



# A quality-of-life measure for adults with primary ciliary dyskinesia: QOL-PCD

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**ABSTRACT** Primary ciliary dyskinesia (PCD) is characterised by chronic suppurative lung disease, rhino-sinusitis, hearing impairment and sub-fertility. We have developed the first multidimensional measure to assess health-related quality of life (HRQoL) in adults with PCD (QOL-PCD).

Following a literature review and expert panel meeting, open-ended interviews with patients investigated the impact of PCD on HRQoL in the UK and North America (n=21). Transcripts were content analysed to derive saturation matrices. Items were rated for relevance by patients (n=49). Saturation matrices, relevance scores, literature review, evaluation of existing measures, and expert opinion contributed to development of a preliminary questionnaire. The questionnaire was refined following cognitive interviews (n=18).

Open-ended interviews identified a spectrum of issues unique to adults with PCD. Saturation matrices confirmed comprehensive coverage of content. QOL-PCD includes 48 items covering the following seven domains: Physical Functioning, Emotional Functioning, Treatment Burden, Respiratory and Sinus Symptoms, Ears and Hearing, Social Functioning, and Vitality and Health Perceptions. Cognitive testing confirmed that content was comprehensive and the items were well-understood by respondents.

Content validity and cognitive testing supported the items and structure. QOL-PCD has been translated into other languages and is awaiting psychometric testing.



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## Introduction

Primary ciliary dyskinesia (PCD) is a rare disease (~1 in 15 000 people) inherited in a genetically heterogeneous, autosomal recessive pattern [1–3]. It is characterised by chronic infection of the upper and lower airways caused by impaired mucociliary clearance as a consequence of abnormal function of motile cilia. In healthy individuals, cilia clear airway mucus, bacteria and debris by coordinated beating. The ciliary dysfunction in PCD leads to a daily wet cough, recurrent chest infections and rhino-sinusitis. By adulthood, bronchiectasis is invariable and many patients develop respiratory failure [4]. Motile cilia are important in organ systems besides the airways, such as the embryonic node, sperm flagella and the female reproductive tract. Therefore, patients frequently have problems caused by non-respiratory dysmotile cilia, *e.g.* serous otitis media (“glue ear”) leading to hearing impairment and immotile sperm causing infertility). The cilia of the embryonic node, responsible for left–right asymmetry of organs, are similar in structure to respiratory cilia. Dysfunction of embryonic nodal cilia in PCD causes laterality defects, including situs inversus (chest and abdominal organs are mirror image of normal; seen in approximately 40% of cases) and situs ambiguous (disturbance of the usual left and right distribution of the thoracic and abdominal organs which does not entirely correspond to mirror image; seen in approximately 10% of cases) and can be associated with congenital heterotaxic heart disease in approximately 2–3% of cases [5].

Monitoring of disease progression and evaluation of therapeutic options has been hampered by a lack of disease-specific outcome measures. Spirometry is an insensitive marker of progressive lung disease, which is evident using high-resolution computed tomography (HRCT) [6]. Although HRCT is a useful staging test, it is an impractical monitoring tool. Lung clearance index (LCI), measured by multiple breath washout, has been investigated as a potential tool for monitoring at specialist centres using sulphur hexafluoride (SF<sub>6</sub>) as a tracer gas [7, 8]. However, contrary to findings in cystic fibrosis (CF), LCI does not appear to be a sensitive test of airway disease in advanced PCD [7]. Furthermore, physiological measures provide information on objective indicators of health to patients and clinicians, but these measures do not reflect the patient perceptions of the impact of the disease on symptoms as well as physical, social and emotional functioning.

