Association between Social Support and Self-Care Behaviors in Adults with Chronic Obstructive Pulmonary Disease

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Abstract

Rationale: Higher social support is associated with a better quality of life and functioning in adults with chronic obstructive pulmonary disease (COPD).

Objectives: To determine the association between structural and functional social support and self-care behaviors in adults with COPD.

Methods: This was a longitudinal study using data from the CASCADE (COPD Activity: Serotonin Transporter, Cytokines, and Depression) study which was focused on depression and functioning in COPD. Physical activity was measured with a validated accelerometer at baseline, year 1, and year 2. Additional self-care behaviors included pulmonary rehabilitation attendance, smoking status, receipt of influenza and/or pneumococcal vaccinations, and medication adherence. Structural social support indicators included living status, being partnered, number of close friends/relatives, and presence of a family caregiver. Functional social support was measured with the Medical Outcomes Social Support Survey (MOSSS). Mixed-effects and logistic regression models were used.

Results: 282 participants with GOLD Stage II-IV COPD were included (age: 68 ± 9; 80% male; FEV_1% predicted: 45 ± 16). For physical activity, participants who lived with others accrued 903 more steps per day than those who lived alone (95% CI: 373, 1433, $p = 0.001$); increases in the MOSSS total score was associated with more steps per day ($\beta = 10$, 95% CI: 2, 18, $p = 0.02$). The odds of pulmonary rehabilitation participation was more than 11 times higher if an individual had a spouse or partner caregiver compared to not having a caregiver (OR = 11.03, 95% CI: 1.93, 62.97, $p < 0.01$). Higher functional social support (MOSS total score) was associated with marginally lower odds of smoking (OR = 0.99, 95% CI: 0.98, 1.00, $p = 0.03$) and higher odds of pneumococcal vaccination (OR = 1.02, 95% CI: 1.00, 1.03, $p = 0.02$). Social support was not associated with influenza vaccination or medication adherence.

Conclusions: Structural social support, which was measured by reports of living with others and having a caregiver, was respectively associated with higher levels of physical activity and greater participation in pulmonary rehabilitation in adults with COPD. Our findings reinforce the critical importance of the social environment in shaping patients' success with self-care.

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Introduction

Chronic obstructive pulmonary disease (COPD) is a progressive disease and it is the third leading cause of death in the United States (1). Management of COPD is typically focused on reducing exacerbation risks and on relieving the impact of symptoms on physical functioning and well-being (2). Patients and their families are primarily responsible for undertaking a number of self-care behaviors to successfully manage COPD and other chronic conditions (3-5). Self-management is a term that is used to describe the process of taking responsibility for one's own day-to-day care to maintain well-being (6). For adults with COPD, engaging in regular physical activity, quitting smoking, participating in pulmonary rehabilitation, receiving vaccinations, and adhering to medication are core behaviors to improve health outcomes (2).

Self-management is influenced by a number of factors, including social support (7). Social support is the individual's experience of being cared for and loved, and having a sense of being valued and needed by other people, and being part of a mutually supportive network (8, 9). Social support has been conceptualized as having two domains: structural and functional. Structural social support describes the characteristics of the social network that surrounds a person, and his/her interactions within this network, e.g. marital status and living arrangements (10). In contrast, functional, or perceived, social support describes the specific functions provided to a person by his/her social network. It can be described using five dimensions— emotional, informational, tangible, affectionate, and positive social interaction (11).

Studies show that higher levels of social support are associated with better self-care behaviors in other chronic diseases such as diabetes, chronic heart disease, and chronic kidney disease (7, 12). Only a few studies of participants with COPD have reported findings on the effect of social support on self-care behaviors. For example, two studies found that

functional social support from family members helped participants manage their COPD (13, 14). However, none of these studies have systematically examined the association of both structural and functional support on self-care behaviors in adults with COPD.

Therefore, the purpose of this study is to determine the association between the individual components of structural and functional social support and self-care behaviors (physical activity, smoking status, participating in pulmonary rehabilitation, receiving vaccinations, and adhering to inhaler or nebulizer medication) in adults with COPD. Some of the results from this paper have been previously reported in the form of an abstract (15).

