# **RESEARCH ARTICLE**

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# Personal social network strengthens adherence to lifestyle changes in individuals with subjective cognitive decline

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#### Abstract

**INTRODUCTION:** Providing medical advice regarding lifestyle changes is currently the most effective intervention for delaying dementia onset among individuals with subjective cognitive decline (SCD). Adherence to such advice can be influenced by individual's social environment. We measured that impact within a Latinamerican population.

**METHODS:** We recruited 183 SCD individuals from a Memory Clinic, analyzed their health-related, and provided them with medical advice. We assessed personal network composition and its healthy habits. We evaluated adherence to medical advice 6 months later.

**RESULTS:** The proportion of heavy drinkers in the network is a risk factor to reduce alcohol consumption (odds ratio [OR] = 31.2, 95% confidence interval [CI] [3.73,301], p = 0.002), poor diets in the network hinders improving diet (p < 0.001 OR = 74.1, 95% CI [14.7,471]), and sedentary people in the network make it difficult to start exercising (OR = 4.92 95% CI [1.39,18.8], p = 0.016).

**DISCUSSION:** Personal networks have an inertial effect, as relationships engaged in an unhealthy habit lower the probability of individuals to quit that habit.

#### **KEYWORDS**

dementia prevention, lifestyle changes, lifestyle risk reduction, personal network, primary prevention, risk factors, social networks, subjective cognitive decline

#### 1 | BACKGROUND

More than 50 million people are diagnosed with dementia worldwide, and its prevalence continues to rise.<sup>1</sup> With this scenario, preventionoriented interventions become extremely important. There is extensive evidence that lifestyle changes can significantly reduce the risk of developing dementia. In particular, maintaining a healthy diet, engaging in regular physical exercise, and managing chronic health conditions, such as high blood pressure, diabetes, and obesity, have all been linked to a lower dementia incidence.<sup>2</sup> There is population-based evidence that control of these modifiable risk factors could reduce the prevalence of dementia by 40%. There is also experimental experience that lifestyle changes can improve cognition. For example, the FINGER trial showed that combined physical activity, a Mediterranean diet, and cognitive exercise improved executive functions and overall cognition over 2 years.<sup>3</sup> These results are currently replicated across several randomized controlled trials (RCTs) worldwide<sup>4</sup> and there is even an advanced Latin American project<sup>5</sup> integrating 12 countries in one multi-domain intervention study. Altogether, these findings suggest that lifestyle changes play a crucial role in reducing the prevalence of dementia

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and highlight the importance of promoting healthy lifestyle choices in dementia prevention efforts.

Subjective cognitive decline (SCD) is a clinical entity in which subjects present with a subjective perception of decline in at least one of their cognitive abilities without objective evidence of cognitive impairment.<sup>6</sup> SCD is of increasing interest as it carries an increased risk of developing dementia (relative risk: 2.17; 95% confidence interval [CI] [1.53,3.07]).<sup>7</sup> These subjects comprise the ideal target population for prevention strategies. Clinical practice guidelines suggest implementing medical advice in these individuals, including smoking cessation, healthy diet and increase physical activity, aiming at control of diabetes, hypertension, and dyslipidemia.<sup>8</sup> However, despite the proven benefits of these lifestyle changes, many individuals struggle to adhere to medical advice and do not make the necessary changes. This is where social networks can play a critical role in supporting and encouraging individuals to make positive lifestyle changes.

Social networks, which comprise the fundamental element of communal life, encompass the interrelationships among individuals that are based on various bonds such as emotional attachment, knowledge exchange, support, or dependency. Social networks operate as a conduit for transmitting information between individuals and as a determinant of habits, promoting both hazardous or safeguarding activities that entail social interaction (e.g., exercise or alcohol intake).<sup>9</sup> Social connectedness is a known determinant of health and disease. The negative effects of social isolation are comparable to that of smoking, hypertension and obesity as risk factors for morbidity. It has been reported that individuals with poor social networks have a 60% higher risk of developing dementia than people with strong social networks.<sup>10</sup> Understanding patients' social networks and how they influence disease risk and health outcomes may provide valuable insights for human health models and reveal modifiable targets for therapeutic intervention. We hypothesize that adherence to medical advice is modified by the personal network of the subjects and the behavior of the people in that network concerning health.

