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Social Networks and Smoking in Rural Women: Intervention Implications

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Conflict of Interest Statement

None declared

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Abstract

Objectives—To characterize the social network characteristics of women in Ohio Appalachia and according to smoking status.

Methods—Women, 18 years of age, were recruited from 3 Ohio Appalachian counties to complete a cross-sectional survey. Sociodemographic and smoking-related information was collected by face-to-face interview. A description of women's time (ie, spends time with) and advice (ie, gets support and advice) social network ties were obtained. An egocentric social network analysis was completed, according to the woman's smoking status.

Results—Of the 408 women enrolled, 20.1% were current smokers. Time networks were larger ($p < .001$), more dense ($p < .001$), and more redundant ($p < .001$) than advice networks. Current smokers had a greater proportion of smoking ties in their networks compared to non-smokers ($p < .001$). Daily face-to-face contact with non-smoking ties was greater in time compared to advice networks ($p < .001$). Current smokers in advice networks tended to have less daily contact with non-smoking ties than non-smokers ($p = .06$).

Conclusions—Differences existed in characteristics of time versus advice egocentric networks. Smoking status was associated with these differences. Results will assist with future development of a network-based smoking cessation intervention.

Keywords

social networks; smoking; special populations

INTRODUCTION

Research has shown that social context influences health and health behaviors, including smoking,^{1,2} and it has been argued that social contextual factors have been inadequately addressed in traditional tobacco dependence treatment approaches.^{2,3} An examination of these factors may help to clarify the pronounced disparities in smoking.^{4,5} For example, 2012 data indicates that the Appalachian region of the state of Ohio, one that represents a population of 2.0 million people⁶ who tend to be higher in poverty⁷ and lower in education⁸ than the rest of the state, also has a much higher prevalence of smoking at 32.7% compared to 25.5% statewide⁹ and 16.8% nationally.¹⁰ The prevalence of smoking among Ohio Appalachian women is 32.1%¹¹ compared to 24.2% for all women in Ohio¹² and 14.8% for women in the U.S..¹⁰ Tobacco-attributable cancers are prevalent in this region,¹³ and Ohio Appalachian women experience a 20.8% higher rate of mortality from invasive cervical cancer than do non-Appalachian women in the state.¹³ Research has documented that cigarette smoking is independently associated with cervical cancer,¹⁴ and also raises the risk of death for women diagnosed with cervical cancer.¹⁵ While factors such as one's social network may operate in pathways associated both with persistent smoking and cessation,¹⁶ little is known about tobacco consumption within the context of social networks in Appalachian women. With the ultimate goal of creating a social network-based smoking

cessation intervention for women, the purpose of this study was to examine the social network characteristics by smoking status of women from Ohio Appalachia.

A social network is defined as a social structure that includes nodes (persons or organizations) fixed within specific types of interdependency through ties (relationships).¹⁷ Although not exhaustive, examples of interdependencies may include shared friendships, advice sharing, and behaviors (e.g. sexual or lifestyle, such as alcohol or tobacco consumption). A personal social network¹⁸ is comprised of an individual (referred to as an 'ego') and the individual's social ties (referred to as an 'alter'). Within a personal (also known as egocentric) social network paradigm, information about the network is obtained *solely* from the ego. Previous studies of personal social networks have asked participants (ie, ego) to report with whom they discuss important matters, go to for support or advice, spend time with, or utilize for instrumental support, or some combination.^{19–22} Research has shown that individuals are able to differentiate, or compartmentalize their social ties, (ie, alters) into specific networks. Since this is the case, it is important to tease apart differences in these networks, especially when thinking of their relationship to health and health behaviors. Moreover, McCarty²³ contends that determining the structure of personal social networks is important. To date, no research has examined the structural characteristics nor frequency and type of contact of *time* (those one spends time with on a regular basis) and *advice* (those one goes to for advice/feedback) social networks with regard to smoking.

As applied to a smoking behavior, an individual's social network may operate in pathways associated with initiation, persistent smoking or cessation.^{3,16} One important structural characteristic of a social network is homophily, or the inclination for people to select and spend time with others who resemble or behave as they do.^{24,25} With regard to persistent smoking, a smoker may intentionally select to spend time and associate with others who persistently engage in their shared and interdependent smoking behavior. Hitchman et al.²⁶ found that smokers who live in households with other adult smokers have been found to gain smoking friends over time, suggesting the possibility that individuals seek out others with similar behaviors. Others have demonstrated that having a large percentage of other smokers in one's network plays the largest role in one's daily smoking, especially among women.²⁷ And, Nguyen and colleagues²⁸ observed that women who quit smoking during the prenatal period expressed concern that smokers in their social network made it most challenging to maintain cessation after pregnancy.

