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Original article

Egocentric social network correlates of physical activity

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Abstract

Background: The social environment might play an important role in explaining people's physical activity (PA) behavior. However, little is known regarding whether personal networks differ between physically active and physically inactive people. This study aimed to examine the relationship between personal network characteristics and adults' physical (in)activity.
Methods: An egocentric social network study was conducted in a random sample in Switzerland ($n = 529$, mean age of 53 years, 54% females). Individual and personal network measures were compared between regular exercisers and non-exercisers. The extent of these factors' association with PA levels was also examined.
Results: Non-exercisers ($n = 183$) had 70% non-exercising individuals in their personal networks, indicating homogeneity, whereas regular exercisers ($n = 346$) had 57% regularly exercising individuals in their networks, meaning more heterogeneous personal networks. Additionally, having more regular exercisers in personal networks was associated with higher PA levels, over and above individual factors. Respondents with an entirely active personal network reported, on average, 1 day of PA more per week than respondents who had a completely inactive personal network. Other personal network characteristics, such as network size or gender composition, were not associated with PA.
Conclusion: Non-exercisers seem to be clustered in inactive networks that provide fewer opportunities and resources, as well as less social support, for PA. To effectively promote PA, both individuals and personal networks need to be addressed, particularly the networks of inactive people (e.g., by promoting group activities).

Keywords: Egocentric network; Exercise; Inactivity; Personal network; Physical activity; Questionnaire; Similarity/homogeneity

1. Introduction

The health benefits of physical activity (PA)—including the decreased risk of physical and mental diseases, such as coronary heart disease, diabetes, and depression—have been widely established.[1–3] Nevertheless, one-third of adults worldwide do not meet the minimum recommendations specified in current public health guidelines.[4,5] Particularly, the proportion of inactive people has remained stable over the past decade despite widespread public health campaigns aimed at enhancing PA. However, in some countries, the overall leisure-time PA (LTPA) of active people has increased.[5,6]

To gain a better understanding of the reasons why people remain physically inactive, ecological models have been proposed that take individual, interpersonal, environmental, national, and global factors into account.[7,8] At the individual level, it has been shown that age, gender, health condition, body mass index (BMI), self-efficacy, and other motivational and emotional factors are associated with PA. In contrast, interpersonal and social environmental factors have been less studied.[7] Because people are embedded in social networks, their health behaviors are also interconnected and tend to resemble that of their significant others.[9,10] Social networks might be, therefore, a key factor in explaining physical inactivity.

Social networks represent stable but evolving webs of relationships with other persons, such as family members, friends, and other close relations that surround individuals.[11] Different factors in these networks, such as PA, are thought to shape people's health behaviors.[12] For instance, social networks can provide social support (e.g., emotional and financial support, advice, and information), social companionship (e.g., sharing PAs), and access to resources (e.g., sports equipment). Moreover, social networks are considered an important source of

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social influence through, for example, social norms or social comparisons.[12,13] However, social network effects on adults' PA behavior have remained fairly understudied.[14]

The few social network studies related to adults' PA have examined specific network characteristics, such as network size or type of relationship.[14–16] These studies' results suggest that having larger and more diverse social networks might be positively related to higher PA levels because they can provide more opportunities and resources for being physically active.[15–17] There is also strong evidence that perceiving social support from family and friends and having a companion with whom to exercise predict higher PA levels.[18–20] Notably, not only the actual activities of significant others (such as family members, friends, or neighbors) but also the perception about these people's regular participation in PAs are associated with higher PA levels.[21–23] Such perceptions are considered more important for influencing people's health behaviors than the actual behaviors of the observed significant others.[24]

The data gathered from these studies, as well as the findings of friendship network studies on children and adolescents,[25,26] suggest that social networks may play an important role in explaining adults' physical (in)activity. However, more research is needed to investigate how social network characteristics are related to PA to get a better understanding of the possible barriers faced by inactive people.[14] This is crucial for effective health interventions, because health benefits can be gained from even low levels of PA.[27]

