



Using a computer-tailored COPD screening assessment to promote advice-seeking behaviors

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ABSTRACT

Background: Chronic Obstructive Pulmonary Disease (COPD) is a leading cause of morbidity and mortality, despite evidence there is a high proportion of underdiagnosis. Online screening assessments are low-cost solutions to identify high-risk adults who may benefit from confirmatory screening (ie, spirometry test). Little evidence exists to support whether high-risk adults seek advice after completing COPD screening assessments and from whom. The purpose of this study is to examine how the perceived quality of an online screening assessment influences high-risk adults to seek advice from a healthcare provider or other online resources.

Methods: Adults without a prior COPD diagnosis ($N = 199$) completed an online survey that included a computer-tailored assessment programmed with the clinically validated COPD Population Screener (COPD-PS).

Results: An elevated COPD risk score was associated with expectations to talk with a healthcare provider ($P < 0.05$) or go on the Internet ($P < 0.05$) to get advice, controlling for statistically significant covariates. Positive perceptions about the quality of the risk score was associated with strengthened expectations to speak with a healthcare provider, but only among high-risk adults ($P < 0.01$).

Conclusions: Results of this study support the use of computer-tailored screening assessments as a scalable solution to encourage high-risk adults to learn more about COPD. Strengthened perceptions about the quality of an online COPD screening assessment increased the likelihood that high-risk adults will speak with their healthcare provider about the condition. Implications are discussed for leveraging telehealth solutions, such as conversational agents (ie, chatbots), to disseminate COPD screening assessments and alleviate its underdiagnosis.

Trial registration: not applicable

Keywords: COPD, Telehealth, Risk assessment, Patient-provider communication

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INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is a leading cause of morbidity and mortality worldwide.¹ COPD is characterized by progressively worsening shortness of breath, wheezing, mucus production, and physical fatigue from participating in the least demanding activities.² Its timely detection and self-management have shown to reduce the occurrence of breathing exacerbations, hospitalizations, and complications due to comorbidities (eg, mental distress).^{3,4} Unfortunately, millions are living with COPD but have yet to be diagnosed.⁵

The opportunity to diagnose COPD is generally missed in about 70%³ and 85%⁶ of adults. Younger age, identifying as woman, having a family history of COPD, not having a prior spirometry test, and living with a prior asthma diagnosis increases the risk of underdiagnosis in COPD.^{7,8} The Global Initiative for Chronic Obstructive Lung Disease (GOLD) recommends only conducting confirmatory testing among adults who are symptomatic or live with its risk factors.⁹ Spirometry is the gold standard instrument to test for COPD and determine the severity of obstruction;⁹ however, it is costly and requires an in-clinic consultation with a trained technician.¹⁰ Low-cost alternatives that identify high-risk adults who would benefit from clinical consultation and confirmatory testing (eg, spirometry test) are needed.

Screening assessments capture individual data on risk factors and produce a personalized recommendation for screening based on those risks.^{9,11,12} Screening assessments are readily available on the Internet and easily retrieved through search engines, and they can also be embedded in telehealth solutions (eg, mobile health apps, patient portals connected to healthcare systems via electronic health records). The COPD Population Screener (COPD-PS)¹³ is a clinically validated assessment that is available on the COPD Foundation's public-facing website.¹⁴ The computer-tailored assessment tells a patient within seconds whether they are at a clinically elevated risk for COPD based on their age and behavioral and symptomatic factors.¹³ It is assumed that publicly available online screening assessments will empower patients to independently learn their risk and seek further

consultation if the result suggests an elevated risk. However, this assumption has not yet been evaluated for COPD.

Effective communication is a driving force for behavior change when it is relevant and convincing.¹⁵⁻¹⁸ Convincing communication is generally from a credible source and presents a strong argument to support desired attitude and behavior changes.¹⁹ Online screening assessments are high-quality when personalized results are scientifically validated²⁰ and when the score is in integer form with qualitative labels.^{20,21} And, despite evidence that online screening assessments do not adhere to best practices for risk communication,²⁰ clinically validated online assessments are favored by patients to aide in medical decision-making.²² Limited research has explored how online screening assessments motivate adults at a high risk for COPD to learn more about the condition. To justify disseminating online COPD screening assessments to the population, research is needed to understand how risk scores motivate subsequent action and how perceptions of score quality buffer or attenuate outcomes associated with advice-seeking.