Social networks can also be shaped by the introduction, or diffusion of new ideas.²⁹ While some networks may resist new ideas or behaviors, a central network member may be well positioned to influence or advise its other members.¹⁶ Concerning smoking cessation, if support and advisement about the adoption of a new health-promoting behavior (ie, quitting smoking) is conveyed by a network member considered to be an opinion leader, behavior change may be accelerated.^{30–32} Christakis and Fowler³³ noted both that social networks are relevant to quitting and that interconnected people, or clusters, often stop smoking jointly, rather than on a one-by-one basis. In their analyses, factors associated with cessation by a network member included spousal, sibling, friend and co-workers' ability to quit smoking and having friends with certain attributes, such as higher educational attainment. However, if an individual's personal network is structurally dense (ie, all members of the network (ego +

alters) are connected), people tend to possess the same (redundant) information.³⁴ It has been suggested that a network with a high level of density and redundancy prohibits input of unique information,³⁴ potentially limiting advice about the adoption of a new health promoting behavior. While a network may vary in its absolute size (ie, total number of alters), in a network where redundancy operates, its' effective size is regarded to be low.

With this in mind, the objectives of this study were to: 1) characterize the structural characteristics of *time* and *advice* personal social networks of women in Ohio Appalachia and according to smoking status; and 2) describe the frequency (daily, weekly, monthly) and type of contact (face to face, phone, internet) between the women in Ohio Appalachia and their ties in *time* and *advice* personal social networks and according to smoking status. Understanding the dynamics of personal network characteristics (i.e. absolute size, density, redundancy, effective size, homophily) within an Appalachian context offers exciting opportunities for the future development of a network-based smoking cessation intervention. This is especially relevant given the high prevalence of tobacco consumption within the Appalachian region.

METHODS

Design and Recruitment

A cross-sectional survey design was used. Women, 18 years of age and older, were recruited from 3 Ohio Appalachian counties using a 2-phase address-based sampling approach previously described by Brick and others.³⁵ The first phase involved the mailing of a recruitment letter that included a \$2 bill and questionnaire with a request for the household to enumerate and provide contact information for women age 18 and older. A self-addressed stamped envelope was provided for return of the completed screener questionnaire. Two additional mailings were sent at weeks 3 and 6, for those not responding to the first mailing. No additional monetary incentives were included with these mailings. Upon return of the screening questionnaire, one eligible woman from each household (ie, age 18 and older and resided in one of 3 Ohio Appalachian counties) was randomly selected for invitation to the study. At phase 2, the eligible woman was contacted by a field interviewer. At that time, the study was explained and the woman was invited to participate. If the woman agreed, a face-to-face survey was scheduled. A total of 408 women completed the survey, for a 71% participation rate. The study was approved by the University's Institutional Review Board. This study was one of four projects funded through the National Cancer Institute (P50 CA105632) and the Behavioral Measurement Shared Resource at The Ohio State University Comprehensive Cancer Center (P30CA016058) to study causes and contributors to cervical cancer disparity among women residing in Ohio Appalachia.

Procedure

The interviewer met each woman at a convenient time and place (usually her home) where the study was again explained and informed consent was obtained. A face-to-face survey was administered by the interviewer. On average, the survey took 60 minutes to complete. Each woman was reimbursed with a \$50 gift card for her time and effort.

Measures

The measures included: 1) socio-demographic characteristics (age, race, education, marital status, income, employment status); 2) smoking status (never, former, current) (NHIS),³⁶ and 3) the specific structural characteristics of a woman's time and advice networks. Structural characteristics measured in both networks were based on factors recommended in previous egocentric network assessments (see Table 1).¹⁶ To assess the time network, each participant (hereafter referred to as 'ego') was asked "to identify up to 9 social ties (hereafter referred to as 'alters') with whom the ego spends time". To assess the advice network, each ego was asked "to identify up to 9 alters that the ego goes to for advice and feedback". Alters could be nominated for inclusion in both network measures. In addition, for both the time and advice network measures, the ego was asked to report the following information about the alter: 1) first name; 2) smoking status (non-smoker or current smoker); 3) age (younger, older or same as ego); 4) education (more, less or same as ego); 5) current romantic or intimate partner (yes/no); and 6) which nominated alters knew each other. Finally, the ego was asked to describe the frequency of contact with each alter (daily, weekly, monthly) and the most typical mode of interaction with each alter (face-to-face, phone, or internet).

