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DEMOGRAPHIC AND HISTORICAL FINDINGS, INCLUDING EXPOSURE TO ENVIRONMENTAL TOBACCO SMOKE, IN DOGS WITH CHRONIC COUGH

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Abstract

Background—Controlled studies investigating risk factors for the common presenting problem of chronic cough in dogs are lacking.

Hypothesis/Objectives—To identify demographic and historical factors associated with chronic cough in dogs, and associations between the characteristics of cough and diagnosis.

Animals—Dogs were patients of an academic internal medicine referral service. Coughing dogs had a duration of cough ≥ 2 months (n=115). Control dogs had presenting problems other than cough (n=104).

Methods—Owners completed written questionnaires. Demographic information and diagnoses were obtained from medical records. Demographic and historical data were compared between coughing and control dogs. Demographic data and exposure to environmental tobacco smoke (ETS) also were compared with hospital accessions and adult smoking rates, respectively. Characteristics of cough were compared among diagnoses.

Results—Most coughing dogs had a diagnosis of large airway disease (n=88; 77%). Tracheobronchomalacia was diagnosed in 59 dogs (51%), including 79% of toy breed dogs. Demographic risk factors included older age, smaller body weight, and being toy breed ($p<0.001$). No association was found between coughing and month ($p=0.239$) or season ($p=0.414$) of presentation. Exposure to ETS was not confirmed to be a risk factor ($p=0.243$). No historical description of cough was unique to a particular diagnosis.

Conclusions and clincal importance—Associations with age, size, and toy breeds were strong. Tracheobronchomalacia is frequent in dogs with chronic cough, but descriptions of cough should be used cautiously in prioritizing differential diagnoses. The association between exposure to ETS and chronic cough deserves additional study.

Keywords

respiratory tract; bronchii; tracheal collapse; environmental; tobacco smoke

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Controlled studies investigating risk factors for the presenting problem of chronic cough in dogs are lacking. In people, there is a well established association between cough and cigarette smoking. Studies also have demonstrated an association between exposure to environmental tobacco smoke (ETS) and chronic cough in adults, [1–4] and between exposure

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to wood smoke and chronic obstructive pulmonary disease.[5] Numerous occupational risk factors have been associated with pulmonary disease in people. Susceptibility to specific respiratory diseases also can be influenced by demographic characteristics. For example, the incidence of cystic fibrosis ranges from 1 in 1353 births in Ireland to1 in 350,000 in Japan.[6,7]

We are not aware of any studies in veterinary medicine that have prospectively examined demographic and historical features of dogs presenting with chronic cough. Few publications have addressed specific diseases that result in chronic cough in dogs. For example, chronic bronchitis was described over 30 years ago in a report of 26 dogs[8] and now is considered 1 of the most common respiratory diseases of dogs.[9] It is defined as a cough present for 2 consecutive months of the preceeding year in the absence of another cause.[8–10] The few studies of chronic bronchitis in dogs since that time have emphasized results of diagnostic tests or treatments.[11–13] Other diseases affecting the large airways (LAD) have a complex relationship with chronic bronchitis, with chronic cough being a common presenting sign, and include tracheal or bronchial collapse (tracheobronchomalacia, TBM), bronchiectasis, bacterial bronchitis, and eosinophilic bronchitis. Other causes of chronic cough may occur independently or in conjunction with LAD. Many of these diseases, including bacterial and aspiration pneumonia, eosinophilic lung disease, pulmonary parasites, heartworm disease, and neoplasia also have been described in the veterinary literature as discrete entities.

The purpose of this study was to collect a broad range of demographic and historical data from dogs in order to identify potential risk factors for chronic cough. The identification of such factors potentially could lead, with further investigation, to an increased understanding of underlying mechanisms for the development or exacerbation of diseases resulting in cough. In addition, the association of historical signs with clinical diagnoses may be useful for prioritizing differential diagnoses for individual patients.

MATERIALS AND METHODS

Dogs in this study were patients of the North Carolina State University Veterinary Teaching Hospital (VTH). Coughing dogs were presented to the Small Animal Internal Medicine service between September 2000 and February 2009 for evaluation of a cough of 2 month's duration or longer. Control dogs were presented to the same service between January 2005 and February 2009 for problems other than chronic cough. Computerized medical record data were queried to provide the breed distribution for the entire patient population of the VTH beginning July 2003, corresponding with introduction of a new computerized medical record system.