Thus, measures are needed to assess the impact of PCD, from the patient’s perspective, on all domains of patient functioning [9–11]. Health-related quality of life (HRQoL) measures have become a vital and necessary component of patient-reported outcomes (PROs) in populations with chronic disease [12]. The US Food and Drug Administration (FDA) defines HRQoL as the patient’s perception of how they “survive, feel, and function” [13]. We used a model for HRQoL originally proposed by WILSON and CLEARY [14] and revised by FERRANS *et al.* [15]. There is extensive agreement that assessment of HRQoL should encompass, at minimum, physical, social and emotional well-being and symptoms which allow for a multidimensional, systematic measure of how the illness and its treatment impact symptoms and other domains of functioning.

Existing PROs do not assess the disease-specific effects of PCD on daily symptoms and functioning. Most studies have utilised either generic (*e.g.* Short Form 36 Health Survey) or broad-based respiratory questionnaires, such as the St George’s Respiratory Questionnaire (SGRQ) [16–19] and two additional studies have utilised qualitative interview methods [20, 21]. These PROs have a number of limitations for assessing HRQoL in adults with PCD. For example, the SGRQ was developed for patients with chronic obstructive airways disease and, thus, has a limited number of respiratory symptoms, no items relevant to ear, nose and throat disease or fertility problems, long and variable recall periods and considerable respondent burden (*e.g.* nearly an hour to complete). Thus, there was an urgent need to develop a disease-specific measure for adults with PCD. These tools can be used to document the progression of disease, monitor patients clinically and serve as an outcome measure for clinical trials of new therapies.

Our ultimate goal is to develop a PCD-specific HRQoL instrument for use as a primary or secondary outcome measure in large, randomised clinical trials. To recruit adequate numbers of participants, multi-centre and multi-national collaboration was required. Therefore, researchers from the UK, North America and Ireland worked closely to develop age-specific questionnaires (child, adolescent, parent-proxy and adult) using guidance developed by the FDA and European Agency for the Evaluation of Medicinal Products (EMA) [13, 22, 23]. Development of the child, adolescent and parent-proxy versions will be reported in a separate manuscript. This manuscript describes the development process for the QOL–PCD Adult version which included the following phases: 1) literature review and expert panels; 2) open-ended interviews with patients in UK, USA and Canada; 3) item generation; 4) cognitive testing; and 5) refinement of the draft measure. QOL–PCD is now being validated in Europe, USA and Canada; the psychometric reliability and validity will be reported when these studies are complete.

## Methods

The protocol for development of the QOL–PCD complied with the FDA and EMA requirements. The study was approved by Southampton and South West Hampshire Research Ethics Committee

(Southampton, UK) A 07/Q1702/109 and by the University of Miami Institutional Review Board (Miami, FL, USA). Informed consent was obtained prior to interviews.

#### *Literature review and expert panel*

First, a systematic literature review was conducted to identify key symptoms and effects of PCD on patient functioning. MEDLINE and EMBASE were searched, and additional references were sought through citations in the identified studies. Abstracts were reviewed and manuscripts sourced for research investigating the effects of PCD on adults.

In the next step, expert clinicians, allied health professionals and researchers met to discuss their own perceptions of the impact of PCD on adults, based on their clinical experiences. These sources of information contributed to a long list of items patients rated for relevance. These items also informed the development of the open-ended interview guide.

#### *Participants*

In the UK, participants for the open-ended and cognitive interviews were recruited from PCD clinics and from an advert through the PCD Family Support Group UK. A list of potential items was sent to the Family Support Group in the UK to rate their relevance. Participants in North America were recruited from a cohort of PCD patients evaluated at the University of North Carolina, as well as from the US PCD Foundation's registry of patients. Expert opinion was also sought during the item generation and item reduction phases from members of the European PCD Group.

Criteria for participation in the open-ended and cognitive interviews included age  $\geq 18$  years with a diagnosis of PCD. Patients were recruited from English-speaking countries: UK, USA and Canada. UK participants had an existing diagnosis from one of the English diagnostic centres [1, 24] based on clinical phenotype plus high-speed video analysis of ciliary function and/or assessment of ciliary ultrastructure by electron microscopy. North American participants were diagnosed at a specialised PCD research center, based on: a compatible clinical phenotype plus defect in ciliary ultrastructure and/or identification of biallelic disease-causing mutations in one of the PCD genes.

#### *Open-ended interviews*

In-depth interviews were conducted either in-person or by phone to elicit the effects of PCD from the patients' perspective. Interviews were conducted in the UK by L. Behan and in USA and Canada by A. L. Quittner, A. Alpern and A.M. Morris. All participants were fluent in English. We attempted to interview patients who were geographically representative and clinically stable. The audio of all interviews was recorded and transcribed for content analysis using either NVivo (version 8 2008; QSR International Pty Ltd, Daresbury, UK) in the UK or Atlas.ti (Version 7.0; Scientific Software Development, Corvallis, OR, USA) in the USA. Thematic coding was used to identify key symptoms and psychosocial impacts. Two members of each research team coded the interview transcripts using consensus coding. When there was a discrepancy, this was discussed and resolved within the pair of coders. We did not calculate percentage agreement since we used a consensus coding process. These data were then analysed to identify critical items based on frequency of endorsement. Content analysis of these transcripts yielded saturation and indicated that the measure was comprehensive and that all relevant items were included.

#### *Item generation*

Questions from the literature review, expert panel and open-ended interviews were also sent by post to respondents of an advert circulated to members of the PCD Support Group and to adult patients at PCD clinics in the UK. A pre-paid envelope and covering letter was included. Participants rated each item using a 5-point Likert scale (1: "not relevant"; to 5: "highly relevant").

Items for the initial QOL-PCD measure were based primarily on the patient-based content analysis. We discussed these results in a series of teleconferences chaired by J.S. Lucas. Each meeting included clinicians, psychologists and interviewers from Ireland, the UK and the USA. Decisions made using a modified Delphi approach guided by two main principles. The primary criterion for including an item was its impact on HRQoL, measured by the frequency with which items were mentioned across patients and in relation to other items mentioned. There was no pre-determined frequency required for inclusion of an item, but the researchers considered the frequency each item was mentioned relative to the other items in that domain. They also considered the importance interviewees placed on these items. Secondly, patients' ratings of relevance from the UK survey were considered. For each item, decisions were made to include an item based on our discussion. When there was initial disagreement, the chair invited each individual to explain their rationale. Unanimous agreement was achieved within two rounds of

discussion. Finally, we determined that all of the content had been identified based on saturation matrices in the UK and US, which showed that no new content emerged after six patients, on average, in each country. We included at least four items on each subscale to ensure adequate internal consistency.

### ***Construct of prototype questionnaire***

Agreement on item selection and wording was achieved during multi-disciplinary, multinational conference calls. Selected items were written using patient language obtained in the qualitative interviews and then combined into scales (e.g. frequency and severity of respiratory symptoms, perceptions of treatment burden). Where appropriate, the items were formulated into questions based on the Cystic Fibrosis Questionnaire-Revised (CFQ-R), which has been well-validated [12, 25]. Some example CFQ-R items that were adapted to the PCD HRQoL measure include: “Did you cough during the day?” and “How often does CF get in the way of meeting your school, work, or personal goals?” Items were written to ensure conceptual, cultural and linguistic equivalence for North America, the UK and Ireland, by researchers from the USA, England and Ireland. We also adhered to both the FDA and EMEA Guidance [13, 22, 23]. For example, as recommended, we asked patients to answer questions based on their symptoms and impact over the past week.

### ***Cognitive interviews***

Cognitive interviews were conducted prior to formal psychometric validation of questionnaires to evaluate how respondents process the question and rating options cognitively; *i.e.* What “meaning” do these items have for respondents? Is this the same meaning we intended? What were they considering when rating frequency or impact? Specifically, we wanted to identify any problems with the instructions, organisation of the questionnaire, item interpretation, memory retrieval, decision-making processes and response selection. A “think aloud” procedure was used to investigate the participants’ comprehension of the instructions, items and rating scales. They were asked clarifying questions, such as: “What were you thinking of when answering that question?” and “What does X word mean to you?” For example, “What does feeling ‘well’ mean to you?”, “What would have made you endorse a higher/lower frequency for that question?”, “How relevant/important is this question for you?”, “Are the rating options clear to you?” and “Are they easy to use?”

Participants were first asked to complete the prototype questionnaire independently. Next, they were interviewed using specific cognitive probes, which focused on the clarity of the question, its meaning, relevance and importance, and what would have shifted their response to an adjacent answer. The audio of all interviews was recorded and transcribed. The results were discussed during a series of teleconferences to determine whether revisions were required for the format, instructions or items. The measure was refined based on the cognitive interviews and then finalised.

## **Results**

### ***Item generation***

Items were generated by the expert panel and the qualitative, open-ended interviews with patients. Characteristics of participants who completed the open-ended interviews (n=21) are shown in table 1. The majority of participants were female, and among US participants, most were between 18 and 35 years of age. As expected, nearly all adults described a chronic cough and sino-nasal symptoms. Eight (38%) participants described themselves as infertile or had required assisted fertilisation, but 10 (48%) participants had not yet tried to conceive or had their fertility status checked. Selected patient quotes from the open-ended interviews conducted with UK and North American participants are presented in table 2.

### ***Content analysis and item reduction***

Content analysis of the transcripts yielded the most important items for each of the 10 domains based on the frequency with which they were mentioned across adults. Saturation of content, across domains, was confirmed when no new themes emerged (figure 1). Our results indicated that this was achieved by the 5–7th interview, depending on the specific content area. We also harmonised the content across UK and North America to identify the most important topics. The items that were considered most important and relevant by the participants who performed the open-ended interviews were also scored as highly relevant by the 49 adult members of the PCD UK support group who completed the survey. Thus, content analysis of the interviews concurred with results of the survey (supplement table S).

TABLE 1 Demographics and clinical characteristics of participants

	Study population	UK	USA
<b>Participants n</b>	21	11	10
<b>Sex</b>			
Male	3 (14)	1 (9)	2 (20)
Female	18 (86)	10 (91)	8 (80)
<b>Age years</b>			
18–35	12 (57)	5 (45)	7 (70)
36–50	4 (19)	1 (9)	3 (30)
51–65	3 (14)	3 (27)	
>65	2 (10)	2 (18)	
<b>Age at diagnosis years</b>			
<5	4 (19)	1 (9)	3 (30)
5–12	4 (19)	0	4 (40)
12–18	1 (5)	1 (9)	0
>18	12 (57)	9 (82)	3 (30)
<b>Race/ethnicity</b>			
UK			
White British		9 (82)	
British Asian		1 (9)	
Asian		1 (9)	
USA			
Caucasian			10 (100)
Hispanic			9 (90)
White non-Hispanic			1 (10)
<b>Symptoms</b>			
Chronic wet cough	21 (100)	11 (100)	10 (100)
Persistent runny nose	20 (95)	11 (100)	9 (90)
Recurrent sinus disease	16 (76)	8 (72)	8 (80)
Infertility	8 (38)	4 (36)	4 (40)
Situs abnormalities	12 (57)	8 (72)	4 (40)
Cardiac disease	0	0	0
<b>FEV<sub>1</sub><sup>#</sup> % predicted</b>			
Range		31–98	29–102
Mean±SD		64±21	65±25
<b>Employment status</b>			
In paid employment	11 (52)	4 (36)	7 (70)
Student	4 (19)	2 (18)	2 (20)
Retired due to age	1 (5)	1 (9)	0
Retired/left work due to PCD	4 (19)	3 (27)	1 (10)
Carer for dependants	1 (5)	1 (9)	0
Other	0	0	0
<b>Marital status</b>			
Single	5 (24)	3 (27)	2 (20)
Living with partner/spouse	16 (76)	8 (73)	8 (80)
Separated from partner/spouse		0	0
Widowed		0	0
<b>Fertility</b>			
Conceived naturally		3 (27)	0
Conceived through IVF		1 (9)	2 (20)
Infertility		3 (27)	2 (20)
Not yet known		4 (36)	6 (60)

Data are presented as n (%), unless otherwise stated. #: forced expiratory volume in 1 s (FEV<sub>1</sub>) is based on n=5 participants in the UK and n=8 in North America; data were unavailable for telephone interviews.