The study's goal was to examine how individual and personal network characteristics are related to the PA behavior of adults in a randomly selected community sample by applying an egocentric social network approach. This data collection method generates personal network data from the perspective of the respondents, reflecting their perceptions.[13] Drawing on prior research,[21,28] it was hypothesized that people who exercised regularly would have more regular exercisers in their personal networks than non-exercisers (who would present the opposite case). Due to the stable proportion of inactive people over the past decades,[6] it was also assumed that non-exercisers would have more homogeneous personal networks in terms of PA. In addition, because larger and more diverse personal networks have been associated with higher PA levels, it was examined whether the personal network size and composition (related to gender and relationship) of regular exercisers were different from those of non-exercisers.[14] Furthermore, the extent to which PA levels were associated with personal network characteristics was investigated and controlled for individual factors.

2. Methods

A postal questionnaire was designed to measure various constructs related to PA and included 2 questions regarding LTPA, the characteristics of each respondent's personal network and demographic characteristics, among others.

2.1. Participants and procedure

A questionnaire and an accompanying letter were sent to a randomly selected sample of German-speaking Swiss households whose addresses were chosen from the telephone directory. The household member who was at least 18 years old and whose birthday was closest to the date when the questionnaire was received was asked to fill out the questionnaire. One reminder was sent out to non-respondents. The questionnaire was designed in conformity with the ethical guidelines of the American Psychological Association (APA). Participants gave informed written consent by answering and sending back the questionnaires.

A 32% response rate ($n = 591$) was achieved. Nine individuals were excluded because they completed less than 50% of the questionnaire items. The other excluded respondents did not indicate their gender or age ($n = 6$), did not make any statements about their PA behavior ($n = 5$) or were under 18 years old ($n = 1$). Furthermore, 41 respondents did not answer the questions about their personal networks. This resulted in a final sample size of $n = 529$ (54% females; $n = 286$). The respondents' ages ranged from 18 to 94 years (53.06 ± 15.96, mean $\pm$ SD). The self-reported educational levels ranged from primary and lower secondary school (7%; $n = 37$) and upper secondary vocational school or upper secondary university preparation school (62%; $n = 328$) to college or university (30%; $n = 160$). Four respondents (1%) did not indicate their educational levels.

2.2. Measures

In this study, LTPA was assessed with 2 independent questions, as follows: (a) the previous week's PA level and (b) regular exercise.

2.2.1. Previous week's PA level

This question assessed the number of days in the previous week that were spent in at least 30 min of moderate-to-vigorous PA.[29,30] According to recommended guidelines for PA, people should be physically active for at least 30 min daily. Beyond the activities of daily living, they should engage in moderate-intensity exercise 5 days a week, 20 min of vigorous-intensity exercise 3 days a week or a combination of both to achieve substantial health benefits.[31] The examples given to the respondents were exercising, undertaking sport activities in leisure time, walking or cycling from place to place. They were instructed to exclude PAs related to their household or work. This question has been demonstrated to perform as well as other short PA tools in terms of reliability and concurrent validity.[29,30]

2.2.2. Regular exercise

The respondents were also asked whether they considered themselves regular exercisers. Based on current recommendations, being a regular exerciser was defined as exercising during leisure time (e.g., walking, swimming, or dancing) 3 days or more a week for at least 20 min each time.[31] Based on the responses to this question, the respondents were classified as either regular exercisers or non-exercisers.

2.2.3. Importance of PA

One question investigated whether the respondents knew about the overall health benefits of PA. They were requested to indicate the degree of their belief in the importance of PA

for their own health, using a 5-point scale ranging from *very important* (1) to *not at all important* (5). The question was recoded so that higher values indicated higher levels of the importance of PA.

2.2.4. Personal network characteristics

To collect personal network data, an egocentric network approach was used by applying a "name generator" question,[13,32,33] which has successfully been used in other studies examining social network effects on health behaviors.[15,34] The respondents ("egos") were asked to name up to 5 close persons ("alters") with whom they "talked about important matters in the last few months". After listing a maximum of 5 important alters by their first names, initials, or pseudonyms, the respondents were asked a set of questions about each alter. The following alter characteristics were specified: (a) the relationship between the ego and the alter (the alter's role as partner, another family member, friend, co-worker, neighbor, or other), (b) the alter's gender (male or female), and (c) the alter's exercising behavior (exercising regularly or not). All the information about the alter was provided from the ego's point of view and therefore described each respondent's perception of his or her direct personal network.

2.2.5. Demographic characteristics

The self-reported demographic characteristics were gender, age, and education. Anthropometric information included weight and height, which were collected to calculate each respondent's BMI (kg/m^2). Additionally, the general self-perceived health status was assessed on a 5-point scale ranging from *very bad* (1) to *very good* (5).

2.3. Statistical analyses

Five network measures were calculated from the name-generator question, as follows: personal network size, proportion of male alters, proportion of family alters (including the spouse), proportion of friend alters, and proportion of regularly exercising alters. Personal network size was calculated by counting all the named alters of an ego. The proportion of male:family:friend alters was determined by dividing the number of named male:family:friend alters by the personal network size. Similarly, the proportion of regularly exercising alters was assessed by dividing the number of regularly exercising alters by the personal network size. These personal network characteristics, as well as demographic and health-related variables, were compared between the exercisers and non-exercisers, using χ^2 tests for categorical variables and Student's t tests for independent samples for continuous variables. For significant results, the effect size Cohen's d is reported. The extent of similarity in exercising behavior between the respondents and their alters was evaluated by ϕ coefficients; further associations between continuous variables were assessed by Pearson correlation coefficients. A multiple regression analysis was conducted to examine the relationship between PA levels (number of physically active days in the previous week) and personal network characteristics, controlled for individual factors. All statistical analyses were performed by using IBM SPSS Version 22.0 for Mac (IBM Corp., Armonk, NY, USA).

3. Results

3.1. Individual differences between regular exercisers and non-exercisers

Sixty-five percent ($n = 346$) of the respondents reported exercising on a regular basis, defined as leisure-time exercising 3 days or more a week for at least 20 min each time. The other 35% ($n = 183$) reported that they did not exercise regularly. There were no statistically significant differences in demographics between the exercisers and the non-exercisers. Sixty-two percent of the male respondents (151/243) and 68% of the female respondents (195/286) reported being regular exercisers ($\chi^2 = 2.21$). Table 1 presents the results for education and age.

Only a few people (14%) reported a poor or moderate health status. The mean values for the exercisers and the non-exercisers suggested a good health status for both groups, but

Table 1
Demographic, health, and personal network characteristics of exercisers and non-exercisers (mean ± SD) ($n = 529$).

Variable	Exercisers ($n = 346$)	Non-exercisers ($n = 183$)	t (529)	Cohen's d
Individual				
Age (year)	52.58 ± 15.95	53.97 ± 15.98	0.95	–
Education[a]	3.73 ± 1.05	3.57 ± 1.00	1.66	–
Health status[a]	3.42 ± 0.75	3.03 ± 0.85	5.52*	0.49
BMI	23.88 ± 3.35	25.49 ± 4.62	4.55*	0.40
Importance of PA[a]	4.63 ± 0.56	4.11 ± 0.84	8.48*	0.73
Last week's days of PA	3.61 ± 1.78	1.51 ± 1.62	12.91*	1.23
Personal network				
Personal network size	3.50 ± 1.37	3.37 ± 1.39	1.04	–
Proportion of male alters	37.57 ± 24.91	37.81 ± 27.77	0.10	–
Proportion of family alters	54.61 ± 29.23	54.83 ± 29.72	0.08	–
Proportion of friend alters	31.06 ± 25.68	26.81 ± 25.32	1.82	–
Proportion of regularly exercising alters	56.73 ± 32.44	30.31 ± 30.95	9.05*	0.83

Note: Missing values of all variables were below 1.6%.
[a] Variables are measured on a scale from 1 to 5.
* $p < 0.001$.
Abbreviations: BMI = body mass index; PA = physical activity.

the exercisers reported a better health status than the non-exercisers ($p < 0.001$). The BMI values, which ranged from 16 to 45 kg/m^2, were significantly lower in the group of exercisers ($p < 0.001$). Overall, 89.8% of the respondents considered PA rather important or very important for their health; nevertheless, the exercisers considered PA significantly more important ($p < 0.001$). The exercisers also reported, on average, more than twice as many physically active days in the previous week than non-exercisers ($p < 0.001$).

3.2. Exercisers' and non-exercisers' personal networks

For the whole sample, the mean personal network size was 3.46 ± 1.38, and the network size correlated positively with being female ($r = 0.20$, $p < 0.001$) and negatively with age ($r = -0.19$, $p < 0.001$). Table 1 shows the differences between the regular exercisers and the non-exercisers in terms of personal network characteristics. Whereas the network size and the proportion of male, family, and friend alters were not different between the groups, there was a strong difference in the proportion of regularly exercising alters ($p < 0.001$). The non-exercisers' networks consisted of fewer exercisers than those of the exercisers ($p < 0.001$). Moreover, regular exercisers had heterogeneous networks in terms of exercise (Fig. 1). The regular exercisers' personal networks comprised 57% exercisers and 43% non-exercisers (note that the base rates in the sample of exercisers and non-exercisers were 65% and 35%, respectively). In contrast, non-exercisers had very homogeneous networks regarding exercise, consisting mainly of non-exercisers (70%).

Additionally, the strength of the association between the respondents' and their alters' exercise behavior depended on their closeness and type of relationship. The strongest association was found between the respondents and their first-named alters ($\phi = 0.30$, $p < 0.001$). The coefficients related to the second- and the third-named alters (second: $\phi = 0.18$, $p < 0.001$; third: $\phi = 0.17$, $p < 0.01$) were lower than those of their fourth- and fifth-named alters (fourth: $\phi = 0.27$, $p < 0.001$; fifth: $\phi = 0.23$, $p < 0.01$). Note that in 65.8% of the cases, the first-named person was the respondent's spouse or life partner. Other family members were predominantly the second- and the third-named alters, whereas friends were predominantly the fourth- and the fifth-named alters.

Table 2
Regression analysis predicting the number of last week's physically active days ($n = 497$).

Variable	B	SE B	β	p
Individual				
Gender	−0.32	0.18	−0.08	0.078
Age	0.02	0.01	0.13	0.002
Education	−0.22	0.08	−0.11	0.007
Health status	0.39	0.11	0.16	<0.001
BMI	−0.06	0.02	−0.12	0.008
Importance of PA	0.68	0.12	0.24	<0.001
Personal network				
Personal network size	0.02	0.07	0.02	0.733
Proportion of male alters	−0.47	0.32	−0.06	0.143
Proportion of family alters	0.03	0.42	0.00	0.943
Proportion of friend alters	0.45	0.46	0.06	0.328
Proportion of exercising alters	1.18	0.25	0.20	<0.001

Notes: Adjusted $R^2_{\text{overall model}} = 19.2\%$ ($p < 0.001$), $f^2 = 0.24$. $\Delta R^2 = 4.4\%$ for alters exercising behavior ($p < 0.001$).
Male = 0, female = 1. Education, health status, and importance of PA were measured on a scale from 1 to 5.
Abbreviations: BMI = body mass index; PA = physical activity.

3.3. Correlates of PA levels

Overall, 19% of the variance of the respondents' physically active days in the previous week could be explained by the included individual, health-related, and personal network variables, which indicates a medium to large effect size ($f^2 = 0.24$)[35] (Table 2). The model assumptions concerning linearity, normality of the error distribution, homoscedasticity and multicollinearity were met. After controlling for individual factors, the percentage of regularly exercising alters was still significantly associated with the respondents' PA levels, whereas this was not the case for other personal network variables. More precisely, the respondents with no regularly exercising alters reported 2.44 physically active days on average, whereas the respondents whose alters all exercised regularly reported 3.52 physically active days on average (Fig. 2).

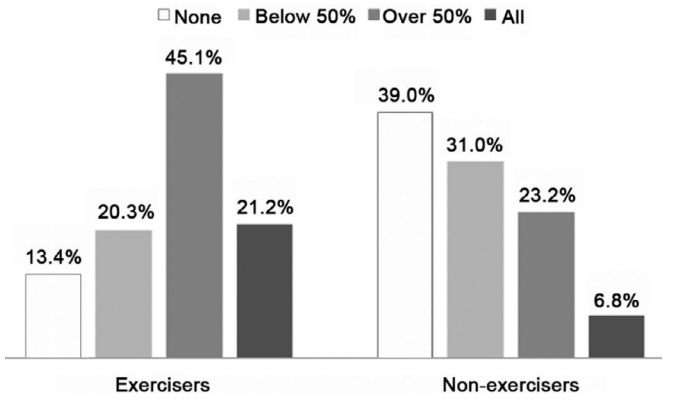

Fig. 1. Clustering effect between non-exercisers and the proportion of regularly exercising alters. "None" means no alter is exercising regularly; "below 50%" means 1%–49% of the alters are exercising regularly; "over 50%" means 50%–99% of the alters are exercising regularly; "all" means all alters are exercising regularly.

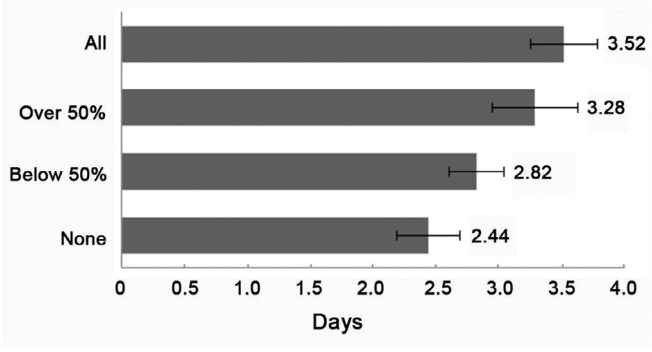

Fig. 2. Respondents' physically active days in the previous week separated by the proportion of regularly exercising alters. "None" means no alter is exercising regularly; "below 50%" means 1%–49% of the alters are exercising regularly; "over 50%" means 50%–99% of the alters are exercising regularly; "all" means all alters are exercising regularly.

4. Discussion

Despite health campaigns for PA, a substantial number of people have remained inactive over the past years.[5,6] Besides individual factors, the social environment might play a significant role in explaining adults' PA behavior.[7] However, there is still limited knowledge about the personal networks of inactive people. Understanding how personal network characteristics are related to physical (in)activity is important for future health interventions, given that significant others are the main sources of social support.[18,19]

This study's results support previous findings that non-exercisers were less health-oriented (higher BMI, lower health status, and lower ratings of importance of PA)[6,7] and had less physically active people in their personal networks than regular exercisers.[21,28] The results also contribute to existing literature by showing that non-exercisers had homogeneous personal networks, whereas regular exercisers had heterogeneous personal networks in terms of PA. Additionally, the proportion of regularly exercising alters was a significant predictor of the respondents' PA levels over and above individual factors, whereas other personal network characteristics were not associated with PA.

More precisely, the regular exercisers' personal networks consisted of nearly twice as many physically active alters compared to those of the non-exercisers. The strength of homogeneity between the respondents and their alters concerning exercising behavior depended on their closeness and type of relationship. The highest correlation was found between the respondents and their first-named alters, the majority of whom were their life partners. On the other hand, associations were stronger for friends than for family members, consistent with previous findings.[21,28] However, considering the base rates of regular exercisers and non-exercisers in this sample, which confirm the current data in Switzerland,[6] the results indicated that PA behavior was only clustered among non-exercisers. Regular exercisers had as many regular exercising alters in their personal networks as one would expect by chance, whereas non-exercisers had twice as many non-exercising alters. In other words, non-exercisers had homogeneous personal networks in terms of PA, whereas regular exercisers had more heterogeneous networks. The fact that inactive people seem to be embedded in inactive personal networks may lead to the consequences that they have, on average, fewer opportunities and role models and less social support to achieve the minimum recommended levels of PA.[12,14] In addition, non-exercisers seem to be exposed to a negative social influence through their personal networks, which might deter them from becoming active at all.[13] On the contrary, the more heterogeneous personal networks of regular exercisers may provide more opportunities and resources for being physically active. The importance of personal networks was shown by a regression analysis. The respondents' PA levels were associated with the proportion of exercising alters, even after controlling for individual factors such as age, gender, education, health status, BMI, and perceived importance of PA for health. This result clearly indicated that besides addressing individual factors, such as educating non-exercisers about the health benefits of PA, people's personal networks need to be involved in the promotion of PA. Strategies for increasing PA levels among partners and friends seem to be most efficient as the homogeneity of PA was highest for those relationships. However, to determine the causal mechanisms between personal networks and PA (e.g., social influence), further longitudinal studies are needed.

In contrast to previous findings,[15,16] this study found no relationship between the network size and PA, although the network size corresponded to that of other studies[15,34] using the same name generator question for collecting egocentric social network data. Because name generator questions are based on free recall and limit the number of possible alters, this method might not be sufficiently reliable for assessing the absolute personal network size, which could lead to inconsistent results.[33] Thus, further studies using other data collection methods are needed to clarify the relationship between the personal network size and PA.

The present study has some limitations that need to be addressed. First, the analyses are based on self-reported data, which are prone to social desirability bias. Because self-reported PA tends to be overestimated compared to an assessment by objective measurements,[30] it might well be that PA levels in this sample would be lower. For future studies, it might be useful to include more objective measures, such as data collection with accelerometers (at least for a subsample), to consider this bias. Additionally, personal network characteristics reflect the respondents' perceptions rather than objective, independent facts. Therefore, it is possible that the respondents perceived themselves as being more similar to their alters than they actually were, and the results of homogeneity might be slightly overestimated. However, as people's behaviors seem to be more influenced by their perceptions than by the actual behavior of their alters,[24] the egocentric social network approach seemed to be appropriate to indicate the importance of people's personal networks for PA. Second, because of the cross-sectional study design, causality cannot be inferred. Thus, further longitudinal studies are required to examine the processes of the relationship between personal networks and PA. Third, the average age of the respondents in this sample was slightly higher than that of the Swiss population, and slightly more women than men completed the questionnaire, which may limit the generalizability of the results.

5. Conclusion

This study showed that people's PA behavior was related to that of their personal networks over and above individual factors. Thus, for an effective promotion of PA, people's personal networks need to be considered. This might be especially important for non-exercisers, who were mostly embedded in inactive personal networks. These inactive networks might provide fewer opportunities and less social support for being physically active than the more heterogeneous networks of regular exercisers. Future public health interventions should, therefore, focus more on the personal networks of inactive

people (e.g., by promoting group exercises) or include their closest reference person. Considering the study's limitations, longitudinal studies including also more objective measures are needed for a deeper understanding of the relationship between personal network characteristics and PA behavior.

Authors' contributions

SD conceived of and designed the study, collected the data, and helped to draft the manuscript and to interpret the data; SM participated in the study design, conducted the statistical analyses, and drafted the manuscript. Both authors have read and approved the final version of the manuscript, and agree with the order of presentation of the authors.

Competing interests

Neither of the authors declare competing interests.

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