Methods

Study Design/Settings

This secondary analysis used data from the COPD Activity: Serotonin Transporter, Cytokines, and Depression (CASCADE) study at three time points (baseline, year 1, and year 2). The CASCADE study was a multi-site prospective observational study of participants with COPD who were followed for two years to study the biological causes and functional consequences of depression. It was approved by the institutional review boards of the three clinical sites, which included one academic medical center and two Veterans Affairs Health Care Systems in the United States. The study was registered with ClinicalTrials.gov (NCT01074515).

Participants

The CASCADE study recruited participants from queries of medical records and pulmonary function tests, chest clinics from the three medical centers, a research database maintained by the investigators, pulmonary rehabilitation programs, Better Breathers support groups, community pulmonary medicine practices, advertisements, the study web site, and

other referrals. The inclusion criteria were: *(1)* clinical diagnosis of COPD; *(2)* post-bronchodilator forced expiratory volume in one second to forced vital capacity ratio (FEV_1/FVC) < 70%; *(3)* moderate to very severe disease with a FEV_1 < 80% predicted; *(4)* age ≥ 40 years; *(5)* current or past cigarette smoking (> 10 pack-years); *(6)* stable disease with no acute exacerbations of COPD in the past 4 weeks; and *(7)* ability to speak, read, and write English.

Because the CASCADE study was focused on depression and inflammation, we excluded participants with any of the following conditions: other chronic lung diseases (e.g., asthma, bronchiectasis, cystic fibrosis, or idiopathic pulmonary fibrosis), uncompensated heart failure (with exacerbation in the past 4 weeks), primary pulmonary vascular disease, chronic antibiotic use or ongoing infection, autoimmune disease, lung cancer or metastatic cancer, chronic renal failure requiring dialysis, chronic uncompensated liver disease, HIV/AIDS, or chronic oral prednisone use, bipolar disease, psychotic disorders, and dementia. For this analysis, we further excluded participants from the CASCADE cohort who did not have objective physical activity measurement at baseline (Figure 1).

Procedures

All CASCADE study participants provided informed consent before their first clinic assessment which included pre-bronchodilator and post-bronchodilator spirometry and completion of questionnaires. At the end of the clinic visit, participants were asked to wear an activity monitor for 7 days. Two days after this clinic visit, a trained mental-health professional completed a depression and anxiety assessment by telephone. These procedures were repeated one and two years later.

Measures

Demographic data included self-reported age, gender, race, education level, employment status, and household income. Alcohol use was measured with the Audit-C, a 3-item alcohol screen which scored on a scale of 0-12 (scores of 0 reflect no alcohol use). In men, a score of 4 or more is considered positive for hazardous drinking; in women, a score of 3 or more is considered positive (16). Spirometry was performed by research coordinators following American Thoracic Society (ATS) standards (17), and post-bronchodilator values were used in the analyses. *Disease severity* measures included the BODE Index (18) and oxygen use. The BODE Index is a 10-point scale multidimensional grading system that includes weighted scores for body mass index (BMI), airflow obstruction (FEV_1), dyspnea (Modified Medical Research Council Scale), and exercise capacity (6-minute walk test). Comorbidities were measured by self-report using the Charlson Comorbidity Index (19) and participants were categorized as having zero or 1+ comorbidities. *Psychological symptoms* were measured with the Hospital Anxiety and Depression Scale (HADS) (20).

Social support. *Structural social support* was measured using three questions: *(1)* whether participants live alone or live with others; *(2)* whether they are partnered; and *(3)* the number of close friends and relatives. Mid-way through the study, we added an additional question regarding the presence of a family/friend caregiver (which family member or friend is most involved in your care now?) and thus have complete data on this variable only at the year 2 assessment. *Functional social support* was measured with the Medical Outcomes Social Support Scale (MOSSS) (11). The MOSSS has 20 questions that can be summarized into a total score and four subscales measuring different dimensions of perceived support: emotional/informational, tangible, affectionate, and positive social interaction.

Self-care behaviors. Physical activity was measured with a Stepwatch 3 Activity Monitor (SAM; OrthoCare Innovations, Washington, D.C.) fastened above the right ankle. The SAM is a highly accurate research grade accelerometer previously validated in adults with COPD

(21). Participants were asked to wear the SAM during waking hours for 7 days. Total step count per day was the primary physical activity variable.