Data Analyses

The socio-demographic characteristics and smoking status of the sample were analyzed using chi-square and Kruskal-Wallis tests. In addition, using an egocentric analytic approach, social networks were characterized structurally. First, *absolute size* (0–9) and *density* (number of relationships among alters/maximum possible number of relationships X 100)¹⁷ were computed. Density scores ranged from 0–1, with a score of 1 representing a network that is completely dense. In completely dense networks all alters are linked (ie, are reported to know each other). A density score of 0 represents a network where none of the alters are linked (ie, none are reported to know any of the other alters). Next, *redundancy* (2 X number of relationships among alters/absolute size, range = 0–8) was calculated. People who are connected to each other tend to possess the same information, and are therefore considered to be redundant.³⁴ A higher redundancy score represents duplication of knowledge in the network. *Effective size* (absolute size – network redundancy range varies by network group) was measured to describe the actual information efficiency of the network, taking the redundancy of alters into consideration with the total number of listed alters.¹⁷ *Homophily*, or similarity of ego with alter on separate characteristics of age, education and smoking status (number of alters with same characteristic as ego/total number of alters) was estimated and ranged from 0–1, with 1 meaning that all alters are the same as the ego on a particular characteristic and 0 meaning that none of the alters are like the ego on a certain characteristic. Finally, *percent smokers* in the network, and *frequency of interaction* and *mode of interaction* with alters were described. All analyses were performed using SAS 9.3.³⁷ To compare differences between the time and advice network, according to smoking status, Signed rank and Kruskal-Wallis tests were utilized, and a Bonferroni correction was added to adjust for multiple comparisons on the same outcome. The overall statistical significance was claimed when the p-value was <.05.

RESULTS

A total of 1950 households were mailed a screening packet in phase one. Of these, 776 questionnaires were completed and returned. Based on the AAPOR RR1 formula,³⁸ this resulted in a 44.4% response rate for phase one. For phase 2, of the 776 questionnaires returned, a total of 599 women were eligible and were invited to participate. Of these, 408 women subsequently completed the survey which represented a 71% participation rate.

Sample Characteristics

Table 2 represents sample socio-demographic characteristics. Participants ranged in age from 18 - 95 ($M = 51.7$). The majority were married or living with a partner (71.6%) and had more than a high school education (65.7%). Almost half had full time employment and a household income of $>\$50,000$. Of the 408 women, 82 (20.1%) were current smokers and 92 (22.5%) were former smokers. Significant differences in socio-demographic characteristics were noted by smoking status. Current smokers were younger than never and former smokers ($p < .001$), and more likely to have never been married ($p = .01$). In addition, current smokers earned less income than never and former smokers ($p < .001$).

Alter Characteristics for Time and Advice Networks

Participants were asked to list up to 9 alters with whom they spent time (ie, time network) and, separately, with whom they went to for advice or feedback (ie, advice network). Table 3 displays the characteristics of alters. The mean number of alters listed for time networks was 6.57 (Range 0–9, $SD = 2.76$), which was significantly more than the average number listed for advice networks at 4.71 (Range 0–9, $SD = 2.63$; $p < .001$). In time networks, 44% of alters had less education than the ego, 26% had more and 28% had about the same. This is in contrast to advice networks, where 31% of alters had less education than ego, 34% had more and 32% had about the same. Compared to time networks, advice networks had significantly fewer alters with less education than egos ($p < .001$) and significantly more alters with higher or about the same education level as egos ($p = .01$). With regard to age, 41% of time network alters were older than egos, 52% were younger, and 7% were about the same age. In contrast, 51% of advice network alters were older than egos, 39% were younger, and 8% were about the same age. Compared to advice networks, time network alters tended to be younger than egos ($p < .001$). Both time and advice networks contained a similar proportion of smokers (20% and 18%, respectively). However, egos who were current smokers had a greater proportion of smoking alters in their networks as compared to never and former smoking egos ($p < .001$). There were no additional differences by smoking status.

