INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is a common, preventable and treatable long-term condition that places a high burden on patients, their carers and health services. It is recognised that there is a large population of individuals that would meet diagnostic criteria for COPD but remain undiagnosed either through lack of contact with health services or lack of consideration of the diagnosis by health-care professionals.

A recent review of COPD screening by the US Preventive Task Force recommended against screening asymptomatic individuals, concluding that there is no net benefit.1 The UK Government’s strategy for COPD in England, published in 2011, supports opportunistic and systematic case finding as well as improved awareness of symptoms and signs among the population and health-care professionals to achieve early disease recognition and prevent late diagnosis.2 However, a subsequent report by the UK National Screening Council recommended against a national COPD screening programme. The reasons for recommending against screening are: limited evidence of benefit of interventions in early stage disease; inconclusive effects on smoking behaviour; and the limitations of spirometry in a population-wide setting.3 However, this report supports case finding in symptomatic individuals with ‘more developed’ COPD.

The differentiation between screening and case finding relates to the presence of symptoms prompting health service utilisation in the latter, where the former offers the screening test to all people in a population that meet certain criteria.3
It is sometimes assumed that participants in screening campaigns are asymptomatic or at least do not have sufficient symptoms to prompt contact with health services. However, there are a broad range of barriers that can prevent individuals from seeking health care and therefore this assumption may not be valid.

A cluster-randomised trial in the United Kingdom demonstrated that targeted case finding in primary care was cost effective and identified more new cases than routine care. This intervention was defined as case finding because only symptomatic individuals were invited for spirometry. In the ‘active’ case finding group, questionnaires were sent to the homes of all eligible individuals, a strategy often utilised in screening. This ‘active’ case finding approach identified more new cases of COPD and was more cost-effective than ‘opportunist’ case finding that was only undertaken when eligible individuals attended the GP practice.

In 2016, there were 7849 people with COPD in Hull and more than 5000 individuals estimated to have the disease that had not yet been diagnosed. We report the findings of a pilot, community-based COPD screening and public awareness initiative consisting of four screening events in public areas in Hull with the aim of characterising participants, evaluating flow through the screening pathway and assessing participants symptom burden.

2 | MATERIALS AND METHODS

2.1 | Screening events

Four, 1-day screening events were undertaken as part of the British Lung Foundations (BLF) ‘Love Your Lungs’ campaign. Screening events occurred during a 2-week period in the summer of 2017. Events were publicised on social media, local radio and on posters and held in public places with high footfall including supermarkets and shopping centres in high smoking prevalence areas within the city. Each screening event was attended by a BLF representative, a smoking cessation specialist and up to three clinicians trained in handheld spirometry.

2.2 | Screening procedures

Individuals were encouraged to undertake screening if they had a prior smoking history and respiratory symptoms but all attendees were welcome. Participants completed a questionnaire collecting lifestyle and symptom data including the COPD Assessment Test (CAT) questionnaire prior to performing Forced Expiratory Volume in 1 second (FEV-1)/Forced Expiratory Volume in 6 seconds (FEV-6) assessment (COPD-6, Vitalograph). Individuals were considered to be screen-positive if their FEV-1 was <80% or if their FEV-1 was ≥80% and their FEV-1/FEV-6 ratio was <0.72. These criteria were selected to minimise false negative results and in recognition of the inherent limitations of performing FEV-1/FEV-6 measurements in a public setting. Participants that were screen-positive were made aware that this did not mean that they have COPD but they were provided with a date and time to attend a 1-stop clinic appointment for further assessment.

2.3 | One-stop clinic

Screen-positive participants were invited to attend a 1-stop clinic appointment. One-stop clinics were held within health centres in the same locality as the screening events. During this appointment, they saw a smoking cessation specialist, underwent diagnostic spirometry (Microlab Mk8 Spirometer, Carefusion Uk Ltd, Basingstoke, UK) and had an appointment with a respiratory physician. A letter was sent to participants’ general practitioners detailing the clinic attendance and any proposed management. COPD diagnosis was made by a respiratory physician on the basis of compatible symptoms, relevant exposure history and spirometry evidence of airflow obstruction defined as FEV-1/FVC <0.7. Consenting current smokers were enrolled into a smoking cessation programme.

