

ORIGINAL PAPER

# WEIGHT-RELATED BEHAVIOURS IN BAHRAINI ADOLESCENT FRIENDSHIP NETWORKS: EXPLORING THE MODERATING ROLE OF FRIENDSHIP NETWORK PROPERTIES

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Received 14 May 2020, Accepted 02 Aug 2020

<https://doi.org/10.31688/ABMU.2020.55.3.03>

## ABSTRACT

**Introduction.** Much of the research in obesity has explored the role of social networks in promoting health through social influence and selection. However, little research has examined how social networks themselves could condition health behaviours. Research began to address more detailed questions regarding peer socialization process and network properties. One of the key questions is whether behaviour association (either peer socialization or selection) is dependent on the local network structure. Examining social network position, structure, and how they interact with behaviour provide valuable insight on how to modify these behaviours.

**The objective of the study** was to examine the moderating role of friendship network properties on the

## RÉSUMÉ

**Comportements liés au poids dans les réseaux sociaux des adolescents dans le Royaume de Bahrein: exploration du rôle modérateur des propriétés des réseaux d'amitié**

**Introduction.** Une grande partie de la recherche sur l'obésité a exploré le rôle des réseaux sociaux dans la promotion de la santé grâce à l'influence et à la sélection sociales. Cependant, peu de recherches ont examiné comment les réseaux sociaux eux-mêmes pouvaient conditionner les comportements de santé. La recherche a commencé à aborder des questions plus détaillées concernant le processus de socialisation par les pairs et les propriétés du réseau. L'une des questions clés est de savoir si l'association de comportement (socialisation ou sélection par les pairs) dépend de la

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association between individual's and friends' weight-related behaviours among adolescents.

**Materials and methods.** Methods are drawn from a set of analytical tools known as 'Social Network Analysis', which uses friendship nomination data from a complete network (socio-metric), along with reported data on diet, physical activity, sedentary behaviour, and sleep deprivation.

**Results.** A total of 673 adolescents aged between 11-15 years, from four schools in Kingdom of Bahrain, participated in this study. Findings from binary logistic regression models suggest that there are associations between adolescents and their friends' in multiple weight-related behaviours. There is also evidence for the moderating role of some network properties on these associations.

**Conclusions.** Properties of friendship network are critical in conditioning associations between individuals and their friends' weight-related behaviours. However, findings are gender specific, which has implications for gender-tailored interventions.

**Keywords:** social networks, friendship networks, diet, physical activity, sedentary behaviour.

## INTRODUCTION

Obesity represents a complex challenge for society since it is caused by a myriad of reasons including genetic, environment and behavioural factors<sup>1</sup>. Unhealthy diet, low levels of physical activity and sedentary behaviour are important factors that have contributed to the increased prevalence of obesity worldwide<sup>2</sup>, which is growing at a disturbing rate<sup>3</sup>. One of the main hypothesized reasons of the continued increase in obesity is that current interventions and preventive measures are individual targets and they lack the proper understanding of obesity in the social context or the social networks<sup>4</sup>. Thus, numerous interventions have been proposed to improve lifestyle behaviours and are often based on theories such as the Social Cognitive Theory, Health Belief Model and Theory of Planned Behaviour, which are focused on the individual level psychological determinants of behaving change<sup>5</sup>. Nonetheless, there are proofs that obesity is a social phenomenon, whereas

structure du réseau local. L'examen de la position, de la structure et de l'interaction des réseaux sociaux avec le comportement fournit des informations précieuses sur la façon de modifier ces comportements.

**L'objectif de l'étude** était d'examiner le rôle modérateur des propriétés du réseau d'amitié sur l'association des comportements liés au poids des individus et des amis chez les adolescents.

**Matériel et méthodes.** Les méthodes sont tirées d'un ensemble d'outils analytiques appelés "analyse des réseaux sociaux", qui utilisent les données de nomination d'amitié d'un réseau complet (socio-métrique), ainsi que les données rapportées sur l'alimentation, l'activité physique, le comportement sédentaire et la privation de sommeil.

**Résultats.** Au total, 673 adolescents âgés de 11 à 15 ans provenant de quatre écoles du Royaume de Bahreïn ont participé à cette étude. Les résultats des modèles de régression logistique binaire suggèrent qu'il existe des associations entre les adolescents et leurs amis dans plusieurs comportements liés au poids. Il existe également des preuves du rôle modérateur de certaines propriétés de réseau sur ces associations.