SCD, adherence to lifestyle changes, and the impact of social networks are conditions of fundamental importance in Latin America for several reasons. On the one hand, this region is expected to have one of the highest prevalence rates in the coming years, as it currently has a large number of individuals at risk. On the other hand, Latino persons are culturally known for maintaining close social ties. This creates a scenario where understanding social bonds can be used as a tool to reduce the risk of dementia in individuals.

Here, we aimed to study the personal network of subjects with SCD who have received medical advice based on established guidelines and to evaluate how certain aspects of their personal network may influence adherence to these recommendations in the medium term (6 months) in a Latin American population.

## 2 | METHODS

Prospective cohort study recruiting SCD participants from the Fleni Memory and Aging Center, in Buenos Aires, Argentina. We selected

#### **RESEARCH IN CONTEXT**

- Systematic review: The authors reviewed the literature using PubMed. While there is abundant evidence that lifestyle changes can prevent dementia, adherence to these measures after medical advice remains understudied. The influence that personal networks may have on this adherence has not been studied. These relevant citations are appropriately cited.
- Interpretation: Our findings show that the percentage of individuals in the personal network who follow unhealthy habits decreases the likelihood that subjects will follow medical advice. This emphasizes the need of including patients' social environment and relationships as targets for prevention.
- 3. Future directions: There is a need to evaluate whether it is possible to actively intervene in the network and whether or not this would impact adherence to medical advice. There is also a need to consider that social networks are culturally dependent. Multicenter and multiethnic studies are needed to ensure that this is generalizable.

subjects who presented with a self-perceived decline in at least one cognitive domain, but normal performance on formal cognitive assessment. Normal cognitive assessment was defined as performance greater than -1.5 Z Score on all tests of the Spanish version of the UDS3 battery according to local normative values for age, sex, and education.<sup>11</sup>

All SCD received medical advice about lifestyle changes for dementia prevention according to WHO guidelines and were invited to participate in the study.

Medical advice was provided by a cognitive neurologist. The interview was standardized and structured in two parts. A general part where subjects were advised to follow the MIND diet, to be physically active, and to avoid smoking and excessive alcohol consumption. In the second part, the risk factor profiles of each subject were analyzed and an action plan was suggested according to the clinical practice guidelines.

Those subjects who consented to participate were surveyed about their risk behaviors, family history of dementia, level of physical activity, and dietary characteristics. Participants' risk of developing dementia based on their risk factors was measured by the CAIDE (Cardiovascular risk factor, aging and incidence of dementia) dementia risk score. We used the International Physical Questionnaire (IPAQ)<sup>12</sup> to define the level of physical activity and we defined sedentarism as IPAQ < 2. To define adherence to a healthy diet we use the MIND (Mediterranean-DASH Diet Intervention for Neurodegenerative Delay) score<sup>13</sup> and we define as a poor diet a MIND score < 8. We also surveyed smoking and heavy alcohol consumption (defined as the

#### TABLE 1 Risk factor definition

Risk factor	Operational definition	Target change
Hypertension	Systolic: 130 mm Hg or higher diastolic: 80 mm Hg or higher during medical consultation, been in antihypertensive medication or received a previous diagnosis of hypertension	
Obesity	Body mass index > 30	
Dyslipidemia	Previous diagnosis of dyslipidemia or being under treatment for the same or presenting values < 40 of HDL (in men) or < 50 (in women), or a value higher than 130 of LDL.	
Sedentarism	IPAQ score < 2	IPAQ score $\geq 2$
Heavy drinking	Consumption of more than 21 units of alcohol per week	Reduce weekly alcohol consumption to below 21 units
Smoking	Currently smoking	Smoke cessation
Poor diet	MIND score < 8	MIND score $\geq 8$

consumption of more than 21 units of alcohol per week). Table 1 summarize the risk factor definition and the target of lifestyle change. In addition, subjects were asked to reconstruct their personal network, their relationships with each other, and their health behaviors using the online personal network survey.<sup>14</sup> Participants were surveyed at 6 months on adherence to proposed changes.