2.4 | Data analysis

Data are presented as mean (SD) or median (range) unless stated otherwise. For categorical data, 2 × 2 contingency tables and Fisher’s exact test were used to identify between group differences. Otherwise, between group differences were analysed using 2-tailed paired and un-paired t tests as appropriate. The relationship between lung function parameters during screening and diagnostic spirometry were assessed using Pearson’s correlation coefficient. Receiver operating characteristic (ROC) curve and Bland and Altman plot were produced using IBM SPSS (version 25).

3 | RESULTS

3.1 | Patient flow

A total of 257 people underwent screening during four community-based events. Eighty-two per cent of participants undertook screening because they were ‘passing’ an event with remaining participants having seen posters, heard about events using social media or been told by friends or family. Participants’ characteristics are detailed in Table 1.

Seventy-seven individuals met positive screening criteria and 59 were referred for review in a 1-stop clinic. Reasons for not being referred to a 1-stop clinic included participant choice (n = 3), living outside the region (n = 5), preexisting COPD diagnosis (n = 3) and health-care professional choice...
Thirty-two participants attended the 1-stop clinic with 18 receiving a diagnosis of COPD. Of the 27 participants referred to a 1-stop clinic that did not attend; 19 did not contact screening staff prior to non-attendance, 7 reported being unable to attend any of the dedicated 1-stop clinics and were offered routine respiratory clinic appointments and 1 cancelled and did not wish to be reappointed. In addition to the 18 patients that received a confirmed diagnosis of COPD, 13 participants received an alternative diagnosis as a cause for their symptoms either in addition to or instead of COPD.

3.2 | Smoking status

There was a higher proportion of current and ex-smokers in the screen positive cohort (81.8% vs 57.2% screen negative, \( P < 0.001 \)) with a higher pack-year smoking history than those that were screen negative (28.2 ± 25.4 and 12.7 ± 23.4, respectively, \( P < 0.001 \)). Similarly, those that received a COPD diagnosis had a higher pack year smoking history than those not diagnosed with COPD (40.2 ± 30.5 pack years compared to 11.4 ± 15.3 pack years, \( P < 0.01 \)).

3.3 | Respiratory symptoms

The proportion of individuals with at least 1 respiratory symptom was significantly higher in those that were screen-positive compared to screen-negative (92% compared to 62%, respectively, \( P < 0.001 \)). The most common symptoms reported by screen-negative individuals were shortness of breath and cough with phlegm (reported by 35% and 34%, respectively). Shortness of breath and wheeze were the most frequently reported symptoms by screen-positive individuals (both symptoms reported by 65%). Cough with phlegm was reported by 50% of screen-positive individuals. Symptom data were unavailable for three individuals with confirmed COPD.

The CAT was used to evaluate the symptom burden experienced by participants of the screening program. The CAT score was significantly greater in screen-positive compared to screen-negative individuals (16.9 ± 1.0 and 9.5 ± 7.7, respectively, \( P < 0.001 \)). However, there was no significant difference between patients attending the 1-stop clinic that were diagnosed with COPD compared to those that were not (19.3 ± 11.4 and 17.4 ± 8.5, \( P = 0.6 \)).

3.4 | Spirometry

FEV-1, FEV-6 and the FEV-1/FEV-6 ratio were significantly reduced in individuals that were screen-positive compared to screen negative (See Table 1, \( P < 0.001 \) for all measures). Paired screening and clinic spirometry data were available for 26 individuals. FEV-1 did not differ significantly between clinic and screening spirometry and strongly correlated (\( r = 0.91, 95\% \) CI 0.80-0.96); forced vital capacity (FVC) recorded during clinic attendance were significantly higher than FEV-6 recorded at screening (2.86 ± 1.09L compared to 2.45 ± 0.95L, \( P < 0.001 \)) but there was a strong correlation (\( r = 0.90, 95\% \) CI 0.78-0.95). Similarly, the forced expiratory ratio was significantly lower on spirometry (0.67 ± 0.14 vs 0.73 ± 0.12, respectively, \( P < 0.001 \)) but strongly correlated (\( r = 0.79, 95\% \) CI 0.58-0.90). The relationship between FEV-1/FEV-6 and FEV-1/FVC is presented in Figure 1. The sensitivity of FEV-1/FEV-6 ratio of <0.72 to detect airflow obstruction defined as an FEV-1/FVC ratio <0.7 was 69% with a specificity of 80%. Receiver operating characteristic analysis was performed to identify the performance of FEV-1/FEV-6 to identify airflow obstruction on diagnostic spirometry (FEV-1/FVC <0.7) (Figure 2). The area under the ROC curve (AUC) is 0.86 (95% CI 0.70-1.00; SEM 0.08).