**Conclusions.** Les propriétés du réseau d'amitié sont essentielles pour conditionner les associations entre les individus et les comportements liés au poids de leurs amis. Cependant, les résultats sont spécifiques au genre, ce qui a des implications pour les interventions adaptées au genre.

**Mots-clés:** réseaux sociaux, réseaux d'amitié, alimentation, activité physique, comportement sédentaire.

a group of individuals may have the tendency to influence each other. For example, a large-scale study found that obesity spreads among family and friends like an infectious disease<sup>6</sup>, so obesity may spread in a similar manner through friendship networks<sup>7</sup>. Social transmission of weight-related behaviours is a viable explanation for the spread of obesity in friendship networks, that has been documented in the literature<sup>8,9</sup>. A better understanding of the role of friendship networks on weight-related behaviours is important in order to learn how to modify these behaviours, especially that, unlike genetics, weight-related behaviours are somewhat modifiable. Network properties and weight-related behaviours have not been examined in detail similarly to socially linked issues such as alcohol consumption, drug use, and tobacco use<sup>10-13</sup>. Brechwald and Prinstein, in 2011, had addressed more detailed questions regarding peer socialization process and network properties<sup>14</sup>; one of these questions is the role of network properties to the relationship between the individual and

his/her peers<sup>10</sup>. We find that some network properties play a moderating role on peer selection and socialization of adolescent alcohol consumption, drug use, tobacco use, aggression and delinquent behaviour<sup>10,12,13</sup>. However, the role of network properties on the socialization and selection process has not been addressed in the obesity literature and the authors feel that this an important gap in the literature that will assist in understanding how network properties interact with weight-related behaviours.

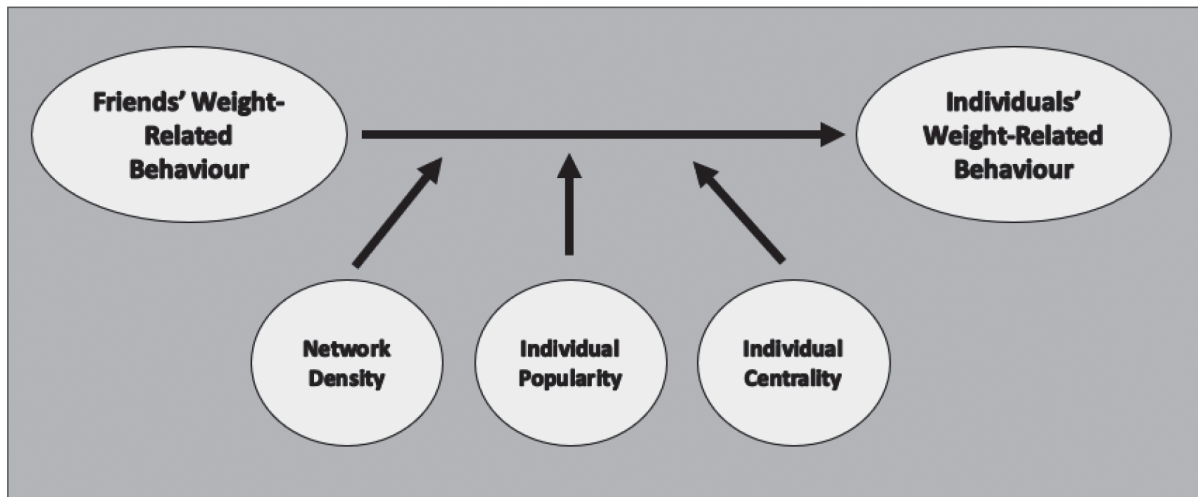
Social influence theories propose that health behaviour is influenced by the individual's social surrounding through different mechanisms including imitation, peer modelling and social learning<sup>15</sup>. Social influence or socialization among peers will result in behavioural similarity. Another potential mechanism that could explain the similarity in behaviour is peer selection or homophile<sup>14</sup>. In such case, friends are chosen based on pre-established behaviours or attitudes<sup>16</sup>. Also, it was observed that social network structure emerges as a significant factor for similarity in obesity-related behaviours<sup>17</sup>. To pinpoint the specific mechanism that could explain the similarity in behaviour is not a simple process and is the focus of a growing body of research<sup>18-20</sup>. Similarity in behaviour amongst peers whether underpinned by social influence or selection or is dictated by network structure. More detailed questions were addressed regarding how social influence and selection interact with network structure<sup>14</sup>. One of the hypotheses is that network properties act as moderators on social influence and selection<sup>10</sup>. The moderating role of some network properties on social influence and selection has been addressed on multiple behaviours among adolescents, including alcohol consumption, drug use, tobacco use, aggression and delinquent behaviour<sup>10-13</sup>. Network density was found as an important moderator on delinquency peer association, individuals were found to be more similar in delinquency to their peers in denser networks<sup>21</sup>. Popularity was also found to moderate social selection based on alcohol consumption; popular adolescents were more likely to select friends who were highest consumers of alcohol<sup>10</sup>. Individual centrality was also found to moderate the relationship between friends' generalized expectancies and youths' expectancies on smoking<sup>22</sup>. The above evidence suggests that, understanding the social dimensions of weight-related behaviours could be enhanced by exploring the underlying structural properties of friendship networks to better understand the impact of socialization and social selection on adolescent behaviour.