The purpose of this study is to examine how an online screening assessment programmed with the COPD-PS¹³ motivates advice-seeking behaviors among high-risk adults. Consistent with the goals of an online screening assessment, we hypothesized that adults with a clinically elevated risk for COPD will have an increased likelihood to seek advice from healthcare provider or other online resources. The likelihood of referring to other online resources is considered in this study because people at-risk or recently diagnosed with COPD commonly refer to the Internet for more information.²³⁻²⁶ Based on message processing models,²⁷ we also hypothesized that the likelihood to seek advice from other source would be strengthened if the score was perceived as high-quality.

METHODS

Study design

A single-arm, post-test only study was embedded in a 15-min web-based survey,

conducted in August 2019. Adults over the age of 18, with a history of smoking tobacco (either former or current), and living without a COPD diagnosis were recruited from a broad consent research registry²⁸ hosted by a large academic medical center in the southeastern United States. We adopted a multi-modal recruitment method, where notifications were delivered to eligible participants via electronic mail (e-mail) and the United States Postal Service (USPS). This method has demonstrated a desirable response rate for studies conducted with research registry participants.²⁹ The study protocol was approved by the University of Florida's Institutional Review Board (#IRB201800755).

Sample and procedures

Of the 1660 adults recruited, 273 consented to participate. Adults who reported a COPD diagnosis ($n = 28$) were directed to the end of the survey and thanked for their time. Of 245 eligible participants, 199 (81.24%) agreed to complete the computer-tailored COPD screening assessment and 20 (7.3%) declined it. Common reasons for declining the assessment included "no need" or "no time;" however, one person said, "I'm scared to find out the results."

The COPD Foundation is a reputable non-profit organization dedicated to empowering and improving the lives of patients at risk or living with the condition. A computer-tailored assessment programmed with the COPD-PS is available on its public-facing website.¹⁴ Upon completing the online assessment, individuals receive an integer risk score (range 0 to 10) followed by a qualitative description of their risk score (ie, "If your total score is 5 or more, your breathing problems may be caused by chronic obstructive pulmonary disease or COPD. The higher your score, the more likely you are to have COPD"). Alongside the integer and qualitative risk score, there is a recommendation about how to openly share signs and symptoms with a healthcare provider (ie, self-efficacy) and a statement that only a healthcare provider can tell you whether you have COPD by assessing your symptoms and completing confirmatory testing called spirometry (ie, response-efficacy). For the current study, we simulated this experience via Qualtrics by integrating the COPD Foundation's "COPD Population

Screener™" logo and tailored risk score messages available on its website.¹⁴

Measures

To understand the general health of the sample, we assessed the presence of chronic illnesses (eg, asthma), family history of COPD, preventive screeners and actions completed within the past 3 years (eg, blood glucose test, flu shot, spirometry test), and perceived health status (1 = poor; 5 = excellent). Demographics (eg, age, gender, race, ethnicity, income, education, health insurance status, self-reported rural residence) were also measured.³⁰

The COPD Population Screener (COPD-PS) is a brief, publicly available risk assessment that has been used in clinical practice to identify individuals who have a high likelihood of having COPD.¹³ The instrument has demonstrated a high degree of sensitivity, predictive validity, and test-retest reliability.^{13,31-33} Sample items and response options include: "In the past 4 weeks, how much of the time did you feel short of breath?" (0 = none/a little of the time; 1 = some of the time; 2 = most of the time/all of the time), and "Do you ever cough up any 'stuff,' such as mucus or phlegm?" (0 = never/only with occasional colds or chest infections; 1 = a few days a month/most days a week; 2 = every day). The sum of all 5 items is the total COPD-PS score, which ranges from 0 to 10. A low risk is categorized as 0 to 4 and a high risk is 5 to 10. The COPD-PS score has comparable predictive utility and validity when conducted via pen-and-pencil or a computer-based program.³¹

The perceived quality of the risk score produced by the COPD-PS was measured with seven items anchored on a 5-point Likert scale (1 = not at all; 5 = extremely).²¹ We asked participants, "How accurate is this number?" Other quality indicators included "precise," "exact," "scientific," "likely to be wrong," and "uncertain." The last two items (ie, "likely to be wrong" and "uncertain") were reverse coded, where 1 = extremely (or low quality) and 5 = not at all (or high quality). The scale produced data with exceptional internal consistency ($\alpha = .91$).

