difference (Male: PRE: 6.81±0.34, POST: 17.8±1.57, Female: PRE: 7±1.63, POST: 18.5±1.65; p<0.001) in which 15 of the male triathletes showed peripheral fatigue while 10 of the female triathletes showed peripheral fatigue. At baseline, before the incremental VO2max tests, for the between-group comparison, it was observed that there were no statistically significant between-group differences in all variables ($p > 0.05$). At baseline before the incremental VO2max tests, regardless of the eating attitudes, for the between-gender comparison, it is observed that there were statistically significant smaller Peak Knee Extension Joint Torque (Male: PRE: 1.90±0.26 N.m/Body Weight, POST: 1.84±0.25 N.m/Body Weight, Female: PRE: 2.28±0.30 N.m/Body Weight, POST: 2.22±0.29 N.m/Body Weight; $p < 0.001$), and Knee Extension Joint Impulse (Male: PRE: 107.73±23.07 N.m*ms, POST: 97.48±22.00 N.m*ms, Female: PRE: 84.10±16.37 N.m*ms, POST: 73.39±14.25 N.m*ms; $p = 0.003$), but not in Time to Peak Knee Extension Joint Torque (Male: PRE: 2101.88±1247.53 ms, POST: 2396.88±1273.18 ms, Female: PRE: 2039.00±1564.39 ms, POST: 2254.00±1423.35 ms; $p = 0.83$), and Slope of Peak Knee Extension Joint Torque (Male: PRE: 0.095±0.067 N.m/ms, POST: 0.071±0.042 N.m/ms, Female: PRE: 0.091±0.065 N.m/ms, POST: 0.064±0.054 N.m/ms; $p = 0.79$).
Regardless of eating attitude, if the gender effect was not included, there was a significant decline in torque exertion, explosive characteristic, and endurance performance observed after the incremental VO2max tests ($p < 0.05$, Figure 2a, 2c and 2d), but not in Agility ($p = 0.36$, Figure 2b). Meanwhile, this decline in Knee Extension Joint Impulse after incremental VO2max tests was found only in females but not in males if the gender effect was counted (Figure 3a and 3b).

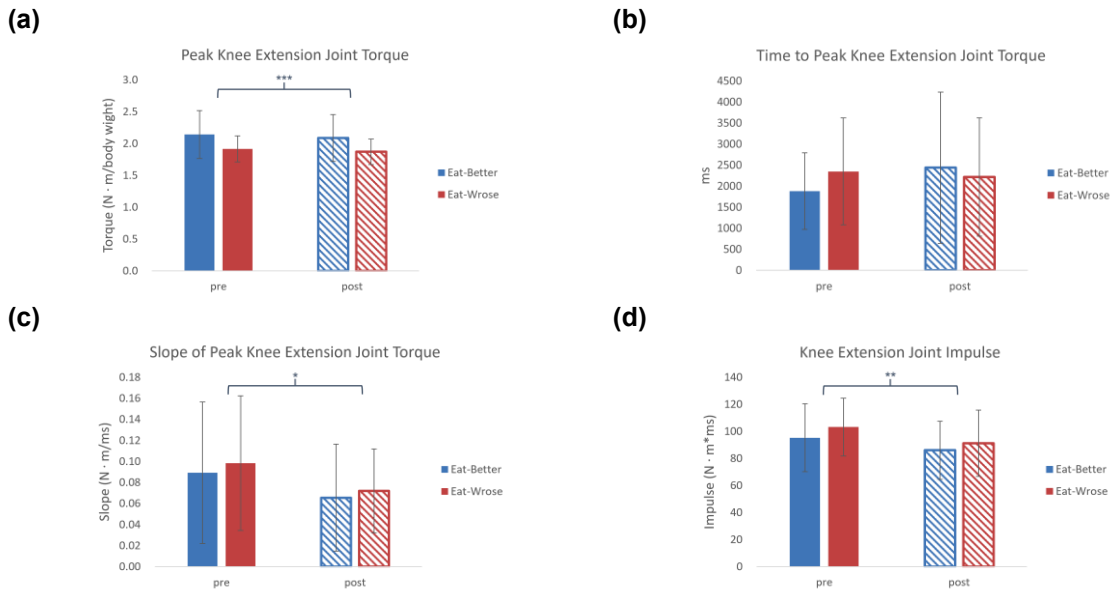

Figure 2: Results of Two-way ANOVA in all variables, * indicates a significant difference ($p < 0.05$); ** indicates a significant difference ($p < 0.01$), and * indicates a significant difference ($p < 0.001$).**

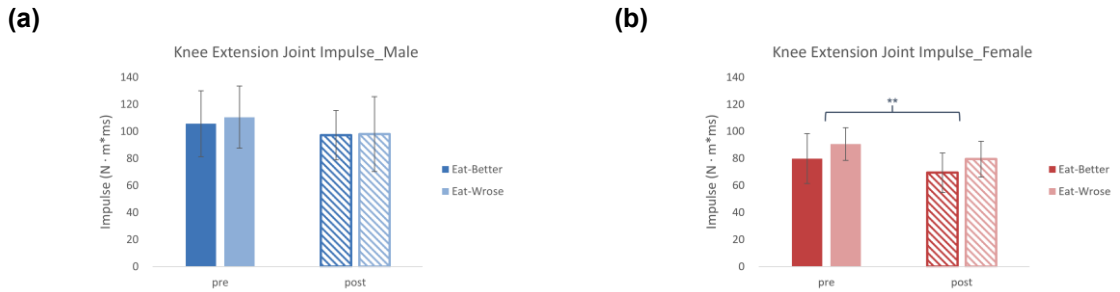

Figure 3: Results of Two-way ANOVA in Knee Extension Joint Impulse with Gender Effect, ** indicates a significant difference ($p < 0.01$).

Regardless of gender, an eating attitude did not result in a noticeable impact on muscular performance in terms of the Peak Knee Extension Joint Torque, Time to Peak Knee Extension Joint Torque, Slope of Peak Knee Extension Joint Torque, and Knee Extension Joint Impulse before and after incremental VO2max tests. Meanwhile, an observable but non-significant decrease in all variables was observed, and this observation was more pronounced in EAT-Worse than in EAT-Better after incremental VO2max tests (Figure 2a-2d). These non-significant findings remain to be explored in a grander study scale in the future.

CONCLUSION: Agreed with what has been reported in the literature (Berger et al., 2012; Hoshikawa et al., 2006), the significant gender effects consistently found in all the reported variables regarding to knee joint torque exertion and endurance performance at baseline evaluation and fatigue status evaluation indicated a need for gender-specific exercise prescription at the knee. However, the Biodex representative's exhaustion during a triathlon may depend on whether the athletes were sprint, middle, or long-distance triathletes, which required further studies. This study found that both EAT-Worse and EAT-Better groups, showed a decline in terms of Peak Knee Extension Joint Torque, Slope of Peak Knee Extension Joint Torque, and Knee Extension Joint Impulse after incremental VO2max tests. EAT-Worse Group showed a more significant decrease compared to EAT-Better Group, suggesting that the decline in knee joint torque exertion and explosive characteristic may be a factor affecting the anti-fatigue capacity in the EAT-Worse group. The limited sample size in the current pilot study will be addressed in future research.

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