Other self-care behaviors were based on self-reported responses to four yes/no questions: "In the past week, have you smoked any cigarettes, even a puff? Have you ever participated in an exercise program for your lungs (pulmonary rehabilitation)? In the last year, did you receive an influenza vaccination (flu shot)? Have you received a pneumonia vaccination in the past (pneumovax)?"

Adherence to inhaler or nebulizer medications was measured with four questions about carelessness, forgetting, stopping medication when feeling better, and using less of the medication than prescribed when feeling better in the past 3 months (22, 23) using a 5-point Likert scale from 1 (most of the time) to 5 (none of the time). An adherence score was created by summing responses to these four questions (score range: 4 to 20). Participants were considered fully adherent if they scored a total of 20 points.

Statistical Analysis

Descriptive statistics were used to describe the data over two years of follow up. With the exception of physical activity, none of the other five self-care behaviors changed significantly at year 1 and 2. Therefore, we used only baseline data to examine the unadjusted and adjusted cross-sectional associations between social support variables (with the exception of caregiver status) and the outcomes of current smoking status, participation in pulmonary rehabilitation, receipt of vaccinations, and adherence with inhaler or nebulizer medication using linear or logistic regression models. One of the structural social support variables, caregiver status, was only ascertained at year 2, and therefore models with caregiver status only used year 2 study data. Each social support variable was included in separate models. Baseline cross-sectional analyses were adjusted for age, gender, race, education level, income,

employment status, alcohol use, BODE, home oxygen use, Charlson comorbidity index, HADS-depression, and HADS-anxiety. Due to the smaller sample size for the cross-sectional model of caregiver support and outcomes using the data from year 2, we adjusted for a more limited set of covariates, demographic (age, gender, employment, household income) and disease severity (BODE Index, oxygen use, and Charlson Comorbidity Index).

For physical activity, mixed–effects longitudinal unadjusted and adjusted models were used to examine relationships between measures of structural/functional social support and physical activity over 2 years. The models contained assessment period (time) as a fixed factor and subject as the random factor. The β coefficient in this model uses the data from all 3 time points to provide an overall estimated effect of social support on physical activity. Demographics (age, gender, race, education level, income, employment status, and alcohol use) were fixed (time-invariant) covariates collected only at baseline; disease severity variables (BODE, home oxygen use, and Charlson comorbidity index), and psychological variables (HADS-depression, HADS-anxiety) were assessed at all three time points and were treated as time-varying covariates. With the mixed effects models we were able to include data for all participants who contributed data for at least one follow-up assessment.

All analyses were conducted using Stata 14.0 (StataCorp LP, College Station, Texas). A p value < 0.05 was considered statistically significant for all tests.

Results

Sample Characteristics

A total of 302 participants were enrolled in the CASCADE study, however, 20 participants were excluded from this analysis due to unusable physical activity data, leaving 282 participants in our baseline study cohort (Figure 1). Participant characteristics at baseline, year 1, and year 2 are shown in Table 1. The sample included mostly white men (80%) with a

mean age of 68 ± 9. One-third of the participants used supplemental oxygen and half had one or more comorbidities; the mean FEV_1% predicted was 45 ± 16 and BODE Index was 4 ± 2. Self-reported symptoms of depression and anxiety were low.

Overall, participants had relatively high levels of structural and functional social support. Over half were married or partnered, 75% were living with others, and 90% reported having a family caregiver. The mean total score on the MOSSS was 68 ± 28.

Participants accrued a mean of 6002 ± 3342 steps per day at baseline with reductions of 474 ± 221 over the two years of follow up. At baseline, 29% were still smoking, 28% had attended a pulmonary rehabilitation program in the past, nearly all had received the influenza or pneumococcal vaccination, and 29% were reported being fully adherent to their inhaler or nebulizer medications.

Social Support and Physical Activity

The longitudinal unadjusted and adjusted linear mixed models examining the association between social support and physical activity over two years are summarized in Table 2. We did not find an interaction between functional or structural social support with time when predicting physical activity. The unadjusted models showed that living with others and having higher levels of perceived social support (total, emotional/informational, and positive social interaction) were significantly associated with higher step counts. In adjusted analyses, participants who lived with others accrued 903 more steps per day than those who lived alone (β = 903, 95% CI: 373, 1433, p = 0.001). Similarly, perceived social support remained significantly associated with higher step counts in the adjusted models. A one-point increase in MOSSS total score was associated with 10 more steps per day (β = 10, 95% CI: 2, 18, p = 0.02).

We also examined whether the effect of overall perceived social support (MOSSS total score) was associated with physical activity after adjusting for structural support (living situation) in the same model over two years. The unadjusted analysis showed that both living with others and having higher levels of total functional social support were significantly and independently associated with higher step counts. However, after adjusting for covariates, only living with others remained associated with higher step counts over the two year period (β = 812, 95% CI: 264, 1359, p = 0.004).

The cross-sectional year 2 analysis showed that the presence of a family caregiver did not have an effect on step counts.

Social Support and Pulmonary Rehabilitation

Logistic regression analyses showed that living with others, being married or partnered, and having 6 or more close friends or relatives were not associated with previous participation in pulmonary rehabilitation (Table 3). However, the odds of participation in pulmonary rehabilitation was more than five times higher if a participant had a caregiver compared to no caregiver (OR 5.51 to 5.75, $p < 0.05$). After adjusting for covariates, the odds of participation in pulmonary rehabilitation was 11 times higher when participants had a spouse or partner as their caregiver compared to those without a caregiver (OR = 11.03, 95% CI: 1.93, 62.97, $p <$ 0.01). Functional social support was not associated with attending pulmonary rehabilitation.

Social Support and Current Smoking Status

The unadjusted logistic regression analyses showed that none of the structural social support measures were associated with current smoking status except for presence of a caregiver (Table 4). However, this association was no longer significant in the adjusted

model. Functional social support had a statistically significant but modest relationship with smoking status (OR = 0.99, 95% CI: 0.98, 1.0, p = 0.03) in the adjusted model.

Social Support and Vaccinations

While there was no relationship between structural or perceived social support and influenza vaccination, perceived social support was associated with marginally higher odds of pneumococcal vaccination in adjusted models (Table 5).

Social Support and Adherence with Inhaler or Nebulizer Medication

There was no significant association between structural or perceived social support and adherence with inhaler or nebulizer medication.

Discussion

We found that the type and level of social support had differing effects on core self-care behaviors in adults with COPD. Living with others had a stronger association with physical activity than functional social support and was associated with a clinically meaningful increase of over +900 steps per day (24) compared to living alone. Having a spouse or partner caregiver was associated with more than a tenfold increase in pulmonary rehabilitation participation compared to having no caregiver. Functional but not structural social support had a small beneficial relationship with smoking behavior and pneumococcal vaccination of unclear clinical significance. Neither structural nor functional support was associated with influenza vaccination or adherence to inhaler or nebulizer medications.

Since higher levels of physical activity have been shown to be associated with lower risk of exacerbations, hospitalizations and all-cause mortality in COPD (25-28), our finding that living with others and having a higher perception of overall social support is positively

associated with physical activity is especially important. To the best of our knowledge, this is the first longitudinal study on the relationship between structural and functional social support and physical activity in adults with COPD.

It is important to note that participants who reported living with others rated far higher levels of functional social support across all four MOSSS subscales (+15 to 27 points) compared to those who lived alone and that the presence of a caregiver had no influence on physical activity. Thus, it is reasonable to surmise that the physical proximity of living with others matters more in terms of opportunities for positive social interactions that results in greater engagement in both self-care and social activities in and outside the home. In an earlier study, Donesky et al found that living with others was associated with a higher frequency, duration, and continuity of walking in adults with COPD (29) but that study did not measure functional social support. More recently, Mesquita et al reported on a cross-sectional study of cohabitating patient-family member dyads in the Netherlands and found that adults with COPD who lived with more active family members had higher levels of physical activity than those with living with an inactive family member (30). Furthermore, loneliness has been shown to be associated with lower levels of physical activity in healthy older adults (31). Our findings are novel and extends the limited evidence base in that we examined the effects of both structural and functional social support on changes in physical activity over time.

We did not find an interaction between functional or structural social support with time when predicting physical activity, suggesting that the rate of change in physical activity did not vary by level of social support over 2 years of follow-up. At all 3 time points, higher social support was associated with increased physical activity, however, higher social support does not protect adults with COPD from declines in physical activity over time. Although physical activity is expected to decline with disease progression (32), living with others may

be one of many important factors that contribute to maintaining patients' daily physical activities through greater opportunities for reciprocal social interactions. It is therefore important to consider how to incorporate social support and interactions into interventions that aim to increase physical activity. More detailed study of these processes are warranted since optimizing living arrangements is potentially modifiable in some situations.

