

RISKS OF EATING AND IMAGE DISORDERS ARE CORRELATED WITH ENERGY AND MACRONUTRIENT INADEQUACIES IN YOUTH RHYTHMIC GYMNASTICS

Maria Letícia Jardim¹, Ana Clara Justino Valencio¹, Lizia Nardi Menegassi², Ricardo Azevedo Da Silva³, Randhall Bruce Carteri^{1,3}

¹Centro Universitário Metodista - IPA, Porto Alegre, Brasil.

²Universidade Federal do Rio Grande do Sul (UFRGS), Porto Alegre, Brasil.

³Universidade Católica de Pelotas, Pelotas, Brazil

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Abstract

Rhythmic Gymnastics is an aesthetic sport with specific requirements that can enhance the development of eating disorders, leading to important nutritional inadequacies potentially compromising sports performance and health. Thus, this work aims to analyze associations between the risk of eating disorders and the perception of body image and eating habits in Brazilian national-level rhythmic gymnastics athletes. Eighteen female athletes aged between 12 and 19 responded to two 24-hour food recalls, the standardized Eating Attitudes Test (EAT-26), the Body Esteem Scale (BES), and the Body Shape Questionnaire (BSQ). There was an association between the risk of eating disorders, distortion of body image, and body mass index (0.51; $p = 0.025$ and -0.50 ; $p = 0.029$). Inverse correlations were found between carbohydrate and lipid intake per kilogram with the risk of eating disorders (-0.69 ; $p = 0.001$, and -0.49 ; $p = 0.03$) and with body image distortion (-0.63 ; $p = 0.004$, and -0.63 ; $p = 0.04$). Also, inverse correlations between energy intake per kilogram and the risk of eating disorders (-0.62 ; $p = 0.004$) and body image distortion (-0.70 ; $p = 0.001$) were found. Our results highlight the importance of a multidisciplinary approach to increase awareness and prevent possible eating disorders in this population.

Keywords: *Eating behavior, Dietary habits, Mental health, Sports psychology.*

INTRODUCTION

Rhythmic gymnastics is an Olympic sport characterized by body movements that show harmony, elegance, gracefulness and lightness while following the rhythm of music (Moubarac, Parra, Cannon, & Monteiro, 2014). As an aesthetic sport, rhythmic gymnastics requires a specific biotype, with flexibility and low body weight index being the main factors that determine success for gymnasts in their presentations (Moubarac et al., 2014). Thus, dietary restrictions are common

among its practitioners which could be related to a higher occurrence of eating disorders (Joy, Kussman, & Nattiv, 2016).

It is well established that there is a high prevalence of eating disorders among rhythmic gymnastics athletes, and eating disorders are commonly related to body image disorders and body esteem, factors potentially enhanced by the competitive environment of high-performance sport (Joy et al., 2016). The internal and/or external pressure for an ideal physique

could lead to excessive training and restrictive dietary practices, yet a detailed description of the common dietary practices of these athletes is still not available (Vieira, Amorim, Vieira, Amorim, & Rocha, 2009) and it is still unclear how the risks of eating and body image disorders are related to dietary habits and food consumption (Fortes et al., 2015).

Notably, body image is pivotal for mental health and success for female athletes engaged in aesthetic sports as has been demonstrated by different studies (Tan, Calitri, Bloodworth, & McNamee, 2016; Varnes et al., 2013). Athletes with healthy body image perceptions are less prone to excessively restrictive dietary practices, which may directly impact their sports performance (Logue et al., 2020; M. R. Silva & Paiva, 2015).

Most of the studies evaluating eating disorders risks in rhythmic gymnastics do not provide insightful details on how these risks influence dietary behavior in this population. As previously demonstrated (Jonnalagadda, Benardot, & Dill, 2000), monitoring dietary habits presents specific limitations, and underreporting dietary intake is a common practice in elite gymnasts, culminating in inadequate estimates of nutritional intake which consequently leads to increased health risks. It is important to emphasize that inadequate dietary intake is the etiological factor that determines the so-called Relative Energy Deficiency in Sport (RED-S; from the English "Relative Energy Deficiency in Sport"), which refers to impaired physiological function, including, but not limited to, metabolic rate, menstrual function, bone health, immunity, protein synthesis, cardiovascular health caused by relative energy deficiency (Mountjoy et al., 2018). Notably, adolescent athletes are at high risk of developing one or more of the components of the athlete's triad, consisting of eating disorders, amenorrhea, and osteoporosis (Mountjoy et al., 2014).