### Cognitive testing

Cognitive interviews were conducted with 15 adults (UK n=9, USA n=6). Review of these transcripts indicated that patients found the items clear, important and relevant and had no difficulty with the response options. Six items were added, based on patient input, after the cognitive testing phase (table 3). These topics included: making plans for the future (vacation, attending family events), treatment burden, intimacy, and pain associated with sinus disease. Thus, the final prototype instrument contained 48 items

TABLE 2 Participant quotes by topic

Topic	Quote	Country of interviewee/sex/age band in years
<b>Impact of respiratory symptoms</b>	"I had to tell the group not to worry because I start huffing and spluttering as I'm walking."	UK/female/36–50
	"When I listen to myself breathe, I always wheeze."	USA/female/18–35
<b>Impact of sinus symptoms</b>	"I'm always blowing my nose, doesn't matter what weather it is."	UK/female/36–50
	"I always have to blow my nose before I eat if I wanna taste anything."	USA/female/36–50
<b>Impact of ear symptoms/hearing loss</b>	"You have to ask people to repeat themselves so many times, they're just, like, 'oh don't worry about it'."	UK/male/18–35
	"I can't go white water rafting because I have tubes in my ears and my ears can't get wet."	USA/female/18–35
<b>Impact of fertility issues</b>	"Finding out that I possibly can't have kids; that's when it started to panic me a little bit."	UK/male/18–35
	"I'm still very uncertain if I ever wanna have children because I don't know how me having this illness will affect them."	USA/female/18–35
<b>Impact of treatment burden</b>	"I don't really want to do it; it's kind of boring and it's not fun and I'd rather do something else. But obviously you have to do it."	UK/female/18–35
	"I think it just requires more planning. I need to wake up earlier or start getting ready for bed earlier, I need to come home from work and do this; it's just more planning."	USA/female/18–35
<b>Emotional functioning</b>	"I'm so frustrated with this illness, I just want it to go away, but, unfortunately, that's how I have to live."	UK/male/18–35
	"...if you go to the doctor [and] you're feeling pretty good and you know your numbers are not good; that can be a big cause of anxiety."	USA/female/18–35
<b>Social functioning</b>	"It has had such a huge impact on my life, and certainly I think it's contributed to the breakup of my first marriage."	UK/female/50–64
	"...there have been times where I've had to cancel things because I've gotten sick. Getting sick can happen overnight; you're fine one day and the next day you feel awful."	USA/female/18–35

(QOL-PCD v1.2). Following this iterative process, the draft version of the QOL-PCD v.1.2 is ready to be tested in a psychometric validation study.

## Discussion

This process, conducted in the UK and North America, yielded the first HRQoL instrument for adults with PCD, the QOL-PCD. It was developed following the guidelines published by the major regulatory bodies in Europe and the USA (*i.e.* EMEA and FDA) [13, 22, 23] and will be submitted to these agencies for consideration as an outcome measure for clinical trials. The most important principle governing its development was our reliance on patient input and their perspective at each phase. Thus, this tool systematically reflects how an adult with PCD "survives, feels, or functions" [13]. Given the rarity of this chronic disease, we developed the content cross-culturally in English-speaking countries (UK, USA and Canada) and found no discrepancies in content across countries. Additional input was obtained from the current literature and from medical experts across Europe and North America.