Expectations to seek advice about personal risk for COPD was measured with 2 items. First, participants were asked the likelihood they will talk

Demographics	N (%)
Age, M (SD)	47.63 (11.20)
Sex	
Male	62 (31.2)
Female	137 (68.8)
Race^a	
White	172 (86.4)
Black or African American	10 (5.0)
Asian	3 (1.5)
American Indian or Alaska Native	2 (1.0)
Native Hawaiian/Pacific Islander	1 (0.5)
Prefer to not answer	7 (3.5)
Ethnicity	
Hispanic or Latino	17 (8.5)
Not Hispanic or Latino	165 (82.9)
Prefer to not answer	10 (5.0)
Missing	7 (3.5)
Income	
Less than \$10,000	20 (10.1)
\$10,000 to under \$19,999	9 (4.5)
\$20,000 to under \$29,000	12 (6.0)
\$30,000 to under \$39,000	18 (9.0)
\$40,000 to under \$49,000	16 (8.0)
\$50,000 to under \$74,999	48 (24.1)
\$75,000 to under \$99,999	21 (10.6)
\$100,000 or more	36 (18.1)
Prefer to not answer	13 (6.5)
Missing	6 (3.0)
Education	
8th grade or less	2 (1.0)
High school incomplete (grades 9-11)	5 (2.5)
High school graduate (grade 12 or GED)	14 (7.0)
Technical, trade or vocational school	16 (8.0)
Some college (no 4-yr degree)	70 (35.2)
College graduate (4-yr degree)	38 (19.1)
Graduate education (masters/doctorate)	45 (22.6)
Prefer to not answer	3 (1.5)
Missing	6 (3.0)

Table 1. Demographic characteristics, N = 199. Note. ^a sum of %s may not add up to 100% as participants were asked to select all that apply

with their healthcare provider about their risk for COPD. Next, they were asked the likelihood they will go online and ask for advice about their risk for the condition. Both items were anchored on a 5-pt Likert scale where 1 = not at all likely and 5 = extremely likely.

Data analysis

Frequency statistics were computed to describe the sample. Chi-square tests were conducted to

examine differences in COPD-PS responses among participants with a low (score 0 to 4) and high (score 5 to 10) risk score. A series of Pearson *r* correlations were conducted to examine the association between socio-demographics and each dependent variable (ie, likelihood of talking to a healthcare provider about COPD; likelihood of going online for more information about COPD). Two moderated linear regression analyses were conducted to examine how the relationship

COPD-PS Items		Low Risk, n (%)	High Risk, n (%)	Total, n (%)	χ^2 (P-value)
During the past 4 weeks, how much of the time do you feel short of breath?	None of the time	58 (34.3) ^a	2 (6.7) ^b	60 (30.2)	
	A little of the time	83 (49.1) ^a	5 (16.7) ^b	88 (44.2)	
	Some of the time	28 (16.6) ^a	15 (50.0) ^b	43 (21.6)	
	Most of the time	0 (0.0) ^a	5 (20.0) ^b	6 (3.0)	
	All of the time	0 (0.0) ^a	2 (6.7) ^b	2 (1.0)	
					70.78 (P < 0.001)
Do you ever cough up any "stuff," such as mucus or phlegm?	No, never	39 (23.1) ^a	2 (6.7) ^b	41 (20.6)	
	Only occasionally	87 (51.5) ^a	4 (13.3) ^b	91 (45.7)	
	Yes, a few days a month	30 (17.8) ^a	5 (16.7) ^a	35 (17.6)	
	Yes, most days a week	10 (5.9) ^a	11 (36.7) ^b	21 (10.6)	
	Yes, every day	3 (1.8) ^a	8 (26.7) ^b	11 (5.5)	
					62.84 (P < 0.001)
Please select the answer that best describes you in the past 12 months. I do less than I used to because of my breathing problems.	Strongly disagree	80 (47.3) ^a	5 (16.7) ^b	85 (42.7)	
	Disagree	65 (38.5) ^a	6 (20.0) ^a	71 (35.7)	
	Unsure	11 (6.5) ^a	3 (10.0) ^a	14 (7)	
	Agree	11 (6.5) ^a	12 (40.0) ^b	23 (11.6)	
	Strongly Agree	2 (1.2) ^a	4 (13.3) ^b	6 (3)	
					45.59 (P < 0.001)
Have you smoked at least 100 cigarettes in your ENTIRE LIFE?	No	14 (8.3) ^a	0 (0.0) ^a	180 (90.5)	
	Yes	150 (88.8) ^a	30 (100.0) ^a	14 (7)	