This reinforces the need for nutritional counseling to prevent possible associated disorders (Mountjoy et al., 2018). Since dietary intake underreporting prevails in the context of eating disorders and in professional rhythmic gymnastics, it is important to investigate specific restrictive dietary practices and their relation to the presence of risks of eating disorders and body image distortion in this population.

As recently highlighted, rigorous studies examining the risks of eating and body image disorders and dietary intake among female athletes are scarce (Gastrich, Quick, Bachmann, & Moriarty, 2020). In addition, to further advance this field, it is imperative to combine different instruments to investigate the risks of eating and body image disorders. Moreover, using appropriate methods to ensure food intake data would provide insights in the influence of the risks of eating and body image disorders on dietary intake of macronutrients and micronutrients, which are important for sports performance. Thus, the objective of this study is twofold: to elucidate the relationship of risks of eating disorders and body image distortion with dietary practices of competitive rhythmic gymnasts, and to provide a detailed description of dietary practices of these athletes.

METHODS

This is an exploratory cross-sectional study, carried out with athletes from rhythmic gymnastics entities in the state of Rio Grande do Sul, South of Brazil. Eighteen female athletes aged between 12 and 19 were included. All participants ($n = 18$, mean age of 16.37, standard deviation of 4.0) had more than one year of practice in the modality and at least one participation in national-level competitions. The exclusion criteria included: previous diagnosis of an eating disorder, and/or any other psychological condition under treatment by a

psychologist or a psychiatrist. The sampling of the study was non-probabilistic and the recruitment was done by direct contact with the technicians responsible for the entities in the Rio Grande do Sul, throughout April and May in 2020. All participants and their legal guardians were informed about the nature and objectives of the study and provided signed informed consent forms for participation. This study was approved in March 2020 by the Methodist University Center Research Ethics Committee and registered in Plataforma Brasil (registration number 34217120.0.0000.5308).

The study was conducted via two video calls (due to pandemic-related restrictions) throughout May and June 2020. The athletes were undergoing their preparatory phase of training periodization and were training at home under their coach supervision to maintain their fitness levels. Two evaluations were performed: In the first evaluation, participants and their guardians received detailed information about the study procedures and provided informed consent. Afterward, the legal guardians left the video call and the athletes were asked to provide a 24-hour dietary recall for the evaluation of their nutritional status and eating habits. At least 48-hours after the first call, participants underwent a second video call evaluation, where they were asked to give a second 24-hour dietary recall and respond to three instruments: The Eating Attitudes Test (EAT-26) (Bighetti, Santos, Santos, & Ribeiro, 2004; Garner, Olmsted, Bohr, & Garfinkel, 1982), Body Esteem Scale Questionnaire (BES) (CAETANO, 2011), and the Body Shape Questionnaire (BSQ) to assess the distortion of body image.

Initially, the participants reported their height and body mass obtained in the last evaluation performed by the club (between February and March of 2020) for Body Mass Index calculations and classifications (Cavazzotto et al., 2014). To estimate the participants' reported food consumption,

two 24-hour food recalls separated by two days were used and the mean intake from the two days were considered (Fisberg, Marchioni, & Colucci, 2009). Participants were first asked about how many meals they had on the previous day, followed by the meal composition (what they ate, if the meals included salt, oils, etc.) and then the portion sizes. To assist participants to estimate portion sizes, a photo album of homemade measuring tools was used during the calls from which they identified portion sizes (i.e. number and size of spoons, glasses, etc.) of each food or drink consumed (Monteiro, 2007). These were then converted to grams accordingly (PINHEIRO, 2013). The composition of energy, macronutrients (carbohydrates, proteins, and fats), and fibres (and other micronutrients) was obtained using food composition databases (Núcleo de Estudos e pesquisas em Alimentação, 2016) and specific labels when necessary.

Subsequently, the mean values of total energy consumption, carbohydrates, proteins, and fats obtained in the 24-hour food recalls were divided by body mass, and the mean value of total energy consumption (kcal) was compared with the estimated daily requirement using the Schofield formula (Carteri & Feldmann, 2019; Reale, Roberts, Lee, Bonsignore, & Anderson, 2020) to obtain energy adequacy ($\text{Energy consumed} / \text{Estimated Energy requirement} \times 100$) multiplied by physical activity level obtained with a specific questionnaire (Guedes, Lopes, & Guedes, 2005). The values obtained for calories (kcal/kg); carbohydrates, proteins, and fats (g/kg); calcium, iron, sodium, total fibres, and cholesterol (g/day), were compared with nutritional recommendations (RDA) for the relevant age group (14- to 18-year-old) (Medicine, 2000; Padovani, Amaya-Farfán, Colugnati, & Domene, 2006). For assessments of underreporting, we calculated the ratio of estimated energy requirement and reported energy intake from the food recalls (Mirmiran, Esmailzadeh, & Azizi, 2006).

The Brazilian validation of the Eating Attitudes Test - EAT26 was used to assess the risk of eating disorders (Bighetti et al., 2004; Garner et al., 1982). The EAT-26 is a self-report questionnaire composed of 26 objective questions, containing the following options: Always / Often / Sometimes / A few times / Almost never / Never, which score from 0 to 3. The total score can vary from 0 to 78 and the results are categorized as the presence (≥ 20) or absence (EAT < 20) of risk of eating disorders (Scherer, Martins, Pelegri, Matheus, & Petroski, 2010).

Body image distortion was assessed using the Brazilian validation of the Body Shape Questionnaire – BSQ, which consists of 34 questions with answers including: 1 - Never; 2 - Rarely; 3 - Sometimes; 4 - Frequently; 5 - Very often; 6 - Always. The total score can vary from 34 to 204 points and the higher the score, the greater the degree of body image distortion. A score of less than 80 is considered as the absence of body image distortion, 80 to 110 indicates mild distortion, 111 to 140 indicates moderate distortion, and a score higher than 140 indicates serious distortion" (Cordás TA, 1994).

Body esteem was assessed using the Brazilian validation of the Body Esteem Scale - BES, which considers different aspects of body image through 38 questions (CAETANO, 2011). The results are obtained by the sum of values attributed to answers, as follows: "I have a strong negative feeling (score = 1) / I have a medium negative feeling (score = 2) / I have neither negative nor positive feelings: I am neutral (score = 3) / I have a medium positive feeling (score = 4) / I have a strong positive feeling (score = 5)". The total score can vary from 38 to 190 points and the higher the score the greater the degree of body esteem.

Subject characteristics, food consumption, and BES score are presented as mean \pm standard deviation. The data obtained from the EAT-26 and BSQ are

presented using simple and relative frequencies. Distributions of all variables were assessed to verify normality, using the Shapiro-Wilk test. The Student's t-test was used to compare the energy consumption found in the 24-hour food recalls with estimated energy requirement. Dietary adequacies were identified using the one-sample t-test for each variable compared with the daily recommended intake for the 14-18 age group. Pearson's linear correlation was used to assess the correlation between different variables. The level of significance established for the analyses was $p < 0.05$. All data were analyzed using the statistical program Statistical Package for Social Sciences (SPSS), version 26.0.

RESULTS

Rhythmic gymnastics athletes have normal body mass

The sample characterization data are shown in Table 1. Considering the nutritional status according to the classification of the body mass index in relation to age, most participants were in the "eutrophic" range (73.7% of the total), four were in the range considered "thin" (21.1% of the total), and one in the "overweight" range (10.5% of the total).

Rhythmic gymnastics athletes have inadequate nutritional intakes

The data on dietary intake are shown in Table 2. No differences were found between the estimated and the total energy intake. We found an estimated energy requirement to reported energy intake ratio of 0.94 ± 0.25 , indicating that the participants were under-reporters as evaluated by the food recalls as this was significantly different to the ratio between the estimated energy requirement and the usual energy intake (2.16 ± 1.11 , $p = 0.002$). The daily total energy intake was not different when compared to the estimated energy requirement. Several inadequacies were observed.

Table 1
Sample characterization data (n = 18).

	Mean ± S.D.
Age (years)	16.37 ± 4.0
Height (m)	1.64 ± 0.1
Body Mass (kg)	54.72 ± 10.0
Body Mass Index (kg /m ²)	20.27 ± 2.6
Estimated Resting Metabolic Rate (kcal/d)	1419.55 ± 110.1

S.D. = standard deviation; kcal/d = kilocalories per day

Table 2
Nutritional intake data (n = 18).

	Mean ± S.D.	Reference	Mean difference	p value
Relative energy intake (kcal/kg)	25.97 ± 8.0	-	-	-
Total energy intake (kcal/d)	1373.12 ± 338.0	-	-	-
Protein (g/kg)	1.61 ± 0.4	0.71 ^a	0.90	0.001
Total protein (g/d)	85.94 ± 18.3	46.0 ^a	39.94	0.001
Carbohydrates (g/kg)	0.8 ± 0.3	3.0 ^b	-2.19	0.001
Carbohydrates (g/d)	165.14 ± 46.14	130.0 ^a	35.14	0.004
Fats (g/d)	3.14 ± 1.2	1.0 ^b	2.14	0.001
Cholesterol (g/d)	350.41 ± 151.7	200 ^a	150.41	0.001
Total dietary fibres (g/d)	14.52 ± 6.0	26.0 ^a	-11.48	0.001
Calcium (g/d)	641.78 ± 429.3	1300 ^a	-668.21	0.001
Iron (g/d)	7.42 ± 1.9	15 ^a	-7.57	0.001
Sodium (g/d)	1095.95 ± 526.4	1500 ^a	-404.05	0.004

kcal/kg = kilocalories per kilogram; kcal/d = kilocalories per day; g/d = grams per day;

a = dietary intake from Institute of Medicine (Medicine, 2000)

b = minimum recommended intake for youth athletes (Bonci, 2010; Meyer, O'Connor, & Shirreffs, 2007)

Table 3
Risk of eating disorders, body image distortions, and body esteem.

Risk of eating disorders (EAT-26)	
Positive risk n(%)	8 (44.4)
Body image distortions (BSQ)	
Not Present	7 (38.9)
Mild distortion	6 (33.3)
Moderate distortion	5 (27.8)
Body esteem (BES)	
Total score (mean± Standard Deviation)	120.95 ± 20.72

Rhythmic gymnastics athletes are mostly at risk for eating disorders

The instruments used in the present study were all considered reliable (Cronbach's alpha: 0.752 for the EAT-26; 0.866 for the BSE and 0.957 for the BSQ). The results of the questionnaires used are shown in Table 03. Some risk of eating disorders (EAT-26 > 21) was found in 44.4% of the sample. Regarding body image, the majority presented some degree of body image distortion (61.1%): six participants presented mild distortion (33.3% of the total), five presented moderate distortion (27.8%) and seven participants (38.9%) did not present distortion of body image.

The risk for eating disorders correlates with body image distortion in rhythmic gymnastics athletes

When evaluating the correlations between the variables, we found an inverse correlation between energy intake per kilogram and the risk of eating disorders (-0.62; $p = 0.004$) and body image distortion (-0.70; $p = 0.001$). Inverse correlation were found between carbohydrate and lipid intake per kilogram with the risk of eating disorders (-0.69; $p = 0.001$, and -0.49; $p = 0.03$), and with body image distortion (-0.63; $p = 0.004$, and -0.63; $p = 0.04$). Positive correlations were found between body mass and body mass index with body image distortion (0.62; $p = 0.002$ and 0.51; $p = 0.025$, respectively). In addition, inverse correlations were found between body esteem and body image distortion (-0.69; $p = 0.001$) and body mass (-0.50; $p = 0.029$). Also, higher risk of eating disorders and higher body image distortion correlates with underreported energy intake in the food recalls (-0.65; $p = 0.002$ and -0.578; $p = 0.010$, respectively).

DISCUSSION

The objective of this study was to verify the association of the risk of eating disorders with body image distortion and

body esteem in rhythmic gymnastics athletes. Our study found a positive association between the risk of eating disorders, distortion of body image, and body mass index. Also, although most athletes presented adequate nutritional status (73.7% were in the "eutrophic" range), there were several nutritional inadequacies observed.