**THE OBJECTIVE OF THE STUDY** was to examine the moderating role of friendship network properties

(density, popularity and centrality) on the association between individual's and friends' weight-related behaviours (unhealthy diet, physical inactivity, sedentary behaviour and sleep deprivation) after reviewing the literature and analysing social network and behavioural survey data.

## **CONCEPTUAL MODEL**

Friendship network properties have been linked to weight-related behaviours; however, the network properties have not been examined in detail similarly to socially linked issues, such as alcohol consumption, drug use, and tobacco use<sup>10-13</sup>. In the past decade, research has begun to address important questions regarding network properties and their role on the relationship between egos and alters behaviours<sup>14</sup>. One of these questions is about how network properties could act as moderators on peer selection and socialization<sup>10</sup>. One potential network property that could act as a moderator is network density. Network density refers to the proportion of ties in the network<sup>23</sup>. There is evidence for adolescents' general poor health to be positively associated with network density<sup>24</sup>. Dense networks have more pathways which allows attitudes and behaviours to flow<sup>16</sup>. In highly dense networks, ideas and behaviours are easily viewed by members which helps establish a group identity or normative group behaviour among adolescents<sup>25</sup> which amplifies their influence on behaviour and norms<sup>21</sup>. A highly dense network is better able to generate trust among individuals and reinforce conformity<sup>26</sup>. Further, adolescents in dense local networks are more likely to feel a strong attachment to the group, which increases susceptibility to influence<sup>27</sup>. As a result, being part of a dense network can amplify similarity/homogeneity in weight-related behaviours and reinforce conformity among adolescents. Another potential network property that could act as a moderator is individual popularity. Popularity or in-degree refers to the number of nominations received<sup>23</sup>. Popularity was found to be positively associated with some health risk behaviours<sup>28</sup>. Popularity is thought to moderate the effects of peer influence among adolescents<sup>10</sup>. Popular adolescents are susceptible to peer influence on behaviours that are associated with high status and are accepted in the group, which suggests that the popular adolescents will change their behaviours to maintain their high status in the group<sup>29</sup>. Additionally, popular adolescents are compelled to match the behaviours of their peers to maintain their high status<sup>30</sup>. As a result, being popular can amplify similarity/homogeneity in weight-related behaviours and reinforce conformity among adolescents. Finally, individual



**Figure 1.** Conceptual model for exploring associations between friends and individuals' weight-related behaviours and the moderating role of friendship network properties.

centrality is a network property that could be a potential moderator. Centrality refers to the degree within which an individual lies on the shortest path connecting others in the network<sup>31</sup>. The centrality of an adolescent within a local group could affect their susceptibility to peer influence<sup>13</sup>, as they receive regular feedback from their group peers<sup>32</sup>. Additionally, central adolescents will have a greater attachment to the group<sup>33</sup>. This may make them more vulnerable to the influence of other members in their group<sup>13</sup>. As a result, being central can amplify similarity/homogeneity in weight-related behaviours and reinforce conformity among adolescents. The moderating role of friendship network properties on the association between individuals' weight-related behaviours and his/her friends' weight-related behaviours has not been investigated in the literature and remains an important gap. Figure 1 shows the proposed conceptual model that maps the associations between individuals and their nominated friends' weight-related behaviours and the role of friendship network properties on these associations which will be tested in this paper.