4 | DISCUSSION

The following key observations are worthy of discussion: (1) a community-based screening and public awareness campaign is capable of identifying previously undiagnosed COPD patients with new diagnosis rates comparable to targeted case finding approaches; (2) respiratory symptoms are common among individuals that self-select to participate in screening and the individuals identified to have COPD during this initiative had a moderate to high symptom burden; (3) current smokers engage in screening but maintaining contact and achieving cessation is challenging; and (4) the sensitivity and specificity of FEV-1/FEV-6 ratio of 0.72 to identify airflow obstruction in this patient cohort was lower than previously reported.

The COPD diagnosis rate in this pilot, community-based COPD screening initiative was 7%. However, the true COPD rate within the screened population may be higher due to the likelihood that some cases were missed as a result of the high non-attendance rate at 1-stop clinics among current and ex-smokers. Published reports of primary care based targeted COPD case finding demonstrate a diagnosis rate of between 2% and 20%. There are, however, fundamental differences in methodology, with the screening intervention we describe being short-term, labour-intensive and combined with a public awareness campaign. Indeed, our screening initiative was opportunistic and involved patient self-selection rather than identifying at risk populations through GP registries. It is also important to consider regional variation in smoking and COPD prevalence when considering the effectiveness of different case finding initiatives. Practice-based targeted case finding in the United Kingdom has been demonstrated to be cost-effective. No
A cost-effectiveness analysis was performed as part of our evaluation. However, our findings suggest that in high smoking prevalence areas, short-term, community screening initiatives can result in a proportion of new COPD cases being identified that is comparable to that obtained through practice-based approaches.

COPD screening is contentious because there is a lack of evidence that early identification of patients alters disease

| TABLE 1  | Participant characteristics and outcomes |
|-----------|-----------------------------------------|
| Characteristic | All participants | Screen-negative | Screen-positive | Confirmed COPD |
| Number | 257 | 180 | 77 | 18 |
| Male : Female | | | | |
| Age: mean (SD) | 58 (16) | 57 (17) | 61 (13) | 64 (13) |
| <20 | 2 | 2 | 0 | 0 |
| 21-30 | 15 | 15 | 0 | 0 |
| 31-40 | 20 | 15 | 5 | 0 |
| 41-50 | 35 | 23 | 12 | 2 |
| 51-60 | 57 | 39 | 18 | 4 |
| 61-70 | 69 | 46 | 23 | 6 |
| 71-80 | 42 | 31 | 11 | 2 |
| >80 | 14 | 9 | 5 | 2 |
| Unknown | 3 | 0 | 3 | 2 |
| Smoking status (%) | | | | |
| Never | 86 (33.5) | 75 (41.7) | 11 (14.3) | 0 (0) |
| Current | 61 (23.7) | 37 (20.6) | 24 (31.2) | 3 (16.7) |
| Ex | 105 (40.9) | 66 (36.7) | 39 (50.6) | 12 (66.7) |
| Unknown | 5 (1.9) | 2 (1.1) | 3 (3.9) | 3 (16.7) |
| Pack Years—mean (SD) | 17.1 (24.9) | 12.7 (23.4) | 28.2 (25.4) | 40.2 (30.5) |
| COPD Awarenessa Median (range) | 2 (1-5) | 2 (1-5) | 3 (1-5) | 4 (1-5) |
| Symptoms—n (%) | | | | |
| Data available for: | n = 247 | n = 173 | n = 74 | n = 15 |
| Dyspnoea | 108 (43.7) | 60 (34.7) | 48 (64.9) | 10 (66.7) |
| Cough | 87 (35.2) | 55 (31.8) | 32 (43.2) | 8 (53.3) |
| Phlegm | 96 (38.9) | 59 (34.1) | 37 (50.0) | 9 (60.0) |
| Winter bronchitis | 60 (24.3) | 37 (21.5) | 23 (31.1) | 6 (40.0) |
| Wheeze | 99 (40.1) