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The influence of social networks within sports teams on athletes' eating and exercise psychopathology: A longitudinal study

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Abstract

Teammates have been found to have an impact on athletes' eating and exercise psychopathology via multiple influence mechanisms (e.g., modelling, making critical comments). However, far less is known about the role of the team social network (i.e. the pattern and strength of relationships between teammates). This novel longitudinal study aimed to explore how athletes' eating and exercise psychopathology becomes more (convergence) or less (divergence) similar to their teammates' over time and to explore how this varies for male and female athletes. A second aim was to identify the role of team social network variables (e.g., popularity) in determining individuals' levels of eating and exercise psychopathology. Athletes (N=199, mean age 18 years, *n*=123 female) from 20 teams/training groups completed a survey regarding their teammate relationships and eating/exercise psychopathology (Eating Disorder Inventory-2; Athlete Compulsive Exercise Test) at three time points over a 7-month period. Significant interaction effects between time and gender were noted for athlete team variability in eating and exercise psychopathology, where both convergence and divergence of eating and exercise psychopathology was evident. In addition, being well connected to teammates, acting as the bridge between groups of teammates or being part of a cohesive team were longitudinally associated with *reduced* exercise psychopathology. Disordered eating and exercise prevention strategies should look to harness the behavioural convergence effect demonstrated here, by encouraging healthy eating/exercise practices among teammates. Furthermore, coaches should foster cohesive teammate relationships and be aware of how an athlete's social positioning within their team may affect their susceptibility to exercise psychopathology.

Key words: Social Network Analysis, Peer Influence, Disordered Eating, Compulsive Exercise, Athlete, Team.

Introduction

Meta-analyses have identified athletes to be at a higher risk of eating and exercise psychopathology compared to non-athletic populations (Chapman & Woodman, 2016; Smolak, Murnen, & Ruble, 2000) and more likely to participate in a broad range of risky weight control strategies (e.g., excessive exercise, bingeing; Sundgot-Borgen & Torstveit, 2010). For female athletes, estimates of disordered eating attitudes (e.g., unhealthy pre-occupation with food/weight, feeling guilty/ashamed after eating) and behaviours (e.g., obsessive calorie counting, food restriction, laxative/diuretic use, self-induced vomiting, frequently skipping meals) range between 18-45% (e.g., Anderson & Petrie, 2012; Martinsen et al., 2010; Nichols et al., 2007). Estimates are generally lower in male athletes at around 10-20% (Petrie et al., 2007; Rosendahl et al., 2009), but still typically higher than in non-athletic males (Croll, Neumark-Sztainer, Story, & Ireland, 2002; Hilbert, De Zwaan, & Braehler, 2012). With regard to disordered *exercise* attitudes and behaviours, prevalence rates have been found to vary widely in athletic populations (1.4-17%, Cook et al., 2013; Lichtenstein & Jensen, 2016; Maselli, Gobbi, Probst, & Carraro, 2019; Mayolas-Pi et al., 2017), but a recent systematic review indicated that the prevalence is generally higher in comparison to non-athletic populations (i.e., 6-9% vs 3-7%; Marques et al., 2019).

Pressures from athletes' teammates or training group peers may play an integral role in the development and maintenance of athletes' eating/exercise psychopathology via the endorsement of a particular body shape (e.g., lean, muscular, thin) coupled with direct (e.g., critical comments about weight/body shape; Muscat & Long, 2008, encouragement/discouragement of healthy eating; Scott, Haycraft, & Plateau, 2019a) and indirect pressures (e.g., modelling of teammates' disordered eating; Engel et al., 2003; Scott et al., 2019a) to diet (Filaire, Rouveix, Pannafieux, & Ferrand, 2007). Indeed, with regard to disordered *eating* attitudes and behaviours, a recent systematic review (Scott, Haycraft, &

Plateau, 2019b) revealed teammates to have both a negative and protective impact. For example, observing and modelling teammates' disordered eating behaviours is linked with increases in athlete disordered eating practices (Greenleaf, Petrie, Reel, & Carter, 2010; Petrie et al., 2007; Scott et al., 2019a; Scott, Plateau, & Haycraft, 2020), whereas providing teammates with anti-dieting advice and having supportive teammate friendships have been identified as protective against disordered eating practices (Kroshus, Kubzansky, Goldman, & Austin, 2015; Scott et al., 2019a, 2020; Smith & Ogle, 2006).

To date, research investigating the impact of teammates on athletes' eating and exercise psychopathology has focused on the potential *mechanisms* by which teammates can be influential (e.g., via modelling of disordered weight control behaviours). What has yet to be ascertained, however, is how the athletes' team social network (i.e., the inter-dependent relationships between athletes within a particular team which provides the potential for social influence; Abbott, 1997) might impact on their eating and exercise psychopathology.

Social Network Analysis is a theory and analytic tool that focuses on the "relationships among social entities, and on the patterns and implications of these relationships" (Wasserman & Faust, 1994, p.3). It has been widely used for quantitatively examining the effects of social influences on pathological behaviours in social groups (e.g., Borgatti, Mehra, Brass, & Labianca, 2009; Burt, Kilduff, & Tasselli, 2013). Despite the fact that sports teams are highly suited to social network investigations, as they comprise a complete social network (a bounded, well-defined group of inter-dependent individuals), the approach is only recently gaining traction among athlete groups (Lusher, Robins, & Kremer, 2010).

Notably, Social Network Analysis enables the generation of social network variables for each individual within a particular network (Wasserman & Faust, 1994). Such network variables include measures of popularity (the proportion of people in a social network that report they are friends with an individual), the ability to influence people (influential individuals are those central to the social network and well connected to others) and control the flow of information (Marsden, 2002). Furthermore, characteristics of the social network as a whole can also be investigated. For example, network density is a measure of how cohesive a social network is - the higher the network density the more likely group conformity will occur (Granovetter, 1973; Krackhardt & Hanson, 1993). The relationships between social network variables and behavioural outcomes can be investigated to determine their impact (e.g., the association between an athlete's popularity and their subsequent disordered eating and exercise attitudes and behaviours). Indeed, an emerging body of literature in the general population has demonstrated the importance of network variables in relation to depressive symptoms (Ueno, 2005), ability to cope with stress, academic achievement, socio-economic status, blood pressure (Hansell, 1985), self-monitoring (Mehra, Kilduff, & Brass, 2001), personality traits (Clifton, Turkheimer, & Oltmanns, 2009), overweight status (Strauss & Pollack, 2003), exercise psychopathology (Patterson & Goodson, 2017), and eating psychopathology (Forney, Schwendler, & Ward, 2019). However, to the authors' knowledge, no study has prospectively investigated the associations between an athlete's positioning within their team social network and their current and subsequent eating/exercise psychopathology. Doing so could yield important findings given the high prevalence of disordered eating and exercise in this population.

In addition to testing individual network variables, a growing body of literature has employed Social Network Analysis within general population samples to understand the *spread* of attitudes and behaviours through social networks (e.g., exercise, Aral & Nicolaides, 2017; happiness, Christakis & Fowler, 2007; binge eating, Crandall, 1988). Moreland and Levine (1982) suggested that when social groups first form, group member behaviours may initially be dissimilar. However, as social pressures are exerted upon group members to behave in a particular way, group members' similarity of behaviours and cohesion tend to increase over time. Investigations into the changes in eating psychopathology among female university students sharing accommodation indicate some discrepant findings. For example, Crandall (1988) found an *increased* similarity over time (convergence) for binge eating, whereas Meyer and Waller (2001) found a convergence for restrictive attitudes and body concerns but a divergence (*decreased* similarity over time) for bulimic tendencies. To date, however, no study has assessed the spread of eating/exercise psychopathology among sports teams or indeed in any male social networks (where the effect of peer influence has been demonstrated to be weaker in comparison to females; Yakusheva, Kapinos, & Eisenberg, 2014) over time. Therefore, further investigation is warranted which explores gender differences in the convergence/divergence of eating and exercise psychopathology among sports teams.

Given the high prevalence of eating/exercise psychopathology in athletes, and the strong influences (e.g., via modelling, anti-dieting advice) of teammates, the use of Social Network Analysis methodologies could strongly enhance the understanding of the development of eating and exercise psychopathology within sport teams. Therefore, in order to address the gaps in the literature, the present study sampled teams of female and male athletes to investigate the following aims: (1) To examine whether athletes' levels of eating/exercise psychopathology become more (convergence) or less (divergence) similar to the levels of their teammates over time, and to explore whether these changes differ for male and female athletes, and (2) To determine the predictive power of prospective relationships between team social network variables and athletes' eating/exercise psychopathology. We hypothesised that athletes' levels of eating/exercise psychopathology would become more similar to their teammates' over time and that this would be more evident for female athletes. In addition, we hypothesised that an athlete's positioning within their team social network would prospectively predict their eating and exercise psychopathology. Specifically, having fewer, poorer quality connections and being more peripheral to the network was hypothesised to be linked to higher levels of eating and exercise psychopathology over time.

Method

Study design

The present study adopted a three-wave longitudinal design. All three waves of data at the network level were analysed to investigate the first study aim, while only waves two and three of data at the individual level were used to investigate the second aim. The "strengthening the reporting of observational studies in epidemiology" guidelines were adhered to (STROBE; Von Elm et al., 2014).

Participants

Data was collected from athletes who were members of sports clubs in the Midlands region of the UK. In order to facilitate recruitment, the relevant gatekeeper (e.g., coach, club chairperson) was approached directly via email and sent an information sheet outlining the purpose and procedure for the study and inviting the athletes in their team/training group to take part. To be eligible to take part, participants were required to be actively training for and/or competing in a sport and at least 15 years old. Once gatekeepers had confirmed they were happy for their athletes to participate, the athletes themselves were then invited to take part. Following gatekeeper approval, very few athletes declined the invitation to take part (response rate: 95%). In total, 388 participants completed the survey at T1, 351 participated again at T2 (an average of 3.75 (SD=0.28) months later), and 218 participated again at T3 (an average of 7.4 (SD=0.54) months after T1). A total of 170 athletes were lost to follow up/excluded as they no longer trained with the team, resulting in a retention rate of 56%. Of the 218 athletes who participated at all three time points, 19 were excluded as they were not deemed to be part of a cohesive friendship group within the team (n=6 reported only dyadic relationships, n=5 did not report any ties, n=8 did not have any reciprocated ties). This left a final sample of 199 athletes from 20 different teams/training groups (9 all-male, 11 all-female) (see Figure 1 for a summary).

Insert Figure 1 about here

On average, teams/training groups included in the study were comprised of 10 athletes (range: 5-17). Sixty-two percent of athletes were female (*n*=123) and 85% were of White ethnicity (*n*=169). Participants had a mean age of 18.38 years (SD=2.70) and a mean BMI of 21.68 kg/m^2 (SD=2.51). Athletes under 18 years (53%) reported competing with their club or school, while athletes aged 18 or over (47%) reported competing with their university sports team. With regard to competitive level, 21% reported competing at the elite level (national/international). Sixty-three percent (*n*=126) participated in lean sports (e.g., aesthetic, endurance, weight-class; as defined by Sundgot-Borgen & Larsen, 1993) and the remaining 37% (*n*=73) competed in non-lean sports (e.g., ball-game, power, technical). At baseline (T1), the athletes had been a member of their current team/training group for an average of 2.10 years (SD=2.65) and trained an average of 5.45 hours (SD=3.06) per week. Outside of training/competing, athletes spent an average of 8.74 (SD=11.47) additional hours in the company of their teammates (or training group mates for those competing in individual sports; *n*=16) and reported that their friendships with their teammates made up an average of 40.3% (SD=21.57) of their total friendships.

Procedure

Ethical approval for this study was granted by the Institutional Ethics Approvals (Human Participants) Sub-Committee. Prior to the commencement of data collection, parental consent was obtained for athletes under 18. At baseline (T1; October 2017), athletes aged 18 and over provided their written informed consent and those under 18 provided their verbal assent before completing the study questionnaires either before or after a training session. Athletes aged 18 and over provided their email address at T1 and were then emailed a link to an online version of the survey to complete at T2 (February 2018) and again at T3 (May 2018), while athletes under 18 completed T2 and T3 questionnaires in person, before or after a training session. At all three time points, participants were reminded of their anonymity and rights to withdraw from the study at any time.

Measures

Demographics and social network. At baseline, participants first provided information about their involvement with sport as well as their age, gender, ethnicity, English language status, and self-reported weight and height (for a BMI calculation). To gather sociocentric network data (i.e., data from members of a specified network), each athlete was asked to list up to 10 of their closest teammates and a 10cm visual analogue scale was used for participants to rate how close they were to each listed teammate from reasonably close friends (1) to extremely close friends (10). At each time point, the social network data was collected to allow the stability of relationship closeness to be established. Participants then completed the following two questionnaires in order of presentation.

Eating Disorder Inventory-2 (EDI-2; Garner, 1991). The EDI-2 assesses eating psychopathology and has been demonstrated as reliable and valid for use with athlete populations (e.g., Nagel, Black, Leverenz, & Coster, 2000; Plessow et al., 2018). For the current study, only the three subscales comprising the EDI short form were used: (1) Drive for Thinness (EDI-DT, 7 items, e.g., "I think about dieting"); (2) Bulimia (EDI-BUL; 7 items, e.g., "I think about bingeing (overeating)"); and (3) Body Dissatisfaction (EDI-BD; 9 items, e.g., "I think that my stomach is too big"). Participants responded on a 6-point Likert scale ranging from "never" to "always" and responses were totalled for each subscale. Higher scores indicate greater levels of disordered eating attitudes and behaviours. For all three time points, internal consistency was acceptable/good for EDI-DT (α=0.76-0.86), good for EDI-BD (α=0.84-0.86) and questionable/acceptable for EDI-BUL (α=0.67-0.72) which is on par with previous athlete samples (e.g., Scott et al., 2019a).

Compulsive Exercise Test - Athlete version (CET-A; Plateau et al., 2014). The CET-A assesses levels of exercise psychopathology and has been validated for use with athlete populations (Plateau et al., 2014). Participants used a 6-point Likert scale (0="never true; 5="always true") to respond to 15 questions comprising three different subscales: (1) avoidance of negative affect (CET-Avoidance; 6 items, e.g., "If I cannot exercise I feel angry and/or frustrated"); (2) mood improvement (CET-Mood Improvement; 5 items, e.g., "I feel happier and/or more positive after I exercise"); and (3) weight control (CET-Weight Control; 4 items, e.g., "I exercise to burn calories and to lose weight"). Responses are averaged for each subscale and higher scores indicate greater levels of compulsive exercise attitudes and behaviours. For all three time points, internal consistency was good/excellent for CET-Avoidance (α=0.88-0.93), excellent for CET-Mood Improvement (α=0.90-0.94), and good for CET-Weight Control (α=0.83-0.87), in line with previous research employing athlete populations (Madigan, Stoeber, & Passfield, 2017).

Data Analysis

Preliminary analysis. Participants were only included in the analyses if they had completed all three time points, therefore, there were very few instances of missing data. Where this did occur, the individual's mean for the particular subscale was imputed (van Buuren, 2012). Shapiro-Wilk tests indicated that very few of the variables were normally distributed, therefore, non-parametric tests were employed where possible. Spearman's two-tailed correlations were conducted between eating/exercise psychopathology variables and age and BMI at T1 (as age and BMI are known to increase the risk of eating psychopathology, e.g., Neumark-Sztainer et al., 2002). Age significantly correlated with all CET subscales ($p \leq 0.05$) and BMI significantly correlated with EDI-Body Dissatisfaction and CET-Weight control ($p \leq 0.05$). Therefore, these variables were controlled for in subsequent analyses, where appropriate.

From T1 to T2, a Wilcoxon T test revealed that athletes reported becoming significantly closer to their teammates (T1 mean closeness=5.71, (SD=1.95); T2 mean closeness=6.17; (SD=1.59) (Z=4.02, $p<0.001$, $r=0.28$), while from T2 to T3, teammate closeness did not significantly increase, indicating stability. Therefore, only T2 social network variables were subsequently used in analysis. Network data taken at T2 (i.e., the list of teammates an athlete has indicated they are friends with) for each athlete were combined into a square sociomatrix on a team by team basis using UCINET software (Borgatti, Everett, & Freeman, 2002). The sociomatrix data was then employed by Netdraw (UCINET plug in; Borgatti, 2002) to create a visualisation (sociogram) of the directed ties between athletes for each team (for an example, see Figure 2). Social network variables were derived for each athlete using the sociogram and then entered into IBM SPSS (version 24.0) for the primary analysis. The following social network variables were calculated.

Eigenvector centrality. This is an index of how well connected an athlete is to teammates that are themselves well connected. A higher level of eigenvector centrality is indicative of athletes who are in a higher position of influence in their team (Borgatti, Everett, & Johnson, 2013; Valente, 2010).

Betweenness centrality. This works on the premise that some athletes in a team are central to a team's social network (e.g., captain) whereas other athletes are more on the fringe of the network (e.g., newcomers to the team). In a team social network, not all athletes would consider themselves well acquainted with each other, however, some may be connected indirectly via a mutual friend (Freeman, 1978). Higher levels of betweenness centrality reflect athletes who indirectly connect two teammates and are key to the flow of information between subgroups within the team.

Closeness centrality. Closeness is an inverse measure of centrality and assesses the degree to which an individual is close to all other individuals in a network. The higher an athlete measures on closeness centrality, the greater their distance from the centre of the network (i.e., the more peripheral they are; Borgatti et al., 2013).

Network density. A measure of network density (Granovetter, 1973) was computed on a team by team basis using the cohesion function in UCINET. Network density refers to the proportion of *potential ties* in a network that are *actual ties*, and ranges from 0-100%. A potential tie is a tie that could potentially exist between two athletes regardless of whether or not it actually does. Highly dense cohesive networks (e.g., Figure 2) are those in which athletes report having many ties between teammates and where conformity to group norms is more likely to occur (Krackhardt & Hanson, 1993). Given that athletes were only allowed to list up to 10 of their closest teammates, teams with 12 or more athletes were excluded from this analysis (*n*=3 female teams, *n*=48 athletes) as all potential ties could not be identified.

Insert Figure 2 about here

Popularity. A measure of popularity was calculated manually for each athlete using Crandall's (1988) "percentage choice" formula. In this study, this was the percentage of athletes in a team reporting a tie with an athlete (percentage choice, peer-reported measure of friendship), divided by the mean percentage choice score for all of the athletes in the team. Numbers less than 1 indicate an athlete is less popular than average.

Primary analysis. To address the first aim, and to explore whether team variance (the range of scores in a team) in eating and exercise psychopathology change over time, and to evaluate the presence of gender differences, a series of repeated measures ANOVAs were conducted. Where sphericity assumptions were violated, Greenhouse-Geisser corrections were employed. The grouping variables were gender (male, female) and time (timepoint 1, 2, 3), and the outcome variables were eating and exercise psychopathology. Significant interaction effects were followed up with tests of simple main effects and pairwise comparisons to explore gender differences in team variance at each of the three time points.

To address the first part of the second aim, a series of two-tailed Spearman's partial correlations were conducted (controlling for gender) to explore the relationships between T2 social network variables with T3 eating and exercise outcomes. To address the second part of this aim, multiple stepwise regressions were conducted, controlling for gender, age/BMI covariates (where appropriate) and T2 outcomes. This was to investigate which social network variables at T2 were the best longitudinal predictors of eating and exercise psychopathology outcome variables at T3. An alpha value of $p \leq 0.05$ was employed for all analyses, given the exploratory nature of this research.

Results

Participants

For the majority of athletes, T1 occurred during their pre-season (88%), T2 occurred during their mid-season (89%) and T3 occurred during their post-season (75%). Comparison of the included athletes and excluded athletes/non-completers revealed no significant differences on any demographic or eating and exercise variables at T1. Most athletes in the sample (80%, n=159) reported close relationships with seven or fewer of their teammates; only 5% (n=10) reported having 10 close friendships with teammates. Descriptive statistics for participant characteristics, eating and exercise psychopathology at T1 and social network variables at T2 are presented in Table 1. Participants' mean scores on the eating and exercise measures were comparable to previous research with athlete populations (e.g., Plateau et al., 2014; Reinking & Alexander, 2005).

Insert Table 1 about here

ANOVA Analysis: Assessing Gender Differences in Change in Team Variance of Eating and Exercise Psychopathology from T1 to T2 to T3

Means and SDs for variance in eating and exercise psychopathology at the team level are reported across the three time points for both males and females in Table 2. To address the first aim, a series of 2 (gender) x 3 (time) mixed ANOVAS were conducted.

Significant gender x time interaction effects were identified for all eating and exercise psychopathology outcome variables (F (1,197) ≥4.87, p≤0.01, np^2 ≥0.02) aside from team variance in EDI-Bulimia (Table 2). In this instance, for all athletes, team variance in EDI-Bulimia increased significantly from T1-T2 (p=0.04, d=0.21) then decreased significantly from T2-T3 (p=0.01, d=0.21).

Insert Table 2 about here

Simple main effects analysis and follow up pairwise comparisons (sidak corrected) were conducted for each of the five variables with significant interaction effects. See Table 2 and Figures 3A-3E.

Eating psychopathology. For EDI-Drive for Thinness (Figure 3A) and EDI-Body Dissatisfaction (Figure 3B), pairwise comparisons revealed that male team variance stayed constant from T1 to T3. However, for females, team variance in EDI-Drive for Thinness (p<0.001, d=0.55) and EDI-Body Dissatisfaction (p=0.05, d=0.23) significantly increased from T1 to T2. Female team variance then remained constant from T2 to T3 for EDI-Drive for Thinness but reduced for EDI-Body dissatisfaction (p<0.001, d=0.77).

Exercise psychopathology. For all CET subscales (Figures 3C-E), pairwise comparisons revealed that male team variance *decreased* from T1 to T2 (CET-Avoidance; p=0.03, d=0.30; CET-Mood Improvement, p<0.001, d=0.92; CET-Weight Control; p<0.001, d=0.94), then *increased* from T2 to T3 (CET-Avoidance; p=0.01, d=0.42; CET-Mood Improvement, p=0.001, d=0.44, CET-Weight Control, p<0.001, d=0.73). In contrast, for female teams, variance *increased* from T1 to T2 for CET-Avoidance (p=0.05, d=0.24) and CET-Mood Improvement (p=0.05, d=0.37) then remained constant from T2 to T3. However, female team variance in CET-Weight Control remained constant from T1 to T2 but reduced from T2-T3 (p<0.001, d=0.48).

**Insert Figure 3 about here **

Correlation Analysis: Examining the Associations Between Social Network Variables at T2 and Individual Athletes' Eating and Exercise Psychopathology at T3

To test the first part of the second aim, Spearman's partial correlation analysis was conducted, controlling for gender given the imbalanced male and female sample sizes (Table 3). This explored whether significant associations existed between demographic variables, social network variables at T2 and individual athletes' levels of eating/exercise psychopathology variables at T3.

There was a small, significant association between well-connected and more influential athletes (high eigenvector centrality) at T2 with *lower* levels of CET-Weight Control at T3. In addition, the stronger the team network density (cohesiveness) at T2, the *lower* the levels of CET-Mood Improvement at T3 (small effect size).

For the covariates, older age was significantly associated with a reduced network density and increased EDI-Body Dissatisfaction and all CET subscales (small-medium effect sizes), while BMI was significantly, positively associated with EDI-Drive for Thinness, EDI-Body Dissatisfaction and CET-Weight Control (small-medium effect sizes). Numerous significant inter-relationships were found for the social network variables, as shown in Table 3.

Insert Table 3 about here

Regression Analysis: Assessing the Predictive Role of Social Network Variables at T2 on Individual Athletes' Eating and Exercise Psychopathology at T3

To test the second part of the second aim, a regression analysis explored which demographic variables (gender, age, BMI) and social network variables at T2 were the best statistical predictors of individual athletes' eating and exercise psychopathology at T3. In order to preserve power, the network density variable was excluded and regression analyses were conducted for the whole sample rather than by gender, due to the smaller sample size of male athletes than female athletes within the study. Gender, age and BMI (where appropriate), closeness centrality, eigenvector centrality, betweenness centrality and popularity were entered together into stepwise regressions to assess which were the best longitudinal predictors of eating and exercise psychopathology variables at T3. To determine whether T2 social network variables explain variance in T3 outcomes beyond any variance explained by the T2 outcome variables, the relevant T2 outcome variable was controlled for in each regression.

Only one regression model was significant. After accounting for the variance explained by T2 CET-Avoidance (Model 1: F (1,198)=186.76, Adj R^2=0.48, p<0.001; T2 CET-Avoidance β=0.70, p<0.001), Betweeness Centrality was a significant longitudinal predictor of T3 CET-Avoidance (Model 2: $F(1,198)=99.20$, Adj $R^2=0.50$, $p<0.001$, T2 CET-Avoidance $\beta=0.70$, $p<0.001$, Betweeness Centrality $\beta=-0.13$, $p=0.01$). Well-connected athletes at T2 (i.e., those who indirectly connect two groups of teammates and are key to the flow of information) were less likely to engage in exercise to avoid negative emotions at T3.

Discussion

This novel social network analysis study first aimed to investigate whether athletes' levels of eating/exercise psychopathology became more (convergence) or less (divergence) similar to the levels of their teammates over time, and to explore whether these changes differed for male and female athletes. A second aim was to determine the predictive power of relationships between team social network variables and athletes' eating/exercise psychopathology. The study's hypotheses were partially supported.

For male athletes, team variance in eating psychopathology generally remained constant across the athletic season. This is in line with Shriver, Betts, and Payton (2009) who have demonstrated stability of male athletes' disordered eating behaviours at the individual level across a similar time frame. In contrast, for female athletes, team variance in eating psychopathology generally increased from baseline to time 2 (indicating divergence), then reduced from time 2 to time 3 (indicating convergence); a pattern observed to a lesser degree in relation to female team variance in *exercise* psychopathology. These novel findings contrast with those from Meyer and Waller (2001) who found variance in drive for thinness and body dissatisfaction among female student flatmates initially converged after 10 weeks then diverged in the following 14 weeks, while bulimic tendencies consistently diverged over time. They argued that these findings are consistent with social identity theory (Tajfel, 1978), where socially validated behaviours (among females) converge (i.e., restriction, body dissatisfaction) and less socially valued behaviours (i.e., bulimic tendencies) diverge.

A plausible explanation for findings in the current study could be related to the sample and context of the time points employed. For the majority of athletes, the study's three time points occurred during their pre-season (T1), mid-season (T2) and post-season (T3). As an athlete transitions from pre-season to midseason, this can be associated with a significant increase in training load/competition frequency, stress (Hyatt & Kavazis, 2019), risk of burnout (Cresswell & Eklund, 2007), and pressure to achieve the ideal physique for their sport (de Bruin & Oudejans, 2018). Evidence suggests that more experienced athletes may be better equipped to deal with such pressures and have *reduced* disordered eating in comparison to their less experienced counterparts (DiBartolo & Shaffer, 2002). On the other hand, some athletes may struggle to deal with competition pressures and/or may be driven to reduce their body weight for performance purposes (e.g., cheerleading flyers, SooHoo, Reel, & Pearce, 2011), thus *increasing* the likelihood that they will engage in disordered eating. Such individual athlete differences may contribute to the increases in eating psychopathology team variance identified at a high-pressure stage of the season. In line with this, towards the end of their season, certain athletes may experience *less* pressure to engage in disordered eating (Thompson, Petrie, & Anderson, 2017), which may contribute to the more consistent levels of disordered eating within teams identified.

Interestingly, with regard to exercise psychopathology, the opposite pattern of findings was identified for male athletes; compulsive exercise attitudes among team members generally grew more similar (converged) from pre-season to mid-season, then became less similar (diverged) from the mid-season to post-season. This mirrors findings from male wrestlers demonstrating a high prevalence of compulsive exercise attitudes during the pre-season (60%), which reduced during the mid-season (40%) and increased again during the post season (47%) (Shriver, Betts, & Payton, 2009). It is widely established that exercise is a socially valued behaviour (more so than dieting; Johnston, Reilly, & Kremer, 2011;

Wiseman, Gray, Mosimann, & Ahrens, 1992), especially in sport settings (Lichtenstein, Emborg, Hemmingsen, & Hansen, 2017). In line with this, strong training session attendance and commitment to training are likely to be highly valued within a sports team, particularly during the competitive season. The increased similarity of compulsive exercise attitudes demonstrated in the present study is therefore consistent with social identity theory (Tajfel, 1978) and previous literature which has found convergence of socially valued attitudes and behaviours (Meyer & Waller, 2001).

It is also noteworthy that gender differences in team variance were observed. When compared to male teams, the range of scores in female teams (team variance) was higher for eating psychopathology and exercise to control weight, while team variance in exercise to improve mood was generally higher for males. It is possible that such gender differences could be accounted for by differences in the size of male and female teams sampled (i.e., female teams were generally larger). Furthermore, a high team variance in eating psychopathology has been demonstrated previously by (Kroshus et al., 2015) and may stem from the fact that female athletes perceive high levels of sociocultural pressure to be thin, (Bryne & McLean, 2002), which may differentially impact upon their disordered eating and weight control exercise engagement. Coaches and sport professionals need to be aware that at particular stages of the season, female athletes in particular may be more likely to depart from the norms of the team and adopt disordered weight control behaviours. In a bid to promote healthy team norms around both eating and exercise, intervention strategies may benefit from harnessing the behavioural convergence effect demonstrated. For example, influential athletes (e.g., captain) could be encouraged to model healthy eating and exercise behaviours.

The present study also aimed to explore associations between, and the predictive ability of, a variety of social network variables and athletes' eating and exercise psychopathology. Overall, our novel findings suggest that an athlete's positioning with their team social network is positively related to their exercise psychopathology. Specifically, being friends with teammates who are themselves well connected, being an individual who connects two groups of teammates and being part of a highly cohesive team may protect against engagement in problematic exercise.

In direct contrast to the present study which found that being well connected to other individuals was related to *reduced* exercise for weight control, Patterson and Goodson (2017) found that being well connected to other individuals (i.e., being central to the social network) was related to *increased* exercise for weight control. Again, a plausible reason for this discrepancy could be due to the nature of the samples assessed. Popular, well connected sorority sisters appear to be those with the highest levels of disordered eating behaviours and a BMI in the low-normal range (Becker, Stojeck, Clifton, & Millier, 2018; Crandall, 1988). It therefore follows that members of a sorority connected to popular sisters may be at an increased risk of engaging in disordered weight control behaviours themselves (i.e., via modelling). However, popularity in an athletic context may be more related to sport related attributes such as being competent or a good team player as opposed to being a particular weight (Fleming et al., 2005). Coaches and sport professionals should be alerted to the negative consequences of having incohesive teams (i.e., with some athletes left out of the social group), and ensure they are fostering supportive teammate relationships which may protect against athletes' engagement with disordered weight control behaviours (Scott et al., 2019a, 2020).

The present study is the first of its kind to assess the importance of the team social network and group dynamics in relation to athletes' eating and exercise psychopathology. The longitudinal design used here affords the ability to assess the convergence/divergence of athletes' behaviour to their teammates' over time, addressing the limitations of crosssectional designs which simply provide a snapshot of behaviour. Likewise, with a prospective design, the true temporal precedence of social network variables and eating/exercise psychopathology can be established. By sampling a population of athletes balanced for gender and sport type (e.g., lean and non-lean sports), the generalisability of findings is increased.

That said, there are some methodological limitations that could be addressed by future research. First, given the exploratory nature of this research, a *p* value of $p \leq 0.05$ was adopted. However, it is acknowledged that the large number of analyses conducted will have inflated the chances of a type 1 error. Second, athletes were permitted to list up to 10 teammates they considered themselves to be close friends with. While it is useful to set nomination limits for the sake of efficient data collection (Valente, 2010), it is possible that a small number of relationships between athletes were not captured in the teams that comprised more than 10 athletes. Third, given that athletes were only included in the final analysis if they had completed all three time points, it is possible that the true composition of the social network may have been distorted as a result of missing data. Finally, due to the diverse nature of teams sampled (i.e., from both adolescent and university student populations), athletes are likely to have experienced different training demands, proximity to their teammates, and stability of their team social network over time. Evidence suggests adolescents are highly susceptible to influences from their peers (Brechwald & Prinstein, 2011). Future research targeting teams with particular attributes (e.g., newly formed teams or those competing at the elite level) and exploring comparisons between different age groups may uncover nuances in the magnitude of convergence/divergence effects identified. Furthermore, in light of evidence suggesting that conformity is more likely to occur in groups with high network density (Granovetter, 1973; Krackhardt & Hanson, 1993), another avenue for future research is to investigate the impact of team network density on the rate of eating and exercise psychopathology team convergence.

Conclusion

In summary, the findings from this study indicate that the team social network plays an integral role in relation to athletes' eating and exercise attitudes and behaviours. Athletes' levels of eating and exercise psychopathology may become more and less similar to their teammates' behaviours over time, with factors such as the stage of the athletic season and gender likely to have an influence on the extent of convergence and divergence. Furthermore, an athlete's positioning within their team social network may protect against engagement with exercise psychopathology. Coaches should aim to foster close knit teammate friendships and utilise the behavioural convergence effect demonstrated to promote healthy eating and exercise behaviour. However, they should be aware of the potential negative impact incohesive teams may have on individual athletes' exercise behaviour. Future research would benefit from targeting teams with specific attributes (i.e., newly formed teams) and over a longer time period to confirm whether the convergence/divergence effects demonstrated are different for particular teams of athletes and consistent over several seasons.

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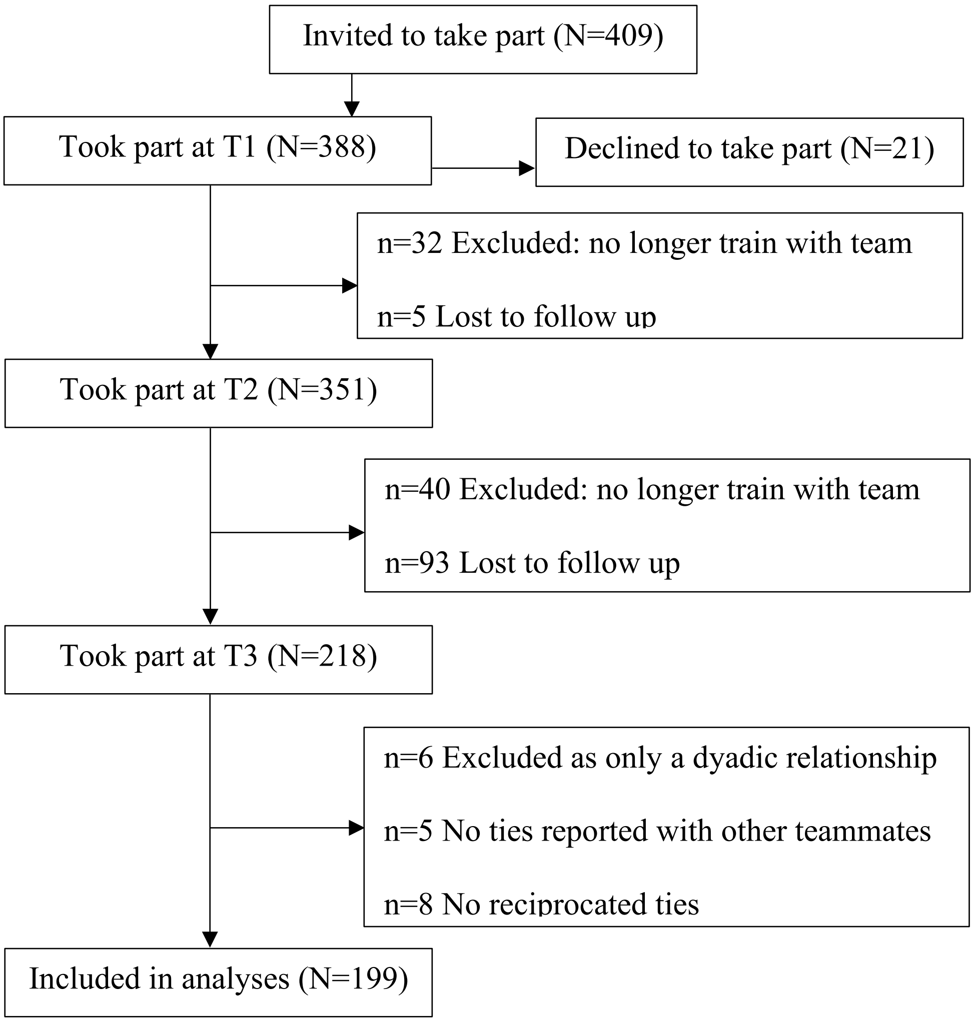

Figure 1. The flow of participants through the three waves of the study.

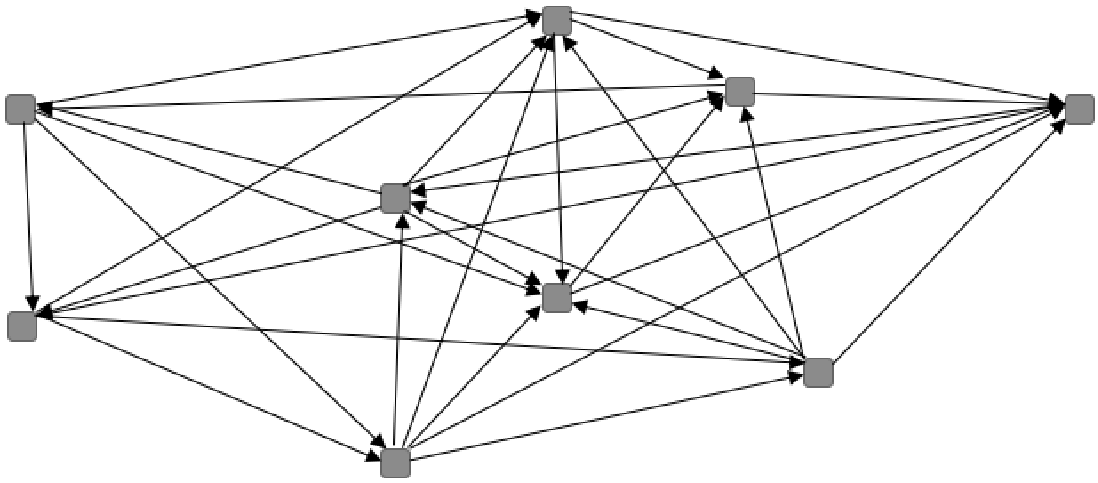

Figure 2. An example of a team sociogram created using Netdraw. Lots of ties (lines) between athletes (squares) indicate that this team has a high network density.

Table 1

Descriptive Statistics for Participant Characteristics, Eating and Exercise Psychopathology at T1 and Social Network Variables at T2.

Measure	Total sample (N=199) Mean (SD)	Females (*n*=123) Mean (SD)	Males (*n*=76) Mean (SD)
Time point 1 (T1)			
Age	18.38 (2.70)	18.35 (2.78)	18.42 (2.58)
BMI	21.68 (2.51)	21.47 (2.38)	22.02 (2.69)
Eating Disorder Inventory-2			
Drive for Thinness	1.82 (2.77)	2.39 (3.15)	0.92 (1.66)
Bulimia	1.70 (2.34)	2.12 (2.64)	1.01 (1.58)
Body Dissatisfaction	6.32 (5.42)	7.85 (5.75)	3.88 (3.78)
Compulsive Exercise Test-Athlete			
Avoidance	2.00 (1.11)	1.92 (1.09)	2.14 (1.13)
Mood Improvement	3.64 (1.16)	3.72 (1.07)	3.50 (1.28)
Weight Control	1.82 (1.21)	1.93 (1.23)	1.65 (1.15)
Time point 2 (T2)			
Eigenvector centrality	0.30 (0.11)	0.28 (0.11)	0.33 (0.10)
Betweeness centrality	2.76 (4.46)	3.51 (5.12)	1.55 (2.70)
Closeness centrality	16.05 (7.62)	18.54 (7.38)	12.01 (6.18)
Network density	0.40 (0.13	0.39 (0.13)	0.46 (0.14)
Popularity	0.97 (0.43)	0.94 (0.44)	1.02 (0.42)

Table 2.

Gender Differences in the Changes in Team Variance of Disordered Eating and Compulsive Exercise Scores from T1 to T2 to T3 (N=199).

	Time point						
	Time point 1 (T1) Mean Variance (SD)		Time point 2 (T2) Mean Variance (SD)		Time point 3 (T3) Mean Variance (SD)		Pairwise Comparisons[a]
Outcome variable	Male	Female	Male	Female	Male	Female	
Drive for Thinness	2.88 (2.98)	10.20 (9.97)	2.44 (1.41)	15.37 (13.21)	3.47 (3.42)	15.08 (17.51)	M T1=T2=T3 F T1<T2=T3
Bulimia	2.82 (2.08)	6.34 (4.63)	4.65 (4.39)	6.76 (4.99)	2.59 (1.57)	6.69 (6.66)	---[b]
Body dissatisfaction	15.26 (4.47)	33.83 (15.60)	17.17 (9.81)	37.05 (17.54)	14.16 (8.24)	26.82 (12.63)	M T1=T2=T3 F T1<T2>T3
Avoidance	1.17 (0.70)	1.08 (0.52)	1.02 (0.49)	1.19 (0.30)	1.23 (0.66)	1.17 (0.53)	M T1>T2<T3 F T1<T2=T3
Mood Improvement	1.70 (0.81)	1.18 (0.47)	1.21 (0.54)	1.39 (0.45)	1.49 (1.17)	1.33 (0.51)	M T1>T2<T3 F T1<T2=T3
Weight Control	1.28 (0.79)	1.54 (0.64)	0.70 (1.64)	1.64 (0.53)	1.08 (0.48)	1.40 (0.53)	M T1>T2<T3 F T1=T2>T3

Note. M = Male F = Female. [a] Significant differences between time points ($p<0.05$) indicated by </>; non-significant differences indicated by '='. [b] No post hoc tests as no significant interaction effect.

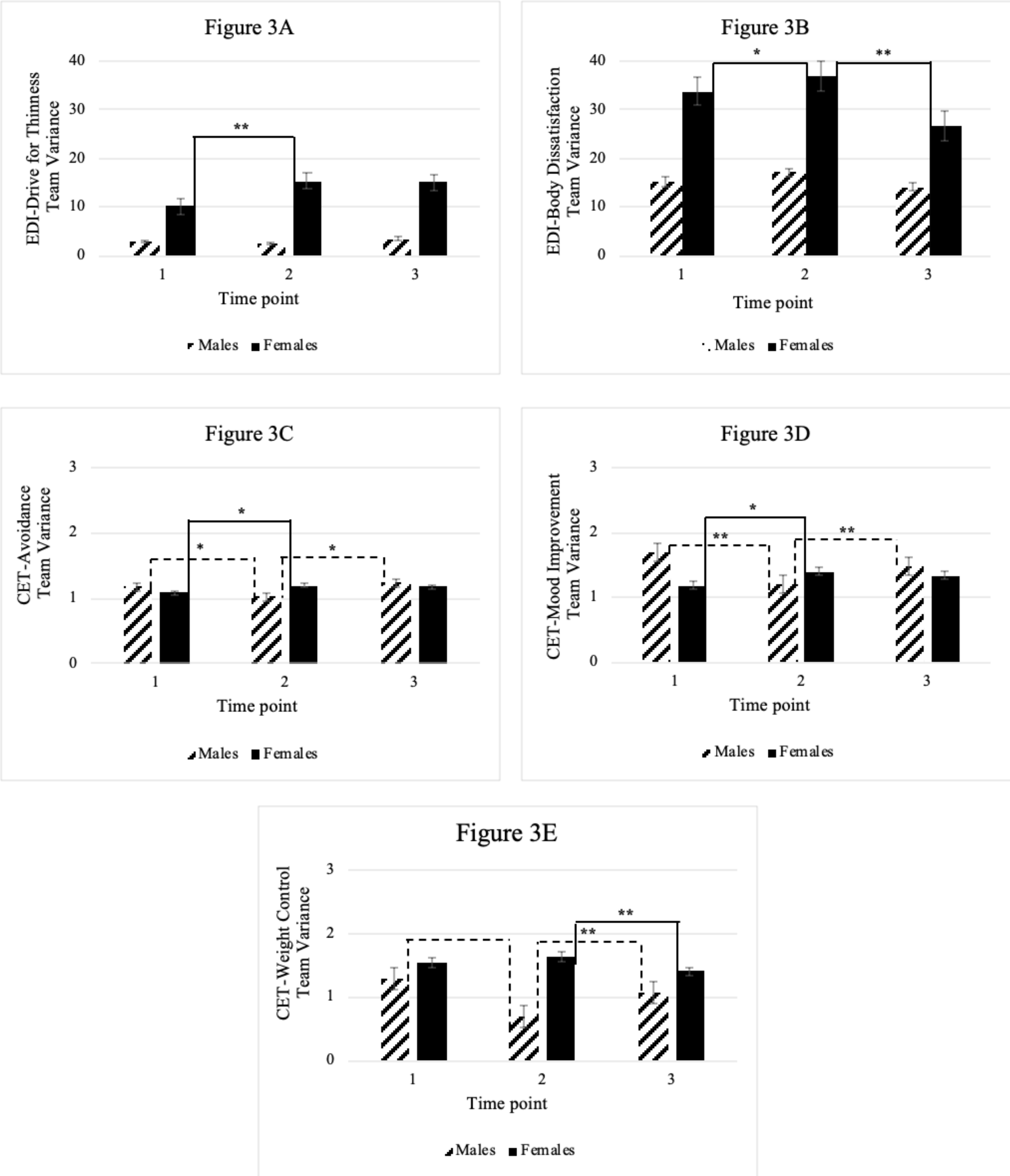

Figure 3. Bar charts to indicate change in eating and exercise psychopathology team variance across the three time points. Significant pairwise comparisons indicated by '*' = $p \leq 0.05$ and '**' = $p < 0.001$.

Table 3.

Spearman's partial correlations between demographic variables, T2 social network variables and T3 eating/exercise variables, controlling for gender (N=199).

	Eating Disorder Inventory-2 (EDI-2)						Compulsive Exercise Test-Athlete (CET-A)						Social Network Variables									
	Drive for Thinness		Bulimia		Body Dissatisfaction		Avoidance		Mood Improvement		Weight Control		Eigenvector centrality		Betweeness centrality		Closeness centrality		Network density		Popularity	
	r	*p*	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*
Age	0.14	0.06	0.11	0.14	**0.18**	**0.01**	**0.25**	**<0.001**	**0.26**	**<0.001**	**0.36**	**<0.001**	0.05	0.49	0.03	0.67	-0.13	0.06	**-0.18**	**0.03**	0.05	0.50
BMI	**0.24**	**0.001**	0.07	0.37	**0.21**	**0.003**	0.05	0.47	0.08	0.27	**0.25**	**<0.001**	-0.08	0.26	-0.02	0.81	-0.01	0.90	-0.11	0.19	-0.003	0.97
Eigenvector centrality	-0.02	0.76	-0.07	0.36	0.02	0.78	-0.02	0.74	-0.05	0.45	**-0.15**	**0.04**	**-**		0.07	0.36	**-0.74**	**<0.001**	**0.37**	**<0.001**	**0.52**	**<0.001**
Betweeness centrality	0.01	0.90	0.08	0.25	-0.08	0.27	-0.06	0.43	0.10	0.17	-0.04	0.62			-		**0.29**	**<0.001**	**-0.37**	**<0.001**	**0.36**	**<0.001**
Closeness centrality	0.01	0.93	0.01	0.88	0.03	0.67	-0.05	0.46	0.01	0.88	0.13	0.07					-		**-0.69**	**<0.001**	**-0.22**	**0.002**
Network density (*n*=148)	0.01	0.92	-0.04	0.62	-0.03	0.69	0.04	0.61	**-0.19**	**0.02**	-0.10	0.22							-		0.01	0.93
Popularity	-0.05	0.52	-0.03	0.71	0.02	0.83	-0.06	0.39	0.01	0.92	-0.05	0.48									-	

Note. Significant associations are highlighted in bold