The proposed model will examine behaviour association between individuals and their nominated friends for seven different weight-related behaviours, including breakfast consumption, fast food consumption, fruit and vegetable consumption, calorie dense snack consumption, physical activity, sedentary behaviour and sleep deprivation as shown in Figure 1. The model will also examine the moderating role of three network properties, including density, popularity and centrality on the behaviour associations. The next section will present the methodology adopted in this research.

## MATERIALS AND METHODS

The research will follow a cross-sectional design; one important tool that will be implemented in this research is social network analysis, which will allow us to determine how network properties may amplify the weight-related behaviour association between friends. The research will use socio-metric networks where data from all participants (including nominated friends) will be collected. Participants will be asked to provide the names of their five closest friends in their school which will allow building the network of each individual and the complete network for every school (popularity). In this research, there will be two types of variables: 1) behavioural variables which are related to the weight-related behaviours of individuals and their friends and will act as both dependent (individual's behaviour) and independent (friends' behaviour) variables in the model; 2) network variables which are related to the friendship network properties and will act as moderators in the model. This research will follow a quantitative non-experimental approach. As a result, a survey instrument was constructed to understand the moderating role of friendship network properties on associations between the individual's weight-related behaviours and his/her friends' weight-related behaviours. Since the items were adapted from previous studies, it was unnecessary to measure instrument validity.

### Statistical analysis

Social network analysis will be paired with regression models in order to examine the moderating role of network properties on behaviour associations. Social network analysis will provide measurements of the network properties and the regression models

will be used to test the associations between the different variables. The selected potential network properties, including density, popularity and centrality will be calculated using social network analysis software UCINET 6 and converted into categorical variables to be tested as moderators for each of the weight-related behaviour association between individuals and their friends. The dependent variables (one for each of the weight-related behaviours) in this research are categorical, more specifically they are binary (outcome was either 1 or 0). Because of the categorical nature of the dependant variables, logistic regression models are suitable to measure the association between the categorical dependent variables and one or more independent variables. Gender segregated binary logistic regression models will be used to test the associations between the individual's weight-related behaviours (dependent variables) and friends' weight-related behaviours (independent variables) using SPSS version 23 (a software offering statistical solutions commonly used for social sciences). The models are gender segregated because findings from previous research were gender-specific<sup>9,34,35</sup>.

## RESULTS

The sample included 673 adolescents aged between 11-15 years, from four schools in Kingdom of Bahrain, with an average age of 13.04 years. Approximately half of the participants were females (51.0%) and the remaining half were males (49.0%). The percentages of overweight and obesity among the participants were alarmingly high, around one third (32%) of the participants were either overweight or obese. The percentages of overweight or obesity among boys were almost twice as high compared to girls (Table 1).

When it comes to dietary behaviours, the majority of the participants skip breakfast regularly (57.9%), eat fast food regularly (83.6%), consume insufficient amounts of fruits and vegetables i.e. less than 5 servings a day (84.4%), and consume calorie dense snacks regularly (89.9%). The percentages are far worst for

the boys when compared with the girls, especially with skipping breakfast (66.7% vs 48.8%). Most of the participants are classified insufficiently active, i.e. spend less than an hour per day engaging in moderate to vigorous physical activity (78.2%). The percentage of insufficiently active girls is substantially higher than the insufficiently active boys (83.2% vs 72.9%). The majority of the participants are classified high sedentary (78.3%), with the average number of hours spent sedentary being 4.3 hours a day, which is more than twice the international recommended guidelines (which is 2 hours or less per day). Moreover, the percentage of high sedentary girls is substantially higher than the high sedentary boys (85.4% vs 71.6% vs). A high percentage of the participants are also sleep deprived, i.e. get less than eight hours of sleep per day (44.4%). The percentage of sleep deprived boys is substantially higher than the sleep deprived girls (48.1% vs 40.2%) (Table 2).

Spearman's rank correlation coefficient (Rho) is calculated to measure correlation between individual's behaviours and friends' behaviours (Table 3). The correlations were calculated for boys and girls separately since the regression models will be gender segregated. There is a positive correlation between individuals and their friends' breakfast consumption among both boys (Rho=.173) and girls (Rho=.154). Boy's fast food consumption is also positively correlated with their friends' fast food consumption (Rho=.214). Girls' calorie dense snacks consumption is positively correlated with their friends' calorie dense consumption (Rho=.117). There is also a positive correlation between individuals and their friends' physical activity levels among both boys (Rho=.189) and girls (Rho=.216). Finally, with sedentary behaviour and sleep, only the girls' behaviour is positively correlated with their friends (Rho= .156, Rho=.136).