Structural Network Characteristics for Time and Advice Networks

Structural network measures of absolute size, density, redundancy, and effective size of network can be found in Table 4. The mean absolute size for time and advice networks were 6.57 ($SD = 2.76$) and 4.71 ($SD = 2.63$), respectively. Time networks were significantly larger than advice networks ($p < .001$). Mean density was 83% for time networks and 78% for advice networks. This difference was statistically significant ($p < .001$). Time networks were also more redundant (mean = 4.57; $SD = 2.48$) as compared to advice networks (mean = 2.77; $SD = 1.99$; $p < .001$). However, for effective size, there was no difference in the time

and advice networks (time mean = 1.99; SD = 1.39; advice mean = 1.98; SD = 1.43). Structural network measures did not differ by ego smoking status in time networks. However, differences existed by ego smoking status in advice networks for absolute size and redundancy. Current smokers had smaller ($p = .01$) and less redundant ($p = .03$) advice networks than never smokers.

Table 4 also reports network homophily as analyzed by smoking status, level of education and age. Smoking homophily was fairly high for both time and advice networks ($M = .75$ and $.77$, respectively); these homophily estimates did not differ by type of network. However, differences were apparent according to smoking status. Current smokers had less homophilous networks than both never and former smokers ($p < .001$), with never and former smokers' networks more likely to be comprised primarily of nonsmokers. Based on education, advice networks were slightly more homophilous than time networks ($p = .01$) although mean homophily scores for both networks were below 50%. Homophily based on age was $M = .07$ for time and $M = .08$ for advice networks. Differences based on smoking status did not exist for homophily of education and age.

Frequency and Mode of Interaction with Alters in Time and Advice Networks

The sample was most likely to be in contact with alters on a daily basis in both the time and advice networks. As presented in Table 5, the total sample reported an average daily contact with 64% and 47% of all alters in time and advice networks, respectively. This difference was statistically significant ($p < .001$). However, no differences were noted according to smoking status. Egos reported mean weekly contact with 29% (time network) and 36% (advice network) of alters, and mean monthly contact with 7% and 14% of alters in time and advice networks, respectively (data not shown).

The self-reported percentage of daily face-to-face contact with smoking alters (Table 5) did not differ between time and advice networks and there was no difference by smoking status. However, as shown in Table 4, the self-reported percentage of daily face-to-face contact with non-smoking alters was significantly greater in time networks, compared to advice networks ($p < .001$). There was no difference by smoking status within the time network. In contrast, it was noted that within the advice network, there was a trend for egos that currently smoked to have a lower percentage of daily contact with non-smoking alters when compared to former and never smokers ($p = .06$).

Finally, within time networks, on average women reported mostly interacting with alters face-to-face (80%), and less by phone (18%) or by internet (2%). For advice networks, on average women reported mostly interacting with alters face-to face (61%), and again, less by phone (34%) or by internet (3%). (Data not shown). Specific to current smoker participants only, egos reported the face-to-face mode as the most frequent format of contact with their non-smoking and smoking alters in both types of networks ($p < .001$). Fewer ego current smokers reported phone contact and almost no one reported the internet as the most frequent mode of contact with both non-smoking and smoking alters. The frequency of contact was significantly greater in time networks compared to advice networks ($p < .001$); there were no differences based on alter smoking status within the two types of networks. (Data not shown).

DISCUSSION

This study was the first of its kind to examine the structural characteristics of 2 types of egocentric (personal) social networks--time and advice--as well as the frequency and type of interaction that occurs within them. These aspects were examined with regard to smoking behavior. As such, it contributes to a growing body of literature about social networks, and informs about differences in social networks that offers consideration for the future development of a network-based smoking cessation intervention.

We found that egos were able to name more alters in time networks than in advice networks. The size of advice networks here mimicked network size found by O'Malley et al.³⁹ when examining ego's close social contacts. The differences between time and advice network size found here suggests that participants were able to compartmentalize two seemingly close groups of alters into different categories. Interestingly, alters in time networks were, on average, younger and less educated compared to alters in advice networks. It appears that advice network individuals are those that egos consider to be "older and wiser" than themselves, at least compared to those listed in time networks. This is interesting in light of Christakis and Fowler's²¹ finding that ego smoking cessation was associated with having friends with higher education.

Time and advice networks did not differ by smoking status of alters. Both types of networks contained a similar proportion of smokers and were found to be homophilous based on smoking status. However, the networks of current smokers were less homophilous based on smoking status than never and former smokers. This finding suggests that smokers have a mix of smokers and non-smokers in both time and advice networks. Unfortunately, it appears that they are less likely to have daily contact with non-smoking alters compared to never and former smokers. This has implications for a network-based smoking cessation intervention. Given Hitchman's²⁶ finding that smokers living in households of smokers tend to gain smoking friends over time, it may be especially important to consider how to increase contact between smokers and their non-smoking alters or, as suggested by Hitchman,²⁶ lose the number of smokers in their networks. The latter may be a more difficult task in practice than the former.

The structural characteristics of time and advice networks found here also has interesting implications for network-based cessation interventions. The structure of time networks was more dense and redundant compared to advice networks, suggesting that new, non-redundant information may come through those to whom egos go to for advice rather than those only with who they are likely to spend time.^{34,40} Given that the advice networks, in this population, are less redundant, more effective, and contain alters who are relatively more educated, it appears that the advice network might be the more salient social network to target in the development of a cessation intervention. One challenge for an advice network-based cessation intervention might be to determine if cessation information should come directly from an advice network member (called induction), or whether a lay-health individual outside the network should lead an intervention in combination with an smoking ego's advice network (called alternation).⁴⁴ This finding might not only inform cessation

interventions, but also other health behavior change interventions designed to reduce health disparities among women in Appalachia.

In addition, with the overwhelming reliance on face-to-face interaction in advice networks, a face-to-face mode of cessation content in a network-based cessation intervention may be the preferred method of delivery in this population. This highlights the importance of considering preferred mode of interaction among egos and alters when thinking of interventions. Of late, scholars have been focusing on the use of technology in smoking cessation interventions.^{41–43} Although this may have merit, scholars have found the use of technology to be dependent on one's motivation to quit,⁴¹ to vary by participant characteristic (eg, women, low education, heavy smokers were less likely to use cessation apps),⁴³ and by population group.⁴² Future research may benefit by testing how mobile apps could be used in conjunction with face-to-face mode of content delivery.

There are several limitations to this study. First, our sample was, on average, more highly educated, with higher household incomes and a lower prevalence of smoking, as compared to the Appalachian region of Ohio. These characteristics are consistent with survey respondents in general.⁴⁵ Importantly, though, while smoking is underrepresented, striking differences by smoking status remained. Current smokers were significantly less educated and had significantly less income than both never and former smokers. Second, we studied women in the rural Appalachian region of Ohio and it is not clear if the results can be generalized to the social network of other rural areas or urban areas. Third, classification of smoking status for both egos and alters relied on ego's self-report of the behavior. In addition, we used ego's self-report of alters' age and level of education. The issue of not being able to validate these self-reports is common to the egocentric personal network literature.⁴⁶ However, we concur with O'Malley et al.,³⁹ making the case that the ego's perception of the alter may be more important than the validation of information. Future studies of comprehensive networks will help to describe a network more completely. Finally, there was less variation in responses given for homophily of age than expected. We believe that this is a result of asking participants whether an alter was older, younger, or the same age as themselves rather than "about" the same age as themselves. It appears that participants took the phrase "the same age" more literally than we anticipated.

In conclusion, the findings of this study could assist with further development and testing of cessation interventions that involve members of the smoker's social network. Wagner⁴⁷ claims that when an ego has network support, the likelihood of maintaining abstinence is increased. However, this study showed that time networks are comprised of different kinds of alters, and are structurally different in nature, than advice networks. Since not all networks serve the same purpose, or function, future work should examine if network type makes a difference in both cessation as well as maintaining abstinence. Network interventions can be quite varied.⁴⁴ Understanding the characteristics of social networks provides a necessary foundation in determining the type of intervention that might aid in smoking cessation. This study provides the first step toward creating a network-based intervention in a rural Appalachian context.

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Human Subjects Statement

This research has been approved by The Ohio State University Institutional Review Board, Protocol #2011C0041.

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Table 1Social network construct descriptions and formulas.^a

Social Network Construct	Description	Range	Formula
Ego	The individual or, focal participant.		
Alter	The people to whom an ego is directly connected.		
Absolute Size	The number of alters that the ego identified.	0–9 per network	A
Alter Tie Count ^b	The number of ties among alters not including the ties between ego and each alter.		T
Density	Proportion of possible ties among ego's alters that were reported to be present. The score is bound between 0 (none of the alters are linked to each other) and 1 (all alters are linked; a completely dense network).	0–1	$\frac{T}{\frac{A}{2}(A-1)}$
Redundancy	People who are connected to each other tend to possess the same information, and are therefore considered to be redundant. A higher redundancy score represents duplication of knowledge in the network.	0–8	$\frac{2T}{A}$
Effective Size	A measure of unique information ego is likely to obtain from her alters. If alters are well connected, they are more likely to share redundant information with ego (lower score). If they are disconnected, they are likely to each provide ego with unique information (higher score).	1–A	$A - \frac{2T}{A}$
Homophily of smoking, age, and education	The tendency for individuals to affiliate with others who are like themselves. I is the number of ego ties to like-alter. The score is bound between 0 (all alters are different than ego with respect to smoking, age, and education) and 1 (all alters are like ego).	0–1	$\frac{I}{A}$
Percentage of Smoking Alters	Proportion of smokers in the ego's network. S is the number of smoking alters.	0–1	$\frac{S}{A}$

Note:

^aSome formulas use terms defined in the construct's description.^bThis construct is only included as a definition for use in other formulas in Table 1 and is not directly used in any analysis.

Table 2

Ego sociodemographic characteristics according to total sample and by smoking status.

	Total (N = 408)	Never smoker (N = 234)	Former smoker (N = 92)	Current smoker (N = 82)	<i>p-value</i> ^a
Age in years, mean $\pm$ SD (range)	51.7 $\pm$ 16.9 (18.4–95.1)	52.6 $\pm$ 17.8 (18.4–95.1)	55.5 $\pm$ 15.2 (22.6–83.4)	44.8 $\pm$ 14.1 (20.0–75.6)	< .001
Race, White, <i>n</i> (%)	401 (98.3%)	230 (98.3%)	91 (98.9%)	80 (97.6%)	.79
Education, <i>n</i> (%)					< .001
Less than high school (HS)	26 (6.4%)	5 (2.1%)	10 (10.9%)	11 (13.4%)	
HS diploma or GED	114 (27.9%)	62 (26.5%)	29 (31.5%)	23 (28.1%)	
>HS diploma	268 (65.7%)	167 (71.4%)	53 (57.6%)	48 (58.5%)	
Marital Status, <i>n</i> (%)					.01
Never married	32 (7.8%)	15 (6.4%)	4 (4.4%)	13 (15.9%)	
Married/living with partner	292 (71.6%)	179 (76.5%)	62 (67.4%)	51 (62.2%)	
Divorced/Widowed/separated	84 (20.6%)	40 (17.1%)	26 (28.3%)	18 (21.9%)	
Household Income, <i>n</i> (%)					< .001
<\$20,000	62 (17.4%)	20 (10%)	13 (15.9%)	29 (39.2%)	
\$20,000–\$50,000	123 (34.5%)	65 (32.3%)	34 (41.5%)	24 (32.4%)	
>\$50,000	172 (48.2%)	116 (57.7%)	35 (42.7%)	21 (28.4%)	
Employment, fulltime/part-time, <i>n</i> (%)	196 (48%)	112 (47.9%)	44 (47.8%)	40 (48.8%)	.99

^aFor categorical variables, chi-square test was used. For continuous variables (age), Kruskal-Wallis test was used

Table 3

Alter characteristics by network type and ego smoking status

	Network			Network			Network		
	Time	Advice	p value ^a	Time NS Ego	Time FS Ego	Time CS Ego	Advice NS Ego	Advice FS Ego	Advice CS Ego
Alter Characteristics									
Total Alters (Absolute size)	N = 408	N = 408	< .001	N = 234	N = 92	N = 82	N = 234	N = 92	N = 82
Mean	6.57	4.71		6.74	6.45	6.22	5.03	4.39	4.17
(SD)	2.76	2.63		2.69	2.90	2.79	2.61	2.59	2.64
Median	7.00	4.00		8.00	7.00	7.00	5.00	4.00	3.00
Non Smoking Alters	N = 405	N = 400	< .001	N = 232	N = 91	N = 82	N = 231	N = 91	N = 78
Mean	5.19	3.88		5.79	5.01	3.70	4.47	3.49	2.56
(SD)	2.58	2.42		2.46	2.50	2.38	2.47	2.20	1.88
Median	6.00	3.00		6.00	5.00	4.00	4.00	3.00	2.00
Smoking Alters	N = 405	N = 400	< .001	N = 232	N = 91	N = 82	N = 231	N = 91	N = 78
Mean	1.38	0.85		0.96	1.43	2.50	0.57	0.78	1.74
(SD)	1.59	1.17		1.31	1.42	1.92	0.99	1.00	1.41
Median	1.00	0.00		1.00	1.00	2.00	0.00	0.00	1.00
Proportion Smokers	N = 405	N = 400	.08	N = 232	N = 91	N = 82	N = 231	N = 91	N = 78
Mean	0.20	0.18		0.13	0.20	0.39	0.11	0.17	0.41
(SD)	0.23	0.24		0.18	0.19	0.27	0.19	0.21	0.30
Median	0.13	0.00		0.11	0.17	0.35	0.00	0.00	0.33
Proportion Education Levels	N = 405	N = 400		N = 232	N = 91	N = 82	N = 231	N = 91	N = 78
<i>Less</i>	Mean	0.44	0.31	0.45	0.38	0.45	0.33	0.31	0.27
(SD)	(0.32)	(0.31)	< .001	(0.32)	(0.32)	(0.34)	(0.30)	(0.34)	(0.30)
Median	0.44	0.25		0.50	0.33	0.47	0.33	0.25	0.19
<i>More</i>	Mean	0.26	0.34	0.25	0.26	0.29	0.34	0.30	0.40
(SD)	(0.28)	(0.32)	< .001	(0.26)	(0.29)	(0.31)	(0.31)	(0.34)	(0.35)
Median	0.22	0.33		0.22	0.17	0.22	0.33	0.20	0.33
<i>Same</i>	Mean	0.28	0.32	0.28	0.32	0.22	0.32	0.34	0.28
(SD)	(0.28)	(0.31)	.01	(0.27)	(0.32)	(0.27)	(0.30)	(0.34)	(0.30)