(continued)

COPD-PS Items		Low Risk, n (%)	High Risk, n (%)	Total, n (%)	χ^2 (P-value)
	Don't know	5 (3.0) ^a	0 (0.0) ^a	5 (2.5)	
					3.73 (<i>P</i> = .16)
How old are you? (in years)	18-34	17 (10.1) ^a	2 (6.7) ^a	19 (9.5)	
	35-49	83 (49.1) ^a	10 (33.3) ^a	93 (46.7)	
	50-59	53 (31.4) ^a	11 (36.7) ^a	64 (32.2)	
	60-69	9 (5.3) ^a	2 (6.7) ^a	11 (5.5)	
	70+	7 (4.1) ^a	5 (16.7) ^b	12 (6)	
					8.60 (<i>P</i> = .07)
COPD-PS Score	Low (Score = 0-4)	-	-	169 (84.9)	
	High (Score = 5-10)	-	-	30 (15.1)	

Table 2. (Continued) Responses on the COPD-PS risk assessment. Note. 199 participants completed the assessment; COPD-PS indicates “low risk” as a score 0 to 4 and “high risk” as a score 5 to 10; Discordant superscripts in each row indicate statistically significant differences between low and high COPD-PS risk score groups

between perceived quality of the COPD-PS score (mean-centered) was associated with the likelihood of (a) talking to a healthcare provider about COPD and (b) going online to ask for advice about COPD. We examined how this relationship was moderated by COPD-PS score (0 = low; 1 = high). Socio-demographic variables statistically significantly correlated with dependent variables were included in regression models. We used SPSS v27 and listwise deletion procedures to manage data. *P* < 0.05 indicated statistical significance.

RESULTS

Sample characteristics

Table 1 includes the demographic information for participants who completed the assessment. The mean age of the sample was 47.63 years old (*SD* = 11.20 years). Most participants identified as female (*n* = 137; 68.8%), white (*n* = 172;

86.4%), and non-Hispanic (*n* = 165; 82.9%). Roughly three-quarters of the sample had either completed some college (*n* = 70; 36.3%), had graduated from college (*n* = 38; 19.7%), or had completed post-graduate studies (*n* = 45; 23.3%). Nearly half of the sample (*n* = 105; 54.5%) had an annual income exceeding \$50,000 before taxes in 2018. Not shown in Table 1 is that over half (*n* = 103; 51.8%) of the participants reported living in a rural/small town, and 15.1% (*n* = 29) said there was a time in the past year when they did not have health insurance coverage.

Over three-quarters of the sample reported at least one chronic disease diagnosis including mental illness (*n* = 59; 29.6%), cardiovascular disease (*n* = 56; 28.1%), arthritis (*n* = 50; 25.1%), diabetes (*n* = 37; 18.6%), asthma (*n* = 26; 13.1%), and cancer (*n* = 13; 6.5%). Most of the sample had completed preventative health screeners or measures in the past 3 years including blood pressure

test ($n = 186$; 93.5%), blood cholesterol test ($n = 175$; 87.9%), blood glucose test ($n = 168$; 91.3%), and flu shot ($n = 126$; 63.3%). 20.6% ($n = 41$) reported having completed a spirometry test in the past three years. About one-third of the sample reported a family history of COPD ($n = 75$; 37.7%). One-quarter ($n = 47$; 23.6%) of participants reported smoking every day and 10.6% ($n = 21$) said they smoked some days in the past month. On average, participants reported a "fair" ($n = 60$; 30.2%) or "good" ($n = 77$; 38.7%) health status ($M = 2.74$; $SD = 0.97$).

COPD-PS SCORES, PERCEIVED QUALITY OF SCORES, AND ADVICE-SEEKING.

Table 2 shows the responses of participants who chose to complete the COPD-PS. Most participants ($n = 180$; 90.5%) reported smoking at least 100 cigarettes in their entire lifetime. About 70% of participants reported rarely feeling short of breath in the past few weeks, coughing up mucus or phlegm, and doing less than they used to because of their breathing problems. These indicators yielded 84.9% ($n = 169$) of participants at a low risk for COPD (i.e., score = 0 to 4) and 15.1% ($n = 30$) at a high risk (i.e., score = 5 to 10). Participants with a low COPD-PS score were more likely to say they felt short of breath "none" or "a little" of the time whereas participants with a high COPD-PS score were more likely to say they were out of breath "most" or "all" of the time, $X^2(4, N = 199) = 70.78$, $P < 0.001$. Those with a low COPD-PS score were also more likely to say that they "never" or "occasionally" cough up mucus or phlegm, but those with a high COPD-PS risk score were most likely to say they do "most days a week" or "every day," $X^2(4, N = 199) = 62.84$, $P < 0.001$. Participants with a low COPD-PS score were more likely to disagree they do less because of any breathing problems but those with a high COPD-PS score were more likely to agree with this statement, $X^2(4, N = 199) = 45.69$, $P < 0.001$. There was not a statistically significant difference in smoking status or age according to COPD-PS score.

Participants reported feeling that the COPD-PS risk score was, on average, "somewhat likely" to be high quality ($M = 3.19$; $SD = 0.85$). The score

was perceived as more accurate among individuals with a low COPD risk score ($M = 3.36$; $SD = 1.0$) compared to those with a high risk score ($M = 2.90$; $SD = 0.98$), $t(191) = 2.30$, $P < 0.05$. Similarly, those with a low risk reported feeling the score was more precise than those with a high risk ($M = 3.21$; $SD = 1.01$ and $M = 2.76$; $SD = 1.10$), $t(190) = 2.20$, $P < 0.05$.

After obtaining a personal risk score, participants were "somewhat likely" to talk to a provider about their risk for COPD ($M = 2.78$; $SD = 1.34$). There were statistically significant associations between likelihood of talking to a healthcare provider about COPD and (a) perceived rurality ($r = 0.15$; $P < 0.05$); (b) annual income ($r = -0.21$; $P < 0.01$); (c) education level ($r = -0.16$; $P < 0.05$); (d) prior asthma diagnosis ($r = 0.27$; $P < 0.001$); (e) family history of COPD ($r = 0.29$; $P < 0.001$); (f) smoked every day in the past month ($r = 0.17$; $P < 0.05$); (g) smoked some days in the past month ($r = 0.16$; $P < 0.05$); and (h) self-reported health status ($r = -0.16$; $P < 0.05$). Also, participants were only "slightly likely" to go online and ask for advice about their risk for the condition ($M = 2.41$; $SD = 1.36$). Statistically significant associations existed between likelihood of seeking online information about COPD and (a) age ($r = -0.16$; $P < 0.05$); (b) annual income ($r = -0.17$; $P < 0.05$); (c) prior asthma diagnosis ($r = 0.25$; $P < 0.001$); (d) smoked every day in the past month ($r = 0.18$; $P < 0.05$); and (e) self-reported health status ($r = -0.18$; $P < 0.05$). Neither health insurance status or having received a spirometry test in the past 3 years were statistically significantly correlated with the likelihood of talking to a healthcare provider or seeking advice on the Internet about COPD after completing the COPD-PS.

Perceived COPD-PS score quality and advice-seeking among low and high-risk adults

Table 3 shows two statistically significant linear regression models examining the moderating effect of COPD-PS risk score on the relationship between its perceived quality and expectations to (a) talk to a healthcare provider, $F(11, 141) = 4.47$, $P < 0.001$, $R^2 = 0.26$; and (b) go online to ask for advice about their COPD risk, $F(8, 152) = 5.68$, $P < 0.001$, $R^2 = 0.23$.

	Likelihood of Talking to a Healthcare Provider			Likelihood of Going Online for Advice		
	<i>b</i>	<i>SE</i>	95% CI	<i>b</i>	<i>SE</i>	95% CI
Age	-	-	-	0.01	0.01	-0.02, 0.02
Rural residence ^a	0.13	0.23	-0.31, 0.58	-	-	-
Annual income ^b	-0.18	0.23	-0.44, 0.48	-0.34	0.22	-0.78, 0.10
Education ^c	0.02	0.23	-0.44, 0.48	-	-	-
Asthma diagnosis	0.83**	0.29	0.26, 1.40	1.09***	0.28	0.53, 1.64
Family history of COPD	0.47*	0.21	0.06, 0.88	-	-	-
Smoke: Everyday	0.19	0.24	-0.28, 0.67	0.33	0.23	-0.12, 0.79
Smoke: Some days	0.42	0.34	-0.25, 1.10	-	-	-
Health status	-0.01	0.12	-0.24, 0.23	-0.03	0.12	-0.27, 0.21
COPD-PS score ^d	0.70*	0.28	0.15, 1.24	0.65*	0.28	0.10, 1.21
Perceived score quality	0.03	0.15	-0.25, 0.32	0.18	0.13	-0.09, 0.45
COPD-PS score x perceived score quality	0.82**	0.31	0.20, 1.43	0.58 [†]	0.32	-0.06, 1.22