### 2.1 Personal network analytics

We analyzed personal social networks with an approach based on graph theory. Each network subject is considered a node, and each social link is a tie. As we analyzed egocentric (or personal) networks, all nodes have a tie to the participant.<sup>15</sup> The participant is called "ego" and the people to whom it is connected are called "alters". We performed an analysis of the composition and structure of the personal network. Compositional analysis refers to exploring the characteristics of the alters. We used as measures of composition: the standard deviation of the alters' ages, the proportion of kin, the sex diversity index, and the proportions of individuals who engage in healthy and unhealthy behaviors. The sex diversity measure is an index of qualitative variation (IQV) measuring the variability of sex between the alters. An equal number of men and women are represented by a value of 1, whereas a value of 0 denotes that all network members are of one sex.<sup>16</sup>

Structural analysis refers to analyzing the overall social network configuration, for example, the size or density of ties. We have com-

puted six metrics for each participant's social network. These metrics include size, density, constraint, effective size, maximum degree, and mean degree. Size refers to the count of network nodes, excluding the ego. Density indicates the level of connectivity in the network, calculated by dividing the sum of ties, excluding the participant's ties, by all possible ties. Constraint represents the degree to which network nodes are interconnected and encompasses size, density, and tie strength. Effective size, which is conceptually the opposite of constraint, signifies the number of networks alters occupying structurally unique positions. Maximum degree and mean degree measure the highest and average number of ties by a network node, respectively, and provide insight into the distribution of ties within the network.

# 2.2 Statistical analysis

All statistics were performed with R version 4.2.1 (2022-06-23). We used the packages tidyverse for data wrangling, igraph for network analysis, and gt and gtsummary for the elaboration of tables.

We constructed multivariate logistic regression models to explain adherence to four medical advices: smoking cessation, regular physical activity, healthy diet, and avoidance of excessive alcohol consumption as a function of the characteristics of the subjects and their personal network. We estimate the fit and accuracy of the model by calculating Akaike Information Criteria (AIC), null and residual deviance, respectively. The regression coefficients are presented as odds ratios (OR) with a 95% CI. We coded the dependent variable so that the event is defined as not following the medical indication. Thus, an OR less than one reflects the adoption of protective behavior and greater than one an increased risk behavior (not following the recommendation). For all analyses, we defined a statistical significance level of p < 0.05.

# 3 | RESULTS

A total of 183 participants diagnosed with SCD were enrolled from May until July 2022 and re-evaluated after 6 months, with no dropouts during the monitoring period. The mean age of the subjects was  $70 \pm 7$ years, with 59% of the participants being female. The subjects' average education was  $15.8 \pm 2.5$  years, and 55.2% had at least one first-degree relative with a family history of dementia. The participants' average CAIDE score was  $7.5 \pm 2.1$ , and 81.4% of the participants were at high risk of developing dementia (CAIDE Score > 6). Of the main modifiable risk factors, 38% of the participants had high blood pressure, 48% had obesity, 43% had dyslipidemia, 9.3% were active smokers, 21.7% consumed excessive alcohol, and 36% were sedentary (IPAQ score < 2). Table 2 summarizes these findings.

### 3.1 Social network features

We reconstructed the personal networks of the entire sample (n = 183). Figure 1 shows how the networks of the subjects are





**FIGURE 1** Network reconstruction and network features. Above, a reconstruction of the network of one of the participants along with the compositional features of the network and its alters. Below a minimum and maximum example of each of the structural features of the networks created

=1

=123

constituted along with an example of those with the lowest and highest of each of the structural network metrics. Concerning network composition, the percentage of network members who were relatives of the ego was on average  $54 \pm 0.3$ , and the average standard deviation of the age of the alters was  $13.2 \pm 5.7$  years old. The average sex diversity index (IQV) was  $0.69 \pm 0.35$  denoting a high gender diversity in the networks (values close to 1 indicate that there are as many men as women). In terms of healthy network behaviors, we analyzed the percentage of individuals who did or did not follow the healthy habits within the participant's network. On average, 11% of the alters of participants´ network consumed alcohol excessively, 40% was sedentary, 26% followed an unhealthy diet, and 42% had health problems. Table 3 summarize these findings.