Alter Characteristics	Network			Network			Network			p value ^b
	Time	Advice	p value ^a	Time NS Ego	Time FS Ego	Time CS Ego	Advice NS Ego	Advice FS Ego	Advice CS Ego	
Median	0.22	0.25		0.22	0.22	0.12	0.29	0.25	0.25	
Proportion Age Levels	N = 405	N = 400		N = 232	N = 91	N = 82	N = 231	N = 91	N = 78	
Older	Mean	0.41	0.51	0.40	0.40	0.42	0.51	0.46	0.58	.05
	(SD)	(0.27)	(0.32)	(0.26)	(0.27)	(0.29)	(0.31)	(0.35)	(0.32)	
	Median	0.4	0.5	0.43	0.40	0.40	0.50	0.50	0.63	
Younger	Mean	0.52	0.39	0.52	0.54	0.51	0.39	0.45	0.32	.04
	(SD)	(0.28)	(0.33)	(0.29)	(0.27)	(0.29)	(0.32)	(0.35)	(0.32)	
	Median	0.5	0.35	0.50	0.56	0.56	0.40	0.50	0.31	
Same	Mean	0.07	0.08	0.08	0.06	0.05	0.09	0.07	0.08	.25
	(SD)	(0.13)	(0.17)	(0.14)	(0.12)	(0.10)	(0.16)	(0.17)	(0.18)	
	Median	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	

Note: NS= never smoker; FS = former smoker; CS = current smoker

^aTest: median pairwise difference is 0 between Network Time and Advice by Signed rank test

^bTest: medians are the same for 3 groups of egos by Kruskal-Wallis

Table 4

Structural network characteristics by network type and ego smoking status

Network Characteristics	Network			Network			Network			<i>p</i> value ⁱ
	Time	Advice	<i>p</i> value ^h	Time NS Ego	Time FS Ego	Time CS Ego	Advice NS Ego	Advice FS Ego	Advice CS Ego	
Absolute Size ^a	N = 408	N = 408	< .001	N = 234	N = 92	N = 82	N = 234	N = 92	N = 82	.01
Mean	6.57	4.71		6.74	6.45	6.22	5.03	4.39	4.17	
(SD)	(2.76)	(2.63)		(2.69)	(2.90)	(2.79)	(2.61)	(2.59)	(2.64)	
Median	7.00	4.00		8.00	7.00	7.00	5.00	4.00	3.00	
Density ^b	N = 383	N = 372	< .001	N = 224	N = 83	N = 76	N = 217	N = 84	N = 71	.52
Mean	.83	.78		.85	.82	.82	.78	.79	.78	
(SD)	(.21)	(.27)		(.21)	(.21)	(.23)	(.23)	(.29)	(.28)	
Median	.94	.90		.99	.90	.90	.87	1.00	.92	
Redundancy ^c	N = 408	N = 406	< .001	N = 234	N = 92	N = 82	N = 233	N = 92	N = 81	.02
Mean	4.57	2.77		4.81	4.33	4.15	2.99	2.50	2.45	
(SD)	(2.48)	(1.99)		(2.48)	(2.47)	(2.45)	(2.00)	(1.91)	(1.97)	
Median	4.67	2.33		4.89	4.56	4.00	2.78	2.00	2.00	
Effective Size ^d	N = 408	N = 406	.56	N = 234	N = 92	N = 82	N = 233	N = 92	N = 81	.08
Mean	1.99	1.98		1.92	2.10	2.07	2.07	1.91	1.80	
(SD)	(1.39)	(1.43)		(1.34)	(1.50)	(1.42)	(1.45)	(1.49)	(1.29)	
Median	1.06	1.00		1.00	1.06	1.29	1.50	1.00	1.00	
Homophily (Smoking) ^e	N = 405	N = 400	.06	N = 232	N = 91	N = 82	N = 231	N = 91	N = 78	< .001
Mean	.75	.77		.86	.78	.39	.88	.80	.41	
(SD)	(.27)	(.29)		(.18)	(.19)	(.27)	(.19)	(.23)	(.30)	
Median	.83	.89		.89	.80	.35	1.00	.80	.33	
Homophily (Education) ^f	N = 405	N = 400	.01	N = 232	N = 91	N = 82	N = 231	N = 91	N = 78	.44
Mean	.28	.32		.28	.32	.22	.32	.34	.28	
(SD)	(.28)	(.31)		(.27)	(.32)	(.27)	(.30)	(.34)	(.30)	