Table 3. Moderated linear regression analyses. Note. “-” indicates that the variable was excluded from the model; CI = Confidence Interval.^a 1 = Rural/small town and 0 = Urban/metropolitan; ^b 1 = \$50 K or more; <\$50 K; ^c 1 = Bachelor’s degree or higher and 0 = Less than a bachelor’s degree; and ^d COPD-PS Risk Score (1 = High; 0 = Low).[†]*P* = .05-0.10; **P* < 0.05; ***P* < 0.01; ****P* < 0.001

The relationship between a COPD-PS risk score classified as “high” and the likelihood of talking with a healthcare provider about personal risk for COPD was statistically significant (*b* = 0.70; *SE* = 0.28; *P* < 0.05). A statistically significant relationship between perceived quality of the COPD-PS score and the likelihood of talking to a healthcare provider about COPD did not exist (*P* = .81). However, the interaction effect of the COPD-PS risk score and its perceived quality statistically significantly predicted the likelihood of talking with a healthcare provider about COPD (*b* = 0.82; *SE* = 0.31; *P* < 0.01). Shown in Fig. 1, the conditional effect was statistically significant for high COPD risk (effect = 0.85; *SE* = 0.28; *P* < 0.01; 95% CI = 0.29, 1.41), but not low risk (*P* = 0.81). This suggests that increasing the perceived quality of a COPD-PS score will motivate individuals to speak with their healthcare provider, but only if they are at a high-risk for COPD based on behavioral and symptomatic factors. A prior asthma diagnosis (*b* = 0.83; *SE* = 0.29; *P* < 0.01) and a family history of COPD were the only two statistically significant covariates associated with the likelihood of talking

with a healthcare provider about COPD (*b* = 0.47; *SE* = 0.21; *P* < 0.05).

A COPD-PS score classified as “high” (*b* = 0.65; *SE* = 0.28; *P* < 0.05) was associated with a greater expectation of going online to ask for advice about their COPD risk. Perceived quality of the COPD-PS score was not statistically significantly associated with the likelihood of going online for advice about COPD risk (*P* = 0.18). The interaction effect of COPD-PS score and its perceived quality on expectations for going online for more information approached statistical significance (*P* = 0.08). A prior asthma diagnosis was the only covariate associated with the expectation of going online to learn more about COPD (*b* = 1.09; *SE* = 0.28; *P* < 0.001).

DISCUSSION

This study examined how the computer-tailored COPD-PS¹³ motivates high-risk adults to seek advice from a healthcare provider and other online resources. The assessment is clinically validated, and the resulting health message included a

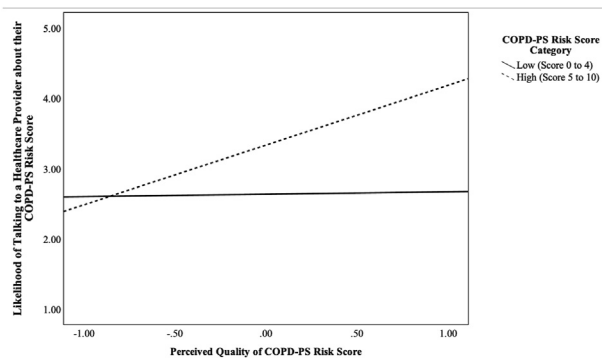


Fig. 1 A graphical depiction of the condition effects on the likelihood of talking to a healthcare provider. The relationship between perceptions about the quality of the COPD-PS score and the likelihood of talking to a healthcare provider about COPD was strongest among individuals with a high COPD risk score

personalized risk score alongside a recommendation to speak with a healthcare provider about their risk and eligibility for confirmatory screening. Results of this study support the use of computer-tailored screening assessments for motivating high-risk adults to seek advice about their COPD risk. Implications for employing novel telehealth solutions to strengthen perceptions of risk score quality are discussed.