=30

High

# 3.2 Lifestyle changes adherence and personal networks

After receiving medical advice, 53% (n = 17) of smokers quit smoking, 64% (n = 25) reduced their alcohol consumption, and 18% (n = 12) started exercising regularly, within 6 months.

We fitted a multivariate logistic regression model to predict reducing alcohol intake below 21 units/week within 6 months after medical advice (event = still heavy drinking), with network size, constraint, effective size, sex diversity, mean degree, the proportion of subjects with sedentarism within the network, and the proportion of heavy drinkers, smokers, and subjects with a bad diet. The model's explanatory power is moderate (Tjur's R2 = 0.20), Null Deviance: 92.61, Residual Deviance: 68.64, and AIC: 90.64. The proportion of heavy drinkers within the network is a significant predictor of continued alcohol abuse despite medical advice (OR = 31.2, 95%CI [3.73, 301], p = 0.002).

=8.5

Similarly, we used a logistic regression model to predict smoking cessation within 6 months after medical advice, including as predictors: network size, constraint, effective size, gender diversity, mean degree, and the proportion of individuals exhibiting sedentary behavior, heavy drinkers, smokers, and individuals with an unhealthy diet. The model's Null Deviance is 64.99, Residual Deviance is 51.99, and AIC is 73.99. The network constraint was found as a significant predictor of quitting smoking (p = 0.013, OR = 0.86, 95%CI[0.76, 0.96]). In this case, the percentage of smokers in the network does not seem to have an influence (p = 0.3, OR = 6.89, 95%CI[0.1,406]). TABLE 2 Demographic features of participants with SCD

	N = 183ª
Demographics	
Age (years old)	70 (7)
Sex (% females)	106 (59%)
Education (years)	15.75 (2.45)
Geriatric depression scale (GDS)	3.1 (2.23)
CAIDE (Cardiovascular risk factor, aging and incidence of dementia) total score	7.48 (2.08)
MIND (Mediterranean-DASH Diet Intervention for Neurodegenerative Delay) diet score	7.90 (1.45)
Risk factors	
Low education (< 12 years)	6 (3.3%)
High blood pressure (systolic > 140mmHG)	69 (38%)
Obesity (BMI > 30 kg/m2)	87 (48%)
Dyslipidemia	77 (43%)
Currently Smoking	17 (9.3%)
Heavy drinking (> 21 units/week)	39 (21%)
Sedentarism (IPAQ < 2)	66 (36%)

Abbreviation: SCD, subjective cognitive decline. <sup>a</sup>Mean (SD); n (%).

We also developed a model to predict engagement in regular physical activity with the same predictors. The model's explanatory power is weak (Tjur's R2 = 0.12), and it is Null Deviance = 238.4, Residual Deviance = 217, and AIC = 239. In this model, the effect of network size is statistically significant (p = 0.025, OR = 0.89 95%CI [0.80,0.98]), and the effect of the percent of alters who do not do physical activity (OR = 4.92 95%CI[1.39,18.8], p = 0.016). The larger the size of the network, the higher the chances of following medical advice to be physically active; the higher the percentage of non-exercisers in the personal network, the higher the risk of not following medical advice.

Finally, we created a predictor model for adopting a healthy diet, which yielded a moderate explanatory power (Tjur's R2 = 0.23), with a Null Deviance of 206.9, Residual Deviance of 166.1, and AIC of 188.1. The percentage of alters in the personal network with unhealthy dietary habits is a significant predictor of not following medical advice (p < 0.001 OR = 74.1, 95%CI[14.7, 471]). Figure 2 illustrates in forest plot form the coefficients of each of the models constructed and their confidence interval.

#### 4 DISCUSSION

Our study investigated the role of personal networks in adherence to lifestyle changes aimed at preventing dementia in participants with SCD. Our most relevant findings show that an important number of subjects adhere to the proposed measures, at least for the first 6 months, and that the percentage of people in an individual's personal network who engage in unhealthy behaviors harms their adherence to lifestyle changes.