A questionnaire asking detailed history questions was provided to owners of both coughing and control dogs. Questions were formatted in a variety of ways, including check boxes and free text answers. For responses with check boxes, clients were instructed to check all that applied. The questionnaires for both control and coughing dogs had identical questions regarding the dog's environment, heartworm prophylaxis, and *Bordetella* vaccination. Questionnaires for coughing dogs had additional questions regarding onset and character of the cough, and events associated with cough.

Coughing dogs were selected for participation either by technicians bringing clients to an examination room or by clinicians who identified cases during review of history as obtained by veterinary students. Control dogs were selected for participation by service technicians based on presentation for signs other than cough. Selection of dogs for both groups was based on attentiveness and availability of technicians, and on clients having sufficient time during the appointment process to complete the questionnaire. Control dogs subsequently were excluded if answers on their questionnaire indicated that they had an ongoing cough or any cough within the past year.

Questionnaires were provided to clients in hard copy for completion during the time the veterinary student was presenting the case to the assigned clinician. No assistance was provided. Questionnaire responses were entered into a database by 1 of the authors (JMB) who had no involvement in obtaining questionnaires, retrieving diagnoses, or statistical analysis.

Medical records were reviewed retrospectively by 1 of the authors (ECH) to obtain signalment, body weight, and clinical diagnoses before the analysis of questionnaire data. Clinical diagnoses were obtained from the case discharge summary as determined by the attending clinician. In cases with outstanding test results noted in the discharge summary, results of those tests were reviewed for refinement of the diagnoses.

For statistical analysis, final diagnoses were categorized as follows: large airway disease (LAD), pneumonia, neoplasia, other diseases, and open. Large airway disease included diagnoses of tracheal collapse, bronchial collapse, chronic bronchitis, bronchiectasis, bacterial bronchitis, and eosinophilic bronchitis. Pneumonia included diagnoses of viral, bacterial, aspiration, and pyogranulomatous pneumonia. Neoplasia included primary and metastatic disease. Other diseases included any condition that was diagnosed that potentially could contribute to cough. Individual dogs could be diagnosed with more than 1 category of disease.

Statistical analysis

Descriptive statistics are presented as mean ± standard deviation. Statistical comparisons were made between coughing dogs and control dogs to identify risk factors associated with cough. Responses to questions regarding onset and character of cough and events associated with cough were compared among diagnostic classifications. Comparisons involving numerical data were made by t-test after confirmation of normal distribution of data. Comparisons involving categorical data were carried out by chi-square analysis. The frequencies of exposure to ETS of coughing and control dogs were compared to government figures for prevalence of cigarette smoking among adults for the state of North Carolina for the years 2000–2008 using a 2-tailed, 1-sample binomial proportion test.[14,15]

A p value <0.05 was considered significant. Statistical significance was noted as questionable when any category contained <10 responses. Statistical calculations were performed using commercially available software.[a]

RESULTS

Questionnaires were obtained from the owners of 115 coughing dogs and 109 control dogs. Duration of cough was 19.0 +/− 27.1 months (range, 2 – 156 months or 0.2 −13.0 years). Clinical diagnoses for cough were available for 104 dogs, and the diagnosis was considered open in 11 dogs. Large airway disease was the most common diagnostic category (Table 1). More than 1 category of disease was identified in 28 dogs, 24 of which had LAD. The primary presenting complaints for control dogs were distributed among the following systems: gastrointestinal (n=38); urinary (including polyuria and polydipsia, n= 25); endocrine (n=10); hematologic (n=7); musculoskeletal (n=7); lymphatic (n=3); reproductive (n=3); dermatologic (n=2); respiratory other than cough (n=2); and non-localizing (n=12).

[a]SAS System, Version 9.2, SAS Institute, Cary, NC.

Risk factors associated with cough

Coughing dogs were presented between 0.5 and 16.3 years of age (9.4 +/− 3.6 years), which was significantly older than control dogs (6.8 +/− 4.3 years; $p < 0.001$). Of coughing dogs, 80 (70%) were ≥8 years of age. Of 5 dogs that were ≤1 year of age, 4 had a bacterial component to their disease (2 with LAD, 2 with pneumonia). There was no association between coughing and sex of dog (p=0.86), or month or season of presentation (p=0.239 and p=0.414, respectively).

Coughing dogs (10.3 +/− 15.0 kg; range, 1.7–40.2 kg) were of significantly smaller body weight than control dogs (22.3 +/− 10.3 kg; range, 2.1–66.7 kg; p<0.001). Dogs of toy breeds, based on American Kennel Club classification, were over-represented among coughing dogs when compared with the breed distribution of control dogs (n= 39; p=0.002) and VTH accessions (p<0.001). Of the 39 toy breed dogs, 32 (82%) had a diagnosis of LAD, which included a diagnosis of TBM in 31 of these 32 dogs (97%). Specific breeds were compared if ≥5 dogs were present in the coughing population. Toy breed dogs that were over-represented among coughing dogs when compared with control dogs and VTH accessions were pomeranians (n=7; p=0.037 and p<0.001) and chihuahuas (n=6; p=0.016 and p=0.022), and that were over-represented only when compared with VTH accessions were Yorkshire terriers (n=7; p=0.003), pugs (n=5; p=0.002), and toy poodles (n=6; p<0.001). Non-toy breed dogs that were over-represented were Cocker spaniels (n=13; p=0.005 compared with controls, p<0.001 compared with VTH accessions), miniature poodles (n=6; p<0.001 compared with VTH accessions), and Shetland sheepdogs (n=5; p=0.008 compared with VTH accessions). Dogs of brachycephalic breeds (n=5) were not over-represented among coughing dogs when compared with control dogs (p=0.689) or VTH accessions (p=0.139, with relatively fewer brachycephalic dogs with cough).

Of 114 responses regarding exposure to ETS from clients whose dogs had cough, 47 (43%) indicated that someone had ever smoked at home (even occasionally; including themselves, family members, housemates, visitors, or guests). Of these 47 dogs, 38 (81%) were from households where smoking had occurred in the past year, 25 (53%) were from households where smoking occurred indoors, and 28 (60%) were from households where smoking occurred more often than weekly. None of the 6 dogs with a diagnosis of neoplasia were from households where smoking had ever occurred. Of 109 responses from clients with control dogs, 26 (24%) indicated that someone had ever smoked at home. Of these 26 control dogs, 25 (96%) were from households where smoking had occurred in the past year, 16 (62%) were from households where smoking occurred indoors, and 19 (73%) were from households where smoking occurred more often than weekly.

Statistical analysis of data related to exposure to ETS as an environmental risk factor for cough was confounded by the lack of questionnaires for control dogs from the years 2000–2004. Considering only contemporaneous responses from clients with coughing dogs collected between 2005 and 2009 when controls were available, 19 of 59 (32%) indicated that someone had ever smoked at home. When compared with the responses from clients with control dogs during this time period, an association between exposure to ETS and cough was not found (p=0.243). Elimination of data from the years 2000–2004 for coughing dogs decreased the sample size of this population by half, resulting in power of only 0.20 for a 0.05 level test. To consider data from the entire population of coughing dogs, population prevalence of smoking among adults by year was used as a basis for comparison. Because 90% of coughing dogs were from NC, comparisons were made between the rates of exposure of dogs to ETS and the prevalence of adult smokers in NC (NC adult prevalence; Table 2). For the years 2000–2009 and 2000–2004, the rate of exposure to ETS was significantly different from the prevalence of smoking in NC adults for coughing dogs (p=0.004 and p<0.001) but not for control dogs (p=0.99 for 2000–2009). For the years

2005–2009, the difference between the prevalence of smoking in NC adults and rate of exposure to ETS approached significance for coughing dogs (p=0.060), but was not significant for control dogs (p=0.68).

Unexpectedly, control dogs were more likely to come from homes where a fireplace of any type was ever used than were coughing dogs (p=0.0076). Of 114 responses from clients with coughing dogs, 44 (39%) reported ever using a fireplace in the home whereas 61 (56%) of 108 responses from clients with control dogs indicated fireplace use. The majority of fireplaces were gas. Twelve of the fireplaces used in the homes of coughing dogs were wood-burning and 1 was coal-burning, whereas 21 were wood-burning in the homes of control dogs.

No other associations with environment were found, including whether dogs spent most of their time indoors, outside or both (p=0.362). The majority of dogs in both populations spent most of their time indoors (88% of coughing dogs, 93% of control dogs).

Over 90% of dogs in both groups were reportedly receiving heartworm preventative medications, and there was no evidence of a difference between groups (p=0.16). There also was no difference between groups with respect to having been vaccinated ever or in the last year for *Bordetella* (p=0.72). However, the questions related to *Bordetella* vaccination frequently were not answered and some clients indicated that they did not know for certain which specific vaccines were administered.

Cough characteristics and association with particular activities as compared with diagnosis

Onset of cough was reported to be gradual in 59 dogs (58%) and sudden in 42 dogs (42%), with no association with diagnosis (Table 3). Similarly, consistency of cough was not found to be associated with diagnosis.

Although some differences were found, no description of the character of cough was unique to a particular diagnosis. The majority of clients (70%) reported a cough that was loud based on a description of “loud or harsh”, “hacking”, “honking,” or some combination of these. However, the frequency of a loud cough was no different between dogs with a diagnosis of LAD alone (72%) or with a diagnosis other than LAD (74%). Moist cough was reported more frequently in dogs with diagnoses other than LAD (44%) than in dogs with a diagnosis of LAD alone (22%; p=0.030). Although the number of dogs was small, quiet cough was reported more frequently in dogs with pneumonia (3 of 10, 30%) than in dogs with LAD alone (5%; p=0.0064).

Responses to questions regarding an association between cough and particular activities are provided in Table 4. When comparing dogs with LAD alone to dogs without LAD, dogs with LAD were more likely to have cough that was worse with exercise (p=0.039). Dogs without LAD were more likely to have cough that was worse with eating (p=0.0016). Three of the 7 dogs without LAD whose cough was worse with eating had esophageal disease and 2 had laryngeal disease. Again, numbers were small.

DISCUSSION

Dogs of small body weight, toy breed dogs, and older dogs were over-represented among coughing dogs. Cocker spaniels also were over-represented, and a predisposition to bronchiectasis has been reported previously in this breed.[16] Wheeldon, et al. [8] reported a predominance of terriers and small terrier-type mongrels among dogs with chronic bronchitis. However, Padrid, et al.[11] reported that over half of dogs with chronic bronchitis weighed ≥15 kg, and 7 of 10 dogs with chronic bronchitis in the report by Bexfield, et al.[13] were large breeds. In the current study, the few young dogs with chronic cough often had a bacterial component to their disease.

We were unable to confirm a statistical association between exposure to ETS at home and chronic cough in pet dogs. Although a strong association can be found if the entire data set considered, the study methodology introduced a possible temporal effect. Data collection was initiated in 2000 to improve the acquisition of patient history and for the creation of a database of detailed historical findings in dogs with chronic cough. The current study was designed several years later, adding a control population for statistical comparisons. The time delay in collection of control data was not anticipated to greatly impact the variables examined. However, upon analysis of data, we questioned whether a decrease in smoking rate among people throughout the duration of the study might have influenced our results. Limiting analysis to data collected as of 2005 resulted in a loss of statistical significance for the higher rater of exposure to ETS among coughing dogs, but also decreased the likelihood of detecting a significant difference as a consequence of decreased sample size. Therefore, we also used the population prevalence of smoking among adults in NC as a fixed standard for comparing the rates of exposure to ETS among both coughing and control dogs for each time period. The results of these comparisons support a strong association between cough and smoking during the earlier years of the study, and suggests an association ($p=0.060$) for the more recent years. However, these comparisons are based on the unproven assumption that a relationship exists between exposure of study dogs to ETS and the prevalence rate of smoking among adults.

Additional studies that specifically target the relationship between ETS and cough in dogs are clearly warranted. Environmental tobacco smoke is a known health risk to people, and with respect to pulmonary disease has been associated with lung cancer, decreased lung function, asthma, chronic bronchitis, chronic obstructive pulmonary disease, and acute and chronic respiratory symptoms including cough, wheeze, chest tightness, and difficulty breathing.[17] Chronic cough in adults has been associated with exposure to ETS in childhood and at work alone in adulthood, indicating that adverse effects may be possible without continuous, ongoing, exposure.[1–4] In people with chronic cough due to chronic bronchitis, evidence-based clinical practice guidelines strongly (Grade A) recommend the following: "In patients with chronic cough who have chronic exposure to respiratory irritants such as personal tobacco use, passive smoke exposure, and workplace hazards, avoidance should always be recommended. It is the most effective means to improve or eliminate the cough of chronic bronchitis."[18]

Several studies have implicated ETS as a health risk in dogs. Studies by Reif, et al found an association between household exposure to ETS and lung cancer in pet dogs of brachycephalic and mesocephalic breeds and for nasal cancer among dolichocephalic dogs.[19,20] No dogs with neoplasia in our study had reported exposure to ETS, but only 6 dogs had this diagnosis. Dogs with exposure to ETS have anthracosis with increased lymphocytes and macrophages in bronchoalveolar lavage fluid.[21] Early laboratory-based studies of direct exposure of dogs to cigarette smoke have documented airway inflammation and changes in airway epithelium.[22–24]

Exposure to wood smoke has been associated with chronic obstructive pulmonary disease in people.[5] In a study of acute cough, an association was found with fireplace, but not wood stove use, whereas wood stove use was associated with increased rates of wheezing.[25] Counter-intuitively, dogs in homes where fireplaces were used were less likely to have chronic cough. The relatively high proportion of gas fireplaces or other cofounding variables not examined in this study, such as relative humidity or ventilation, may have influenced this outcome.

The inability to identify specific historical descriptions of cough as being unique to particular diagnoses was striking, but some associations were found. Based on experience, textbook authors (including ECH) have associated loud, harsh, hacking or honking cough with LAD and soft cough with alveolar disease (pneumonia or pulmonary edema).[26–28] Although dogs with LAD alone often had a cough described by these terms, so did an equal proportion of dogs with a diagnosis other than LAD. Soft cough was more frequently reported in the few dogs with pneumonia compared with dogs with LAD alone. However, only 30% of dogs with pneumonia were presented with this description.

Other limitations of study design could have influenced results involving diagnoses, such as characteristics of cough and association with specific activities. The study population included dogs referred to an internal medicine service within an academic hospital with many other specialty services. Dogs with obvious diagnoses may never have been referred, and dogs with a presumptive diagnosis of oncologic or cardiac disease would likely be referred directly to other services. The majority of dogs had 1 or more LAD, with other categories of disease represented by relatively small numbers of dogs. Most dogs had already received treatments for their cough from their primary veterinarian, and such treatments may have influenced the descriptions of cough or decreased the number of dogs identified with bacterial infections. Diagnoses were based on the clinical determination of the primary clinician as indicated in the case summary, and no criteria were in place regarding a minimum diagnostic evaluation. Diagnoses of exclusion, such as chronic bronchitis, may have been more likely when complete diagnostic evaluations were not performed, whereas diagnoses such as TBM or infection likely were missed when specific tests were not performed.

This study also was limited by the methods used to collect information from the clients. There are many potential sources for error when obtaining data by questionnaire. This study was conceived as an economical method to obtain a broad range of data in a prospective manner. The use of questionnaires was superior to a retrospective review of history as written in the medical record, where the absence of a comment (such as the presence of smoking in the household) could indicate either a negative response or a failure of the question to be asked. Methods were consistent from client to client regardless of whether the dog was in the coughing or control group and regardless of the clinical diagnosis. To minimize investigator bias, data entry of questionnaire responses and determination of diagnoses from the medical records were performed independently by different investigators.

Frequency of diagnoses was not a specific aim of this project. However, TBM was diagnosed in approximately half of all dogs and in the majority of toy breed dogs with chronic cough. With the advent of computed tomography scans obtained during forced expiration, TBM is being diagnosed more frequently in people, and associated diseases are numerous.[29] The incidence of TBM reported in this study may have been under-represented because special effort often is required to make this diagnosis.[30]

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Abbreviations

ETS	environmental tobacco smoke
LAD	large airway disease
TBM	tracheobronchomalacia
VTH	veterinary teaching hospital
NC	North Carolina

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TABLE 1

Clinical diagnoses by category of 115 dogs with chronic cough.

LARGE AIRWAY DISEASE	**88 (77%)**
CHRONIC BRONCHITIS	77 (67%)
Bacterial component	8 (7%)
Eosinophilic component	16 (14%)
Bronchiectasis	12 (10%)
TRACHEOBRONCHOMALACIA	59 (51%)
Tracheal collapse, unspecified	3 (3%)
Tracheal collapse, extrathoracic	5 (4%)
Tracheal collapse, intrathoracic	39 (34%)
Bronchial collapse	46 (40%)
PNEUMONIA	**10 (9%)**
Aspiration	3 (3%)
Bacterial	4 (3%)
Other	3 (3%)
PULMONARY NEOPLASIA	**6 (5%)**
OTHER POTENTIALLY RELATED DISEASES	**32 (28%)**
Significant Left Atrial Enlargement	8 (7%)
Esophageal or pharyngeal disease	7 (6%)
Laryngeal disease	5 (4%)

Table 2

Rates of exposure to environmental tobacco smoke (ETS) of coughing and control dogs and prevalence of smoking among adults in North Carolina for the years 2000-2004 and 2004–2009.

Years	Exposure to ETS among coughing dogs (%)	Exposure to ETS among control dogs (%)	Smoking prevalence in NC (%)[a]	P value coughing vs control dogs	P value coughing dogs vs smoking prevalence	P value control dogs vs smoking prevalence
2000–2009	47/114 (41.2)	26/109 (23.9)	23.9	nd	0.004	0.99
2000–2004	28/55 (50.9)	nd	25.3	nd	<0.001	nd
2005–2009	19/59 (32.2)	26/109 (23.9)	22.2	0.243	0.060	0.68

nd, not determined;

[a]Through 2008. From: CDC. State-specific prevalence and trends in adult cigarette smoking-United States, 2998–2007. MMWR 2009;58:221–226 and CDC. State-specific secondhand smoke exposure and current cigarette smoking among adults-United States, 2008. MMWR 2009;58:1232–1235.

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Table 3

Characteristics of cough in dogs with chronic cough.

Characteristic	All dogs (n=115)	LAD alone (n=64)	No LAD (n=27)	*P*-value LAD alone vs No LAD
Onset (responses exclusive)				
Gradual	59 (51%)	33 (55%)	14 (52%)	0.873
Sudden	42 (37%)	23 (36%)	11 (41%)	0.758
Neither selected	14 (12%)	8 (13%)	2 (7%)	0.606
Consistency (responses exclusive)				
Consistent day to day	31 (27%)	18 (28%)	6 (22%)	0.459
Better on some days	51 (44%)	29 (45%)	12 (44%)	0.753
Better some weeks	9 (8%)	3 (5%)	3 (11%)	0.292
Better some months	2 (2%)	2 (3%)	0 (0%)	0.339
Sometimes absent	11 (10%)	4 (6%)	4 (15%)	0.217
None selected	11 (10%)	8 (13%)	2 (7%)	0.478
Character of cough (responses not exclusive)				
Dry	54 (47%)	36 (56%)	10 (37%)	0.094
Moist	35 (30%)	14 (22%)[a]	12 (44%)[a]	0.030
Gag or retch	62 (54%)	33 (52%)	15 (56%)	0.727
Quiet or soft	9 (8%)	3 (5%)	2 (7%)	0.603
Loud[b]	80 (70%)	46 (72%)	20 (74%)	0.830
Loud or harsh	33 (29%)	15 (23%)	10 (37%)	0.184
Hacking	57 (50%)	31 (48%)	15 (56%)	0.535
Honking	28 (24%)	15 (23%)	8 (30%)	0.535
No description selected	3	2 (3%)	1 (4%)	na

LAD, large airway disease;

[a]Statistically different.

[b]Total dogs with a description of loud or harsh, hacking, and/or coughing.

Table 4

Association of cough with particular activities.

Characteristic	All dogs (n=115)	LAD alone (n=64)	No LAD (n=27)	*P*-value LAD alone vs No LAD
Association with exercise				
Worse	49 (43%)	29 (45%)[a]	6 (22%)[a]	0.039
Better	4 (3%)	0 (0%)	4 (15%)	0.0016
Association with excitement				
Worse	66 (57%)	36 (56%)	13 (48%)	0.479
Better	1 (1%)	1 (2%)	0 (0%)	0.514
Association with drinking				
Worse	24 (21%)	10 (16%)	8 (30%)	0.126
Better	5 (4%)	3 (5%)	0 (0%)	0.253
Association with eating				
Worse	12 (10%)	2 (3%)[b]	7 (26%)[b]	0.0016
Better	4 (3%)	3 (5%)	0 (0%)	0.253
Association with sleep				
Worse	45 (39%)	25 (39%)	10 (37%)	0.856
Better	23 (20%)	14 (22%)	2 (7%)	0.978
Association with weather or season				
Worse	22 (19%)	15 (23%)	2 (7%)	0.073
Better	8 (7%)	7 (11%)	0 (0%)	0.074

LAD, large airway disease;

[a,b]Statistically different.