Correlations only provide a description of the type and direction of relationship between the variables. Regression models on the other hand can predict relationships between the dependent and independent variables which will be used to answer the research questions and test the conceptual model

**Table 1.** BMI percentiles and weight status.

<i>Weight Status</i>	<i>Boys</i>	<i>Girls</i>	<i>Total</i>
Number of children assessed:	328	345	673
Underweight (< 5th %)	7%	7%	7%
Normal BMI (5th - 85th %)	47%	74%	61%
Overweight or obese (≥ 85th %)*	45%	19%	32%
Obese (≥ 95th %)	12%	6%	9%



**Table 2.** Weight-related behaviours in the sample.

	Boys (n=328)	Girls (n=345)	Total (n=673)
<b>Breakfast</b>			
Does not eat regularly	66.7%	48.8%	57.9%
Eats regularly	35.1%	51.2%	42.1%
<b>Fast Food</b>			
Does not eat fast food regularly	16.8%	16.2%	16.4%
Eats fast food regularly	83.2%	83.8%	83.6%
<b>Fruits and Vegetables</b>			
Insufficient consumption	85.8%	82.9%	84.4%
Sufficient consumption	14.2%	17.1%	15.6%
<b>Calorie Dense Snacks</b>			
Does not consume regularly	8.7%	11.6%	10.1%
Consumes regularly	91.3%	88.4%	89.9%
<b>Physical Activity</b>			
Insufficiently Active	72.9%	83.2%	78.2%
Sufficiently Active	27.1%	16.8%	21.8%
<b>Sedentary Behaviour</b>			
Low Sedentary	28.4%	14.6%	21.7%
High Sedentary	71.6%	85.4%	78.3%
<b>Sleep</b>			
Insufficient Sleep	48.1%	40.2%	44.4%
Sufficient Sleep	51.6%	59.8%	55.6%
<b>Total</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>

**Table 3.** Spearman's rank correlation co-efficient (Rho) between individuals' behaviours and friends' behaviours.

<i>Individual Behaviour</i>	<i>Friends' Behaviour</i>	
	Rho Boys (n=328)	Rho Girls (n=347)
Breakfast	.173*	.154*
Fast Food	.214*	-.077
Fruits and Vegetables	.095	.093
Calorie Dense Snacks	-.085	.117*
Physical Activity	.189*	.216*
Sedentary Behaviour	.025	.156*
Sleep	.017	.136*

\* Correlation is significant at the 0.05 level.

that was proposed in section 3. Each model tested for four things:

- 1) Association between individuals and their friends for each one of weight-related behaviours.
- 2) Whether or not network density acts as a moderator on these associations.
- 3) Whether or not individual popularity acts as a moderator on these associations.
- 4) Whether or not network individual centrality acts as a moderator on these associations. Since, the models were segregated by gender, then each

behaviour (numbered 1 to 7) had two models ("a" for boys and "b" for girls), as shown in Table 4. The findings from the binary logistic regression models presented in Table 4 indicate that there is evidence for associations between friends in breakfast consumption, fruits and vegetables consumption, calorie dense snacks consumption and physical activity among both boys and girls. Among boys, there is evidence for associations between friends in fast food consumption. Among girls, there is evidence for associations between friends

**Table 4.** Binary logistic regression models between individuals and friends’ weight-related behaviours and the role of network properties as moderators.