#### TABLE 3 Network features

Characteristic	Overall, $N = 183^{a}$
Network size	8.7 (5.1)
Network density	0.77 (0.25)
Network constraint	52 (19)
Network effective size	3.06 (1.81)
Maximum degree	5.28 (2.36)
Mean degree	4.26 (2.15)
Percent kin	0.54 (0.32)
Standard deviation of age	13.2 (5.7)
Diversity of sex (IQV)	0.69 (0.35)
Percent contacted weekly or less often	0.12 (0.18)
Percent who have been known for less than 6 years	0.07 (0.13)
Percent who live more than 15 miles away	0.27 (0.29)
Percent who heavy drink	0.11 (0.23)
Percent who smoke	0.10 (0.19)
Percent who do not exercise	0.40 (0.29)
Percent who have a unhealthy diet	0.26 (0.29)
Percent who have health problems	0.42 (0.31)

Abbreviation: IQV, index of qualitative variation.

<sup>a</sup>Mean (SD).

The beneficial role of lifestyle changes in preventing cognitive decline is well-established, although it remains uncertain whether individuals can successfully implement them. While epidemiological studies highlight the consequences of not adopting lifestyle changes. RCTs demonstrate the benefits of their implementation, but adherence can be influenced by study procedures. A pertinent question is whether patients can successfully adhere to lifestyle changes based solely on medical advice. Our study provides evidence that an individual's personal network is a crucial factor in shaping their adherence to lifestyle changes.

Our findings suggest that personal networks have an inertial effect on lifestyle changes. The proportion of subjects engaged in an unhealthy habit increases the resistance of individuals to quit that habit. Because these results come from a multivariate model, this effect is present even after adjusting for link size and density. We found that larger network size is associated with more adherence to physical exercise advice. It can be assumed that individuals with a larger network size are more receptive to accepting the opinions of others, as this is necessary to maintain the network. Permeability to the advice of others may be the key to adopting medical advice. In addition, physical activity is also a social activity per se, more sociable individuals (with larger networks) may feel more comfortable adopting it than others with more solitary behaviors.

Our study highlights the presence of the social dimension as a catalyst for adherence to preventive measures. Lifestyle is something that individuals shape in the context of the people with whom they share their lives. Clinicians and public health programs must include social





**FIGURE 2** Forest plot of the multivariate logistic regression models predicting failure in adhere to medical advice. Model coefficients are presented as odds ratio and their 95% confidence interval. In color, whether the coefficient estimate increases the risk of not following medical advice (red) or reduces it (blue). Confidence intervals that exceed the limits of the graph are represented with an arrow showing the direction in which they do so

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ties as a target in dementia prevention if they are to achieve better adherence of people to the proposals. The inertia of social networks can be overcome in several ways. Healthy nodes can be added to dilute the proportion of unhealthy nodes or the habits of unhealthy nodes can be improved. Encouraging individuals to share medical consultations with family and friends, creating support groups, promoting prevention programs in public spaces aimed at people of all ages, and relying on community partners where social groups crystallize (such as clubs, schools, and associations) are simple measures that can improve social participation in prevention.

It is important to note that our study has some limitations. First of all, we have a small sample size compared to the high frequency of SCD. This may decrease the power of our study, which may result in some variables with small effects not being detected. Another important limitation is that all subjects come from the same center. These are barriers to the generalizability of the results. Our study aims to highlight the influence of social networks and has been able to detect the variables with the greatest impact. Whether these results can be applied to the whole population will require multicenter and multiethnic studies in the future.

The choice to conduct this study in Latin America is not a naïve one. Latino individuals are at high risk for cognitive impairment and many of their countries have limited resources to alleviate this situation. Prevention measures are simple, low-cost, and highly effective. As previously mentioned, strong social ties are a constant throughout Latin America, highlighting the importance of social issues as a pathway to designing effective and ethnically respectful interventions.

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#### CONFLICT OF INTEREST STATEMENT

None of the authors declare any past or present conflict of interest with this study. Author disclosures are available in the supporting information.

#### CONSENT STATEMENT

All subjects participating in the study gave their informed consent to participate in the study.

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### SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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