Open-ended interviews highlighted the importance not only of patients' respiratory symptoms, but the effects of sinus disease and hearing problems on daily functioning. Although sinus disease is also

Respiratory symptoms	UK participants											Total	US participants											Total
	1	2	3	4	5	6	7	8	9	10	11		1	2	3	4	5	6	7	8	9	10		
Cough	1	1	1	1	1	1	1	1	1	1	1	11	Cough	1	1	1	0	1	1	1	1	1	1	9
Shortness of breath	1	1	1	1	1	1	1	0	1	1	0	9	Chest congestion	0	1	0	1	1	1	1	1	1	0	7
Chest congestion	1	1	1	1	1	1	1	0	0	1	1	9	Chest pain	1	1	0	1	1	0	1	1	0	1	7
Cough up mucus	1	0	1	1	1	1	1	0	0	1	1	8	Cough up mucus	1	0	1	1	0	1	1	0	0	0	5
Chest tightness	1	1	0	0	1	0	1	0	0	0	1	5	Shortness of breath	0	0	1	0	1	0	0	1	1	1	5
Wheezing	0	1	1	0	1	0	0	0	0	0	1	4	Chest tightness	1	0	1	1	0	0	0	0	0	1	4
Cough interrupts sleep	0	1	1	0	0	0	0	0	0	0	1	3	Cough interrupts sleep	1	0	1	0	1	0	0	0	0	0	3
Chest pain	0	0	0	0	1	1	0	0	0	0	1	3	Wheezing	1	0	1	0	0	0	0	0	1	0	3
Cough with exertion	0	0	1	1	0	0	1	0	0	0	0	3	Cough with exertion	0	1	0	0	0	0	0	0	0	0	1
Chest pain with exertion	0	0	0	0	0	0	0	0	0	0	0	0	Sleep disturbances from chest pain	0	1	0	0	0	0	0	0	0	0	1
Sleep disturbances from chest pain	0	0	0	0	0	0	0	0	0	0	0	0	Chest pain with exertion	1	0	0	0	0	0	0	0	0	0	1

  

Rhino-sinus symptoms	1	2	3	4	5	6	7	8	9	10	11	Total
Runny nose	1	1	1	1	1	1	1	1	1	1	1	11
Stuffy nose	1	0	1	1	0	0	0	0	1	0	1	5
Post-nasal drip	1	0	0	0	0	0	0	1	0	0	0	2
Sinus pain/headache	0	0	1	1	0	0	0	0	0	0	0	2
Sinus surgery	1	0	0	1	0	0	0	0	0	0	0	2
Difficulty smelling	1	0	0	1	0	0	0	0	0	0	0	2 <sup>#</sup>
Sinus congestion	1	0	1	0	0	0	0	0	0	0	0	2
Sinus pressure	0	0	1	0	0	0	0	0	0	0	0	1
Difficulty tasting	0	0	0	1	0	0	0	0	0	0	0	1

  

Ear and hearing symptoms	1	2	3	4	5	6	7	8	9	10	11	Total
Trouble hearing	1	0	1	0	1	0	0	0	1	1	1	6
Ears blocked	1	0	1	0	1	0	0	0	1	0	1	5
Ear ringing	0	0	0	0	0	0	0	0	0	0	0	0
Problems with balance	0	0	0	0	0	0	0	0	0	0	0	0

  

US participants	1	2	3	4	5	6	7	8	9	10	Total
Stuffy nose	1	1	0	1	1	1	1	1	1	0	8
Sinus pain/headache	1	1	0	1	1	1	0	1	1	1	8
Runny nose	1	1	0	0	1	0	1	1	1	1	7
Post-nasal drip	0	0	0	1	0	1	0	0	1	1	4
Difficulty smelling	0	1	0	0	1	0	0	1	1	1	5 <sup>#</sup>
Sinus surgery	1	1	0	0	0	0	0	1	0	1	4
Difficulty tasting	0	1	0	1	1	0	0	0	0	0	3
Sinus congestion	0	0	0	1	1	0	0	0	1	0	3
Sinus pressure	1	0	0	0	0	0	0	0	0	0	1

  

US participants	1	2	3	4	5	6	7	8	9	10	Total
Trouble hearing	1	1	1	1	1	1	1	1	1	1	10
Ears blocked	0	1	0	1	0	0	0	0	0	1	5
Ear ringing	0	0	0	0	0	1	0	0	0	0	2
Problems with balance	1	0	0	0	0	0	0	0	0	0	1

FIGURE 1 Saturation grids for UK and US participants: respiratory symptoms, sinus symptoms, and ear and hearing symptoms. Vertical lines indicate saturation was reached. All items above the horizontal lines were retained for the final questionnaire. Shaded cells refer to the first time the item was mentioned. <sup>#</sup>: participants did not indicate adverse effects of difficulty smelling; therefore it was not included in the final questionnaire.

problematic for patients with CF and non-CF bronchiectasis, patients with PCD emphasised the additional impact of their upper respiratory tract symptoms. This highlights that PCD has distinct features from other bronchiectatic diseases [26], and deserves individualised management. Thus, a number of items assessing rhino-sinus and ear symptoms appear on the final instrument, differentiating it from disease-specific HRQoL measures for adults with CF or non-CF bronchiectasis [12, 27].

The study population was not fully representative of the PCD population. In common with many previous studies, it was more difficult to recruit men than women with only three men (14%) participating in the interviews. Approximately 6% of patients with PCD have cardiovascular disease [5]. None of the 21 interviewees in this study had cardiovascular disease, but even if we had designed the study population to be representative of the PCD population we would have aimed to have only one patient. Moreover, we would not be able to recruit patients with the diverse spectrum of cardiac disease *e.g.* complex cyanotic heart disease versus simple cardiac anomaly. It is therefore a limitation of the questionnaire that it does not include items relevant to patients with cardiac disease.

A reliable patient-reported outcome measure for PCD is particularly important, given that physiological measures such as forced expiratory volume in 1 s and LCI are not sensitive or predictive, and HRCT is not suitable for repeat testing due to radiation exposure. Importantly, the QOL-PCD provides a measure of the multidimensional effects of PCD on adults, from their own perspective including its impact on the upper and lower respiratory systems, treatment burden and social and emotional functioning. Reliability and validity studies are currently in process and will be reported in due course.

In summary, the QOL-PCD was developed and has undergone cognitive testing in adults from several English-speaking countries. It has been translated into Dutch, German, and Danish, with plans to develop translations from major European countries and the Middle East. A multi-national, psychometric field-study is now planned to assess several forms of reliability and validity. Similar processes have been used to develop age-specific HRQoL measures for children and adolescents with PCD and parent caregivers. These instruments will also be translated into other languages and validated in future studies.

TABLE 3 Summary of modifications to QOL-PCD after cognitive testing

Modifications after cognitive testing	
<b>Items added to scales</b>	Respiratory symptoms: Wheezing Chest tightness Sinus symptoms: Post-nasal drip Sinus pain Physical functioning: Carrying heavy things, such as books and shopping bags Health perceptions: I feel healthy Emotional functioning: Felt depressed Felt lonely Social functioning: Stay at home more often than would like Feel comfortable coughing in front of others Feel comfortable blowing nose in front of others Intimacy with a partner (kissing, hugging, sexual activity) Worried about being exposed to others who are sick Comfortable doing treatments (airway clearance, physiotherapy) in front of others Treatment burden Physiotherapy/airway clearance made you feel tired quickly
<b>Items deleted from scales</b>	Health perceptions: I feel in control of my PCD Emotional functioning: Felt angry Felt limited Felt self-conscious Social functioning: Self-conscious coughing and blowing my nose in public Treatment burden: Treatments made you feel better Physiotherapy is hard work
<b>Wording modifications</b>	Emotional functioning: “Felt anxious” changed to “felt worried” “Felt frustrated” changed to “felt frustrated about doing your daily treatments”

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