Model	Behaviour	Gender	Variable	p-value	Odd Ratio	95% CI for odd ratio	
						Lower	Upper
1a	Breakfast Consumption	Boys	Behaviour association	.021*	1.861	0.849	4.08
			Density as a moderator	.030*	2.559	1.093	5.992
			Popularity as a moderator	.048*	4.384	1.012	19.001
			Centrality as a moderator	0.665	0.673	0.112	4.045
1b		Girls	Behaviour association	.001*	13.329	3.016	58.895
			Density as a moderator	.003*	4.679	1.686	12.983
			Popularity as a moderator	0.689	1.482	0.216	10.162
			Centrality as a moderator	.007*	4.211	1.487	11.924
2a	Fast Food Consumption	Boys	Behaviour association	.000*	2.798	1.603	4.883
			Density as a moderator	.030*	2.454	1.091	5.517
			Popularity as a moderator	.082**	1.699	0.935	3.088
			Centrality as a moderator	0.16	12.403	0.369	417.029
2b		Girls	Behaviour association	0.811	0.431	0	420.778
			Density as a moderator	0.852	0.734	0.028	18.953
			Popularity as a moderator	0.13	19.237	0.417	887.003
			Centrality as a moderator	0.953	0.896	0.023	35.439
3a	Fruit and Vegetable Consumption	Boys	Behaviour association	.001*	7.248	2.178	24.119
			Density as a moderator	.084**	14.462	0.697	300.146
			Popularity as a moderator	.007*	3.413	1.393	8.364
			Centrality as a moderator	0.185	0.562	0.24	1.316
3b		Girls	Behaviour association	.008*	3.222	1.358	7.646
			Density as a moderator	.096**	6.896	0.711	66.915
			Popularity as a moderator	0.701	0.481	0.012	20.09
			Centrality as a moderator	.092*	1.713	0.916	3.205
4a	Calorie Dense Snack Consumption	Boys	Behaviour association	.026*	2.694	0.194	37.396
			Density as a moderator	.007*	1.072	0.37	3.11
			Popularity as a moderator	.035*	1.621	0.517	5.083
			Centrality as a moderator	0.175	0.019	0	5.857
4b		Girls	Behaviour association	.030*	2.086	0.318	13.692
			Density as a moderator	.011*	1.602	0.73	3.512
			Popularity as a moderator	0.592	1.284	0.515	3.198
			Centrality as a moderator	.011*	2.316	0.625	8.582
5a	Physical Activity	Boys	Behaviour association	.035*	1.192	0.189	7.511
			Density as a moderator	.065**	3.092	0.934	10.234
			Popularity as a moderator	.038*	1.253	0.578	2.717
			Centrality as a moderator	0.26	0.208	0.014	3.191
5b		Girls	Behaviour association	.000*	4.698	2.318	9.518
			Density as a moderator	.032*	3.066	0.625	15.026
			Popularity as a moderator	0.285	3.979	0.316	50.164
			Centrality as a moderator	.041*	2.834	1.042	7.707
6a	Sedentary Behaviour	Boys	Behaviour association	0.539	8.354	0.009	7346.763
			Density as a moderator	0.899	1.29	0.025	66.753
			Popularity as a moderator	0.584	3.91	0.03	514.973
			Centrality as a moderator	0.179	0.048	0.001	4.022

Model	Behaviour	Gender	Variable	p-value	Odd Ratio	95% CI for odd ratio	
						Lower	Upper
6b	Sedentary Behaviour (continuare)	Girls	Behaviour association	.045*	1.893	1.014	3.534
			Density as a moderator	0.447	0.327	0.018	5.849
			Popularity as a moderator	0.423	2.386	0.284	20.025
			Centrality as a moderator	0.214	0.262	0.032	2.162
7a	Sleep Deprivation	Boys	Behaviour association	0.956	1.136	0.012	109.662
			Density as a moderator	0.246	0.278	0.032	2.412
			Popularity as a moderator	0.294	0.36	0.053	2.429
			Centrality as a moderator	0.122	5.344	0.638	44.783
7b	Sleep Deprivation	Girls	Behaviour association	0.482	4.815	0.061	383.165
			Density as a moderator	0.651	1.764	0.151	20.606
			Popularity as a moderator	0.473	0.523	0.089	3.067
			Centrality as a moderator	0.497	0.537	0.089	3.226

\*Independent variable is significant at the 0.05 level.

\*\*Independent variable is significant at the 0.10 level.

in sedentary behaviour. Additionally, network density emerges as a moderator on the associations between friends in breakfast consumption, fast food consumption (boys only), fruits and vegetables consumption, calorie dense snacks consumption and physical activity. In addition, individual popularity emerges as a moderator on the associations between friends in breakfast consumption, fast food consumption, fruits and vegetables consumption, calorie dense snacks consumption and physical activity among boys only. Finally, individual centrality emerges as a moderator on the associations between friends in breakfast consumption, fruits and vegetables consumption, calorie dense snacks consumption and physical activity among girls only (Table 4).

## DISCUSSION

The aim of this study was to explore the moderating role of network properties on behaviour associations in weight-related behaviours. We found strong associations between adolescents and their friends' health behaviours. We also found that properties of friendship network are critical in conditioning associations between individuals and their friends' weight-related behaviours. Network density emerges as an important moderator of the delinquency-peer association, with dense networks containing stronger delinquency peer associations than those that are less dense<sup>21</sup>. Similarly, in the studied sample, there is evidence for the moderating role of network density to amplify/strengthen the association between individual behaviour and friends' behaviour for breakfast consumption, fast food consumption (boys only), fruits

and vegetables consumption, calorie dense snacks consumption and physical activity.

Popularity was found to moderate associations between friends' drinking behaviours<sup>10</sup>. Additionally, popularity conditions the delinquency-peer association among adolescents<sup>1</sup>. Similarly, in the studied sample, there is evidence for the moderating role of individual popularity to amplify/strengthen the association between individual behaviour and friends' behaviour for breakfast consumption, fast food consumption, fruits and vegetables consumption, calorie dense snacks consumption and physical activity among boys only. Popular boys have stronger behaviour associations with their friends' in weight-related behaviours. This is an interesting finding, but more research is needed to confirm this finding and, whether or not, it is context related. Previous studies in other socially similar behaviours did not use gender segregated regression models and thus did not report any differences or similarities in the moderating role of network properties on behaviours associations<sup>10,12,13</sup>. Further research is needed to understand why popularity emerged as an important moderator for behaviour association with boys only. It may be because gaining popularity (i.e. receiving a higher number of nominations) is different among boys and girls and the underlying factors that constitute popularity is what is causing the behaviour associations to be stronger among boys only. One classic study conducted in the U.S., found that elementary school boys gained popularity based on their athletic ability, toughness, coolness and success in cross-gender relationships<sup>36</sup>. The same study found that elementary school girls gained popularity based on their parent's socio-economic status, their appearance, and their



academic success<sup>36</sup>. But since there are no regional studies conducted to investigate factors affecting popularity among boys and girls, it is difficult to explain this finding of the research.

The centrality of adolescents within their network could affect their susceptibility to peer influence<sup>13</sup>. Adolescents in central network positions receive regular feedback from their peers which subjects them to more peer influence than less central adolescents<sup>32</sup>. Additionally, central adolescents will have a greater attachment to the group<sup>33</sup>. As a result, being central can amplify association between friends in weight-related behaviours. In the studied sample, there is evidence for the moderating role of individual centrality to amplify/strengthen the association between individual behaviour and friends' behaviour for breakfast consumption, fruits and vegetables consumption, calorie dense snacks consumption and physical activity among girls only. Girls who hold central positions in the network are more likely to have behaviour associations with their friends' in weight-related behaviours. This is also an interesting finding and more research is needed to confirm this finding and if it is context related.

### Limitations of the study

Although this study has several achievements, it is not without its limitations. Limitations included the cross-sectional nature of the data, which limits the causal interferences that could be made about the associations between individuals and their friends' behaviours. Further longitudinal exploration is needed to determine the underlying mechanism of behaviour association being either peer socialization or selection as this may have important intervention implications. Future research should also explore the moderating role of other network properties since social network analysis provides measurements of several network properties.

### CONCLUSIONS

Understanding the moderating role of network properties will assist in understanding how network properties interact with weight-related behaviours among friends. This study is the first to use social network analysis to investigate weight-related behaviours in adolescent friendship networks in the Gulf Cooperation Council region and specifically in the schools of the Kingdom of Bahrain. Finally, future work may benefit from understanding why individual popularity emerges as an important moderator for behaviour association for boys only and individual centrality emerges as an important moderator for behaviour association for girls only in this sample.

### Author contributions

*Conceptualization, N.A. and T.D.; methodology, N.A. D.K.; software, N.A.; validation, T.D. and H.L.; formal analysis, N.A.; investigation, N.A., S.T.; resources, N.A., S.T.; data curation, N.A.; writing – original draft preparation, N.A., H.L., D.K. and S.T.; writing – review and editing, D.K., S.T.; visualization, D.K., and S.T.; supervision, T.D. and H.L.; project administration, N.A. All the authors have read and agreed with the final version of the article.*

### Compliance with Ethics Requirements:

„The authors declare no conflict of interest regarding this article“

„The authors declare that all the procedures and experiments of this study respect the ethical standards in the Helsinki Declaration of 1975, as revised in 2008(5), as well as the national law. Informed consent was obtained from all the subjects included in the study“

„No funding for this study“

### Acknowledgments:

None

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