Maturation during adolescence is accompanied by physical and emotional problems that may result in psychological disorders or increased health risks due to inadequate dietary habits, smoking, consumption of alcoholic beverages and illegal drugs (Hart et al., 2020). Among female adolescents, this risk is greater due to the need to adapt to aesthetic standards imposed by society alongside the requirements of the sports practice itself (Joy et al., 2016; Trindade, Appolinario, Mattos, Treasure, & Nazar, 2019). Notably, the participating athletes showed adequate nutritional status related to height and weight adequacy, similar to several studies evaluating rhythmic gymnasts from Brazil (Bortoleto, Bellotto, & Gandolfi, 2014; Laffitte, Zap, Leandro, & Colleone, 2013; Viebig, Takara, Lopes, & Francisco, 2006), albeit these results contrasts with a study evaluating 20 international-level and 61 national-level rhythmic gymnasts aged between 13 to 20 who were classified as underweight with their BMI value 17 ± 1.8 kg/m² (Borrione et al., 2013). We believe that the competition level explains this difference, mainly due to higher training experience and training volumes, and body composition (less fat mass and higher muscle mass).

We observed several nutritional inadequacies when compared to the recommended values (Medicine, 2000; Padovani et al., 2006). In the present work, we performed the estimation of energy requirements according to the "Schofield" equation, considered accurate for this population (Carteri & Feldmann, 2019; Reale et al., 2020), and found that energy intake was adequate. However, the

distribution of macronutrients did not correspond to the reference values indicated by the recommendations, especially when considering young athletes. Through the dietary recalls, there was excessive consumption of protein and fats and total carbohydrates, alongside a low consumption of carbohydrates per kilogram. Similarly, a study that included 13 young Brazilian rhythmic gymnasts reported higher protein and fat intake while also higher intake of carbohydrates per kilogram when compared to the recommended values (Bortoleto et al., 2014). In addition to the difference in the carbohydrate per kilogram intake, the authors compared their results to the national guidelines for athletes, which are not specific to youth athletes or different age groups (Hernandez & Nahas, 2009). If we compare the mean protein intake by kilogram with the minimum recommended values from the American College of Sports Medicine of 1.2 to 1.6 grams per kilogram (Rodriguez, Di Marco, & Langley, 2009), considered appropriate for youth athletes, it would also be significantly different (mean difference of 0.41, $p = 0.001$) but within the recommended range. This reinforces the belief that young athletes usually consume more protein than recommended by RDA (Jeukendrup & Cronin, 2011). Also, although the total daily intake of carbohydrates seems appropriate when compared to the dietary recommendations of 130 grams per day (Medicine, 2000), the relative intake (grams per kilogram) are low when compared to the minimum recommendations for young athletes (Bonci, 2010; Meyer et al., 2007) or adults (Rodriguez et al., 2009). This is important when considering that the lower intake of carbohydrates and lipids per kilogram was associated with a higher risk of eating disorders. It indicates that these athletes are at risk of consuming less of these macronutrients. The increased popularity of low carbohydrate consumption (less than 45% of total energy intake) for weight

management may have been responsible for the low intake of this nutrient by gymnasts, even if it can potentially impair their sports performance (Laffitte et al., 2013; Macedo, Santos, Tinsley, & Reischak-Oliveira, 2020). In addition, we found an inadequate consumption of calcium and iron. This is worrying, considering that this deficiency can contribute to the development of anemia and osteoporosis (Kerksick et al., 2018; Mountjoy et al., 2014). Also, the values of fibre and sodium were below the recommended values (26 and 1.5 grams per day, respectively) which may compromise sports performance (Kerksick et al., 2018; Mountjoy et al., 2018). These findings are similar to the study evaluating the presence of eating disorders in Olympic gymnastics athletes that reported inadequate intake of carbohydrates, proteins, and fats, alongside calcium, iron, and potassium (Morgani & Mendes, 2011).