Pulmonary rehabilitation is integral in the management of COPD (2). However, participation in, and adherence to, pulmonary rehabilitation remains very poor (33, 34). There was a high rate of participation in pulmonary rehabilitation in our sample, which is not an accurate reflection of uptake in the general U.S. COPD population and likely reflects our recruitment efforts for the main study that included pulmonary rehabilitation programs. We found that while living with others and being partnered were not associated with having participated in a pulmonary rehabilitation program prior to enrollment in our study, having a spouse or partner as a *caregiver* had a strong relationship with participation. This is not surprising since our question specifically asked if participants had a family or friend who is most involved in their care. Our finding is consistent with previous studies reporting that lack of encouragement and support from family and friends were associated with non-participation and non-adherence to pulmonary rehabilitation (35-37). We recognize there are a number of other barriers to participation in pulmonary rehabilitation beyond social support, e.g. transportation challenges, access, insurance coverage, motivation, that we were unable to account for in our analysis.

Smoking is the main cause of COPD (2), and is associated with an increased risk of COPD exacerbations (38). Accordingly, identifying factors associated with smoking cessation is a high priority. In this study, we found that higher functional but not structural social support was related to decreased likelihood of being a current smoker. Previous studies have found that smoking cessation in adults with COPD is more related to worse disease severity,

use of smoking cessation medications, and having health insurance (39). It is unclear how best to incorporate social or family support to help adults with COPD quit smoking (40) though there are some evidence to suggest that people with high levels of partner support and perceived social support are more successful at quitting smoking (41-43). Our results suggest that functional social support, especially tangible social support, play a positive role in smoking cessation.

Influenza and pneumococcal vaccination are important primary and secondary prevention strategies to prevent exacerbations in adults with COPD (2, 44-46). The lack of variation in influenza vaccination in our study may partly explain why we did not find any relationship between social support and influenza vaccination as 85% of the sample reported receiving an influenza vaccination. Interestingly, Burns et al found that community-dwelling older adults who lived with others were more likely to report influenza vaccination than those living alone (47). We found that higher functional social support was associated with modest higher odds of pneumococcal vaccination.

Pharmacological treatment helps to reduce symptoms and exacerbations in COPD (2). We found that neither structural nor functional social support was associated with adherence to inhaler or nebulizer medication. Using the same adherence measure, Khdour et al also found that neither marital status nor living arrangements were associated with medication adherence in COPD (48). However, in another large study that relied on both subjective (self-reporting) and objective (canister weight change) measurement of adherence over a 2-year period, participants who were married were more likely to adhere to their inhalers compared to unmarried individuals (49). In a cross-sectional study using pharmacy refill data, Trivedi et al found that caregivers, especially spouses, improved medication adherence in individuals with COPD compared to those without caregivers (50). These inconsistent findings may be due to the different adherence measurements used across studies, and the fact that we used a

self-report measure of adherence.

Limitations

Several limitations are worth noting. The majority of our sample were men, most of whom had attended some college, many with a history of military service who were relatively active and had low levels of depression and anxiety and thus our findings may not generalize to larger COPD population. While we measured both structural and functional social support, we did not measure other potentially important dimensions of social relationships such as family conflict and cohesion that might have adverse influences on self-care behaviors (51). In addition, since most of the dependent variables did not change over time, we were only able to examine cross-sectional relationships between social support and self-care behaviors with the exception of physical activity. Finally, the lack of correction for multiple comparisons may have resulted in spurious associations in these analyses but we were careful to not over interpret our findings.

Conclusions

Structural social support measured by reports of living with others and having a caregiver were respectively associated with higher levels of physical activity and greater participation in pulmonary rehabilitation in adults with COPD. Our findings reinforce the critical importance of the social environment in shaping patients' success with self-care. While our study should be replicated in larger, more representative samples, we believe that efforts to engage patients in these core self-care behaviors must at the very least, routinely assess for and tangibly assist patients in marshalling the necessary social support to maximize their chances of effecting positive change.

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Figure Legend

Figure 1. Study Sample Flowchart

Table 1. Sample Characteristics

Variables	Baseline (n=282)	Y1 (n=255)	Y2 (n=225)
Age, years	67.7 ± 8.6	68.6 ± 8.6	69.6 ± 8.6
Gender, Male	226 (80%)	203 (80%)	181 (80%)
Race, Caucasian/White	246 (87%)	225 (88%)	201 (89%)
Education, Some college or more	218 (77%)	197 (77%)	176 (78%)
Income, ≥20K/year	172 (62%)	161 (64%)	141 (64%)
Currently employed	42 (15%)	39 (15%)	25 (11%)
Alcohol misuse*	54 (19%)	44 (17%)	39 (17%)
FEV1 % predicted	44.9 ± 15.7	46.5 ± 16.7	44.9 ± 17.3
BODE Index (↓0-10)	3.7 ± 2.3	3.5 ± 2.3	3.4 ± 2.4
O2 supplementation	98 (34%)	91 (36%)	93 (41%)
Charlson comorbidity index ≥1	138 (49%)	121 (48%)	109 (48%)
HADS-Depression (↓0-21)	4.2 ± 4.1	3.2 ± 4.0	3.0 ± 3.3
HADS-Anxiety (↓0-21)	5.0 ± 3.9	3.6 ± 3.8	3.3 ± 3.6
Structural social support			
Marital status: Partnered	163 (58%)	147 (58%)	124 (55%)
Live with others	211 (75%)	190 (75%)	162 (72%)
Report having 6+ close friends or relatives	125 (44%)	112 (45%)	108 (48%)
Presence of unpaid caregiver†			n=215
Partner	N/A	N/A	117 (54%)
Other (child, sibling, friend)	N/A	N/A	76 (35%)
None	N/A	N/A	22 (10%)
Functional social support			
MOSSS, Total (0-100↑)	68.4 ± 27.8	73.8 ± 24.9	73.5 ± 25.1
Emotional/informational	66.7 ± 28.3	71.8 ± 25.1	72.8 ± 25.8
Tangible	70.5 ± 29.4	73.6 ± 26.9	73.2 ± 29.1
Affectionate	72.0 ± 32.3	78.6 ± 28.9	76.7 ± 30.1
Positive social interaction	70.6 ± 30.2	76.1 ± 27.0	75.4 ± 27.0
Self-care behaviors			
Physical activity, total steps/day	6001.5 ± 3341.8	5830.6 ± 3260.7	5527.7 ± 3121.0
Current smoker	86 (29%)	67 (25%)	60 (25%)
Participation in pulmonary rehabilitation	83 (28%)	84 (32%)	82 (35%)
Received influenza vaccination in the last year	262 (87%)	234 (88%)	201 (85%)
Received pneumococcal vaccination in the past	252 (84%)	223 (84%)	200 (85%)
Full adherence with inhaler or nebulizer medication	81 (29%)	77 (31%)	70 (32%)

Data are presented as n (%) or mean ± SD. Direction of arrows represent scores reflecting better health. HADS = Hospital Anxiety and Depression Scale, MOSSS = Medical Outcomes Social Support Survey

* Possible alcohol misuse based on an Audit C score ≥ 4 in men or ≥ 3 in women

↑ indicates that higher scores are better health
↓ indicates that lower scores are better health
† Since this question was added after the study started, we only have data for the second year of follow up.

Table 2. Associations between Social Support and Physical Activity

	Unadjusted			Adjusted*		
Models†	B	*p*	95% CI	B	*p*	95% CI
Structural social support						
Live with others	779.7	**<0.01**	227.2, 1372.3	903.0	**<0.01**	372.8, 1433.2
Married/partnered	454.8	0.12	-113.1, 1022.8	490.1	0.07	-31.5, 1011.8
6+ friends and relatives	-117.5	0.50	-459.6, 224.6	-149.4	0.40	-497.1, 198.4
Caregiver‡						
No caregiver	Ref	Ref	Ref	Ref	Ref	Ref
Spouse or partner	-388.9	0.61	-1881.8, 1103.9	453.3	0.48	-803.8, 1710.4
Other	-1061.7	0.18	-2617.7, 494.2	-3.3	0.99	-1281.0, 1274.4
Functional social support: MOSSS scores						
Total	11.8	**<0.01**	3.5, 20.2	10.1	**0.02**	1.9, 18.3
Emotional and informational	10.9	**<0.01**	3.0, 18.8	9.1	**0.02**	1.3, 16.8
Tangible	6.0	0.12	-1.5, 13.5	5.9	0.11	-1.3, 13.2
Affectionate	5.0	0.16	-1.9, 11.9	3.8	0.27	-2.9, 10.5
Positive social interaction	9.0	**0.01**	1.9, 16.1	7.9	**0.03**	0.8, 14.9

MOSSS = Medical Outcomes Study Social Support Scale

* Adjusted for year, age, gender, race, education level, income, employment status, alcohol use, BODE, home oxygen use, Charlson comorbidity index, HADS-depression, and HADS-anxiety.

† Each social support measure was modeled separately.

‡ Only year 2 data used for caregiver analyses. Reference group of caregiver was participants without caregiver. Model adjusted for age, gender, income, employment status, BODE, home oxygen use, and Charlson comorbidity index.

Table 3. Associations between Social Support and Pulmonary Rehabilitation

	Unadjusted			Adjusted*		
Models†	OR	*p*	95% CI	OR	*p*	95% CI
Structural social support						
Live with others	0.92	0.79	0.51, 1.67	1.29	0.49	0.64, 2.60
Married/partnered	1.14	0.64	0.67, 1.92	1.43	0.28	0.75, 2.72
6+ close friends and relatives	1.38	0.23	0.82, 2.32	1.53	0.16	0.84, 2.77
Caregiver‡						
No caregiver	Ref	Ref	Ref	Ref	Ref	Ref
Spouse or partner	5.75	**0.02**	1.28, 25.84	11.03	**<0.01**	1.93, 62.97
Other	5.51	**0.03**	1.20, 25.39	4.34	0.10	0.77, 24.31
Functional social support: MOSSS scores						
Total	1.00	0.49	0.99, 1.01	1.00	0.52	0.99, 1.01
Emotional and informational	1.01	0.34	1.00, 1.01	1.01	0.27	1.00, 1.02
Tangible	1.00	0.81	0.99, 1.01	1.00	0.97	0.99, 1.01
Affectionate	1.01	0.23	1.00, 1.01	1.00	0.32	1.00, 1.01
Positive social interaction	1.00	0.47	1.00, 1.01	1.00	0.38	0.99, 1.01

MOSSS = Medical Outcomes Study Social Support Scale

*Adjusted for age, gender, race, education level, income, employment status, alcohol use, BODE, home oxygen use, Charlson comorbidity index, HADS-depression, and HADS-anxiety

† Each social support measure was modeled separately.

‡ Only year 2 data used for caregiver analyses. Reference group of caregiver was participants without caregiver. Model adjusted for age, gender, income, employment status, BODE, home oxygen use, and Charlson comorbidity index

Table 4. Associations between Social Support and Current Smoking Status

	Unadjusted			Adjusted*		
Models†	OR	*p*	95% CI	OR	*p*	95% CI
Structural social support						
Live with others	1.01	0.97	0.55, 1.86	0.79	0.51	0.39, 1.60
Married/partnered	0.87	0.60	0.51, 1.48	0.91	0.76	0.48, 1.71
6+ close friends and relatives	0.71	0.21	0.41, 1.21	0.92	0.79	0.49, 1.72
Caregiver‡						
No caregiver	Ref	Ref	Ref	Ref	Ref	Ref
Spouse or partner	0.32	**0.02**	0.12, 0.82	0.52	0.25	0.17, 1.59
Other	0.19	**<0.01**	0.07, 0.53	0.37	0.10	0.11, 1.20
Functional social support: MOSSS scores						
Total	0.99	**<0.01**	0.98, 1.00	0.99	**0.03**	0.98, 1.00
Emotional and informational	0.99	**0.03**	0.98, 1.00	0.99	0.11	0.98, 1.00
Tangible	0.99	**<0.01**	0.98, 0.99	0.98	**<0.01**	0.97, 1.00
Affectionate	0.99	**0.04**	0.98, 1.00	0.99	0.14	0.98, 1.00
Positive social interaction	0.99	**0.03**	0.98, 1.00	0.99	0.06	0.98, 1.00

MOSSS = Medical Outcomes Study Social Support Scale

*Adjusted for age, gender, race, education level, income, employment status, alcohol use, BODE, home oxygen use, Charlson comorbidity index, HADS-depression, and HADS-anxiety

† Each social support measure was modeled separately.

‡ Only year 2 data used for caregiver analyses. Reference group of caregiver was participants without caregiver. Model adjusted for age, gender, income, employment status, BODE, home oxygen use, and Charlson comorbidity index

Table 5. Associations between Social Support and Pneumococcal Vaccination

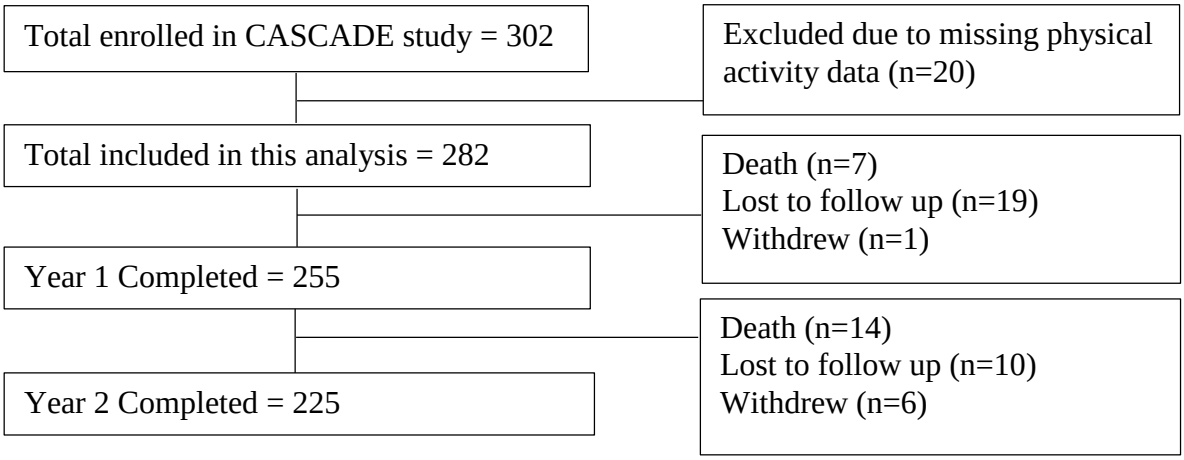
	Unadjusted			Adjusted*		
Models†	OR	*p*	95% CI	OR	*p*	95% CI
Structural social support						
Live with others	1.17	0.67	0.57, 2.43	1.23	0.62	0.53, 2.85
Married/partnered	1.39	0.32	0.72, 2.66	0.98	0.96	0.46, 2.11
6+ close friends and relatives	1.60	0.17	0.82, 3.16	1.26	0.57	0.57, 2.77
Caregiver‡						
No caregiver	Ref	Ref	Ref	Ref	Ref	Ref
Spouse or partner	0.91	0.89	0.24, 3.40	0.60	0.49	0.14, 2.54
Other	0.89	0.87	0.23, 3.49	0.83	0.80	0.19, 3.59
Functional social support: MOSSS scores						
Total	1.02	**<0.01**	1.01, 1.03	1.02	**0.02**	1.00, 1.03
Emotional and informational	1.02	**<0.01**	1.01, 1.03	1.02	**<0.01**	1.01, 1.03
Tangible	1.02	**<0.01**	1.01, 1.03	1.02	**0.02**	1.00, 1.03
Affectionate	1.01	**<0.01**	1.01, 1.02	1.01	**0.04**	1.00, 1.02
Positive social interaction	1.01	**0.02**	1.00, 1.02	1.01	0.07	1.00, 1.02

MOSSS = Medical Outcomes Study Social Support Scale

*Adjusted for age, gender, race, education level, income, employment status, alcohol use, BODE, home oxygen use, Charlson comorbidity index, HADS-depression, and HADS-anxiety

† Each social support measure was modeled separately.

‡ Only year 2 data used for caregiver analyses. Reference group of caregiver was participants without caregiver. Model adjusted for age, gender, income, employment status, BODE, home oxygen use, and Charlson comorbidity index


Total enrolled in CASCADE study = 302
Excluded due to missing physical activity data (n=20)
Total included in this analysis = 282
Death (n=7)
Lost to follow up (n=19)
Withdrew (n=1)
Year 1 Completed = 255
Death (n=14)
Lost to follow up (n=10)
Withdrew (n=6)
Year 2 Completed = 225