Principal findings

A clinically elevated risk for COPD as determined by the COPD-PS was associated with greater expectations to seek advice from a healthcare provider. This finding is consistent with behavior change theory, which posits that increasing an individual's perceived risk for an undesirable condition (eg, an incurable, life threatening condition such as COPD) will motivate a protective health behavior change.^{34,35} The message that coincided with a personalized risk score also encouraged participants to disclose their symptoms to a healthcare provider because only a healthcare provider can diagnose COPD. Self- and response-efficacy serve an integral role in favorably processing threat- and fear-based health messages.³⁶ Results of this study adds to literature demonstrating the value of presenting efficacy-based messages alongside objective risk scores to promote protective behavior change among those at the highest risk.

The relationship between a clinically elevated risk for COPD and expectations to speak with a healthcare provider was strengthened alongside

increasing beliefs about the quality of the risk score (eg, accurate, precise, scientific). Research has demonstrated that a COPD diagnosis is commonly met with denial and negotiations about illness identity,³⁷ which stems from a combination of fear of being diagnosed with an incurable condition and questioning the validity of a diagnostic test.³⁸ In fact, this fear was a reason why one participant refused to take the online screening assessment. This study, however, found that high-risk adults were less likely than their low-risk counterparts to believe their risk score was accurate or precise. Future research is needed to understand how the perceived quality of a risk score from an online COPD screening assessment is influenced by other factors including (but not limited to) numeracy, emotion about a potential diagnosis, and knowledge about the condition.³⁵

Adults with a clinically elevated COPD risk score reported an increased expectation to seek advice from other online resources. Unfortunately, patients with COPD, especially those with lower lung-specific quality of life,²³ have compromised confidence in their ability to find health information and evaluate its quality.^{39,40} Alongside evidence demonstrating value in providing strategies to help patients interpret and act upon medical test results,⁴¹ online COPD screening assessments should include credible education resources to meet the needs of patients at varying degrees of risk. Self-reported symptoms (eg, inability to engage in regular activities, breathlessness), rather than smoking status or age, were most common among individuals with high COPD risk scores. Smoking every or some days in the past month was positively associated with seeking advice from a healthcare provider or online resources in exploratory correlations; however, smoking status was not a statistically significant predictor in subsequent regression models where other covariates were considered. Therefore, post-assessment messages and education should reinforce COPD symptoms.

Reporting an asthma diagnosis and a family history of COPD increased expectations to learn more about COPD. Adults with asthma were likely to seek advice from healthcare providers and online resources, adjusting for the COPD-PS score. However, adults with a family history of COPD reported expectations to speak with a healthcare

provider but not to seek advice from other online resources. There is a genetic component to COPD (ie, alpha-1 antitrypsin deficiency) and having a family history is associated with more severe symptoms and breathing exacerbations.⁴² Also, the relationship between asthma and COPD is complex, as asthma is both a common misdiagnosis of COPD and a comorbid condition of COPD.⁴³ Neither items in the COPD-PS nor its subsequent health messaging included content about a family history of COPD or asthma. COPD risk education may be most effective when a family member is diagnosed or when people seek medical assistance for other respiratory ailments, such as asthma.

Practical implications

Increasing the perceived quality of risk scores produced by an online COPD screening assessment increases high-risk adults' expectations to speak with their healthcare provider, especially when the assessment is hosted by a reputable disease-oriented organization. Best practices in risk communication recommend including disclosures about scoring procedures, numeric values alongside verbal labels, and the potential for uncertainty in the estimate.²⁰ For example, presenting health risk scores as an integer leads to greater believability and recall.²¹ There are other methods, including conversational agents (ie, chatbot) which are typically accepted by patients and perceived by patients as being trustworthy.⁴⁴⁻⁴⁶ Chatbots and other dialogue-based interfaces facilitate human-friendly interactions for patient data collection, delivering accessible and personalized health information to patients. There is further evidence that emotionally responsive and intelligent chatbots build patient trust,⁴⁷ leading to increased believability and perception of chatbots as an authoritative source of health information.^{48,49} Trustworthy chatbot-patient relationships have potential to enhance perception of data quality, increasing the likelihood of proactive health behavior change among high-risk adults. This conversational format may also serve as practice for the patient to initiate the clinical conversation, either via telemedicine or in-person appointments. Future research is needed to explore the potential of conversational agents to

facilitate discussions about disease risk and coordinate confirmatory screening options for adults who may benefit.

Interventions are not effectively diffused into routine practice without a strategic dissemination plan.⁵⁰ Although the online COPD-PS is available on a reputable website, it may not be regularly attended by those who have yet to receive a diagnosis. Research is needed to examine how different sources, channels, and settings influence high-risk adults' perceptions of the risk score quality and their expectations to seek advice about confirmatory screening. This will optimize dissemination and implementation of screening assessments into the workflows of systems and providers to reach patients who would benefit the most. Several dissemination models are available and readily used in practice.⁵¹

Residing in a rural geographic region was positively correlated with a greater likelihood of talking with a healthcare provider after completing the computer-tailored COPD-PS, but it was no longer a statistically significant predictor when entered alongside competing covariates in the regression model. COPD disproportionately affects rural communities, and a common reason that COPD is diagnosed at a late stage is because there are limited opportunities and coverage for healthcare.⁵² However, neither health insurance coverage nor having received a prior spirometry test were associated with either talking to a healthcare provider or seeking advice from other online resources. Further research is needed to understand how online screening assessments for COPD can be leveraged in medically underserved communities, or rural regions where COPD disproportionately affects its residents.

Limitations

This study predominantly comprised non-Hispanic white adults with at least some college experience and an average annual income greater than \$50,000. And while the sample generally reported a fair-to-good health status and at least one chronic ailment, most participants reported having received preventative health screenings in the past three years. Research is needed to confirm the results of this study among medically underserved

adults living with low socioeconomic statuses. Also, leveraging a research registry and optimizing recruitment strategies would be useful to obtain a stronger response rate. Surprisingly, neither age nor smoking history (ie, smoking at least 100 cigarettes in their lifetime) were associated with high or low risk scores from the COPD-PS. Future research aiming to replicate this study should target individuals according to their symptoms (eg, shortness of breath, mucus/sputum production) and examine the effect of message acceptance according to pack-year smoking behaviors.

This was a cross-sectional study, limiting our ability to follow patients and determine whether intentions to seek advice about COPD translated into actionable behaviors and an immediate or eventual COPD diagnosis. This limitation demonstrates an important opportunity for future research to further combat underdiagnosis in COPD. For example, researchers may consider exploring with whom (e.g., primary care provider, specialist) high-risk patients' concerns are discussed and the content of these discussions. Researchers may also explore whether immediate or eventual COPD diagnosis is common among high-risk adults, depending on the source of their advice. For example, in our survey, the source of the COPD-PS was the COPD Foundation, a reputable organization with relevant information about COPD from advocates, clinicians, patients, and caregivers. It would be useful from a patient education perspective to understand whether high-risk adults subsequently search for information from this resource or consult other online resources commonly used by this patient population (e.g., Facebook).²⁶ And, finally, as outlined in our introduction, we have noted there are several COPD screening assessments available for use. Future research should replicate this study with a different screening assessment to identify or curate the most effective assessment for motivating high-risk adults to seek support and ultimately obtain an accurate diagnosis.

Conclusions

This study demonstrated that after completing an online COPD screening assessment, high-risk adults reported the greatest expectations to refer to a healthcare provider or other online resources about their risk. The relationship between being at

a clinically elevated risk for COPD and intending to speak with a healthcare provider was strengthened by the perceived quality of the score (eg, accurate, precise, scientific). Expectations to seek online health information about COPD was also common among high-risk adults, regardless of the perceived quality of their risk score. Healthcare providers are the only ones who can diagnose someone with COPD and prescribe a treatment regimen. Therefore, novel methods are needed to disseminate online COPD screening assessments to high-risk adults while also strengthening perceived score quality. Conversational agents may be a useful method given their versatile use on healthcare providers' websites and capabilities to be embedded in electronic health record systems (ie, patient portals) and telemedicine dashboards.

Abbreviations

COPD, Chronic Obstructive Pulmonary Disease; COPD-PS, Chronic Obstructive Pulmonary Disease Population Screener; GOLD, Global Initiative for Chronic Obstructive Lung Disease; US, United States.

Authors' consent for publication

We give the *World Allergy Organization Journal* the right to publish this article should it be accepted.

Availability of data and materials

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics approval

University of Florida IRB approved data collection procedures.

Author contribution

Conceptualization, S.R.P., H.W., B.E.B., T.C.; Methodology, S.R.P., H.W.; Formal Analysis, S.R.P., H.W.; Resources, S.R.P.; Writing - Original Draft Preparation, S.R.P., H.W.; Writing - Review and Editing, S.R.P., H.W., B.E.B., T.C.

Declaration of competing interest

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