Importantly, the prevalence of eating disorders is higher in Brazil compared to the rest of the world (Kolar, Rodriguez, Chams, & Hoek, 2016), and this risk may be higher in female adolescents, not necessarily linked to their nutritional status (Marthendal, Shimizu, & Azevedo, 2014). We found some risk of eating disorders in 44.4%, which is similar to a recent study in high-level Greek rhythmic gymnasts (Donti, Donti, Gaspari, Pleksida, & Psychountaki, 2021). However, our result is higher than the previous study in the same region with twenty-one Rhythmic Gymnastics athletes aged between 7 and 21 that reported an occurrence of 33.33% risk of eating disorders. This risk was higher in the categories of 9- and 10-year-olds and 15-year-olds or older (Marques, Gudolle, Lehnen, Lopes, & Becker Júnior, 2007). Accordingly, the level of aesthetic and physical demands within rhythmic gymnastics is important for the risk of eating disorders in this population, which can also be influenced by the state of mood and the influence of the media (Neves, Meireles, Carvalho, Almeida, & Ferreira,

2016). Reinforcing this assumption, a study evaluating 48 rhythmic gymnastics athletes from different categories\ comparing them with 48 elementary and high school students reported the risk of eating disorders in 82% of athletes aged 10 to 14 years and in 100% of athletes aged 15 to 18 years (Vieira et al., 2009). Although these values are higher than those reported in the present study, it should be noted that there is a difference in the competitive level. In the mentioned study all athletes had at least two years of competitive practice (Vieira et al., 2009).

The risk for eating disorders is linked to the distortion of body image and body esteem (Gonçalves & Kapczinski, 2008; Vitolo, Bortolini, & Horta, 2006). The risk of body image distortion was present in 57% of the study participants. Similarly to previous studies, it indicates higher body image distortion in female athlete adolescents, and shows that body image distortion influences the risk for eating disorders and dietary habits (de Bruin, Oudejans, & Bakker, 2007; Martins, Pelegrini, Matheus, & Petroski, 2010; Neves et al., 2016; Zaccagni, Rinaldo, & Gualdi-Russo). We expanded these results using interaction and mediation analysis, demonstrating that there is an effect of body image distortion in energy adequacy, which is mediated by body esteem. Additionally, body esteem presented correlation but no significant interaction with the eating attitude as evaluated by the EAT-26, and eating attitude was no mediator of the effects of body image distortion in the energy adequacy. Also, correlations were found between energy adequacy, nutritional status and the risk of eating disorders, and body image distortion. We confirmed previous studies in young students where dissatisfaction with thinness was associated with nutritional status only among women (Bosi, Luiz, Morgado, Costa, & Carvalho, 2006; L. P. R. d. Silva et al., 2019; Torstveit, Rosenvinge, & Sundgot-Borgen, 2008) and confirmed that body esteem may

influence dietary habits, potentially leading to restrictions (de Bruin et al., 2007).

Some limitations of our study should be considered: The sampling method was non-probabilistic, and no prior power analysis was conducted. In addition, due to the pandemic restrictions to conduct anthropometric evaluation and the fact that some athletes changed cities (due to home training and limited access to training facilities at the time), we opted to use the reported height and weight of the last evaluation made by their club. This hindered our body composition analysis. It should be noted that we conducted a detailed analysis of the dietary intake, using a reliable method, and compared it to the established guidelines. This allowed us to expand our results to reinforce the necessary focus on the eating habits of these athletes. It must be considered that the definitive diagnosis in adolescents is often hindered by the stigma associated with eating disorders. Additionally, there is the possibility of manipulating responses, failing to mention specific symptoms and delaying treatment interventions. Since female adolescents are at higher risk for eating and body image disorders regardless of their engagement in sports, our results reinforce the need for nutritional education interventions in female adolescents and practitioners of rhythmic gymnastics and highlight the importance of a multidisciplinary approach with an aim to increase awareness and prevent possible eating disorders in this scenario.

CONCLUSION

Rhythmic gymnastics has its own specific requirements. The present study identified that 44.4% of the athletes were at risk of eating disorders and 61.1% had some degree of body image distortion. In addition, we showed that body image distortion and the risk of eating disorders are correlated with the energy consumption in this population. Also, the high intake of cholesterol, together with insufficient

intake of sodium, calcium, dietary fibres, and carbohydrate per kilogram could impact sports performance and health. Our results expand current literature, while at the same time reinforce the importance of a multidisciplinary approach with an aim to increase awareness and prevent possible eating disorders in this population.

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Corresponding author:

Randhall Bruce Carteri

Affiliations: Centro Universitário Metodista - IPA, Porto Alegre, RS, Brazil. Universidade Católica de Pelotas, Pelotas, RS, Brazil.

ORCID: <http://orcid.org/0000-0003-4124-9470>

Email: rcarteri@outlook.com

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