Network Characteristics	Network			Network			Network		
	Time		Advice	Time		FS Ego	Advice		CS Ego
	Time	Advice		NS Ego	FS Ego	CS Ego	NS Ego	FS Ego	CS Ego
<i>p value</i> ^h									
<i>p value</i> ⁱ									
<i>p value</i> ^j									
Median	.22	.25		.22	.22	.12	.29	.25	.25
Homophily (Age) ^g	N = 405	N = 400	.22	N = 232	N = 91	N = 82	N = 231	N = 91	N = 78
Mean	.07	.08		.08	.06	.05	.09	.07	.08
(SD)	(.13)	(.17)		(.14)	(.12)	(.10)	(.16)	(.17)	(.18)
Median	0	0		0	0	0	0	0	0

Note: NS=never smoker; FS=former smoker; CS=current smoker

^aDefined as number of alters [range 0–9 for each question, 18 maximum]

^bDefined as [(number of relationships amongst alters/number of relationships possible)X100]

^cDefined as [(absolute sizeXnumber of relationships amongst alters)/absolute size]

^dDefined as [absolute size-redundancy]

^eCalculated as the ratio of alters sharing the same smoking status with ego and the total alters the ego has. Never and Former smoking egos are regarded as non-smokers.

^fCalculated as the ratio of alters sharing the same education level with ego and the total alters the ego has.

^gCalculated as the ratio of alters the same age with ego and the total alters the ego has.

^hTest: median pairwise difference is 0 between Network Time and Advice by Signed rank test

ⁱTest: medians are the same for 3 groups of egos by Kruskal-Wallis

Table 5

Frequency of daily face-to-face contact by network type and ego smoking status.

	Time Network				Advice Network				p value ^d based on network type
	N	Mean	SD	Median	N	Mean	SD	Median	
% of <i>all alters</i> seen									
Total sample	405	64	32	67	400	47	31	43	< .001
NS	232	62	32	61	231	48	30	40	< .001
FS	91	64	32	67	91	47	33	50	< .001
CS	82	67	31	67	78	47	32	50	< .001
p value ^b based on smoking status		.48				.98			

	Time Network				Advice Network				p value ^d based on network type
	N	Mean	SD	Median	N	Mean	SD	Median	
% of <i>smoking alters</i> seen									
Total sample	248	56	42	55	193	48	44	50	.19
NS	117	53	46	50	84	45	46	33	.38
FS	62	53	42	50	45	45	45	33	.52
CS	69	63	37	67	64	54	42	50	.57
p value ^b based on smoking status		.31				.39			

	Time Network				Advice Network				p value ^d based on network type
	N	Mean	SD	Median	N	Mean	SD	Median	
% of <i>non-smoking alters</i> seen									
Total sample	399	65	33	67	387	46	34	44	< .001
NS	230	64	32	67	230	48	32	44	< .001
FS	91	66	35	71	89	47	36	50	< .001
CS	78	67	35	69	68	38	36	33	< .001
p value ^b based on smoking status		.56				.06			

Note: NS=never smoker; FS=former smoker; CS=current smoker. Analytic sample size for frequency calculations based on respondent nomination.

^aTest: pairwise difference is 0 between Time and Advice Network by Signed rank test

^bTest: medians are the same for 3 groups of egos by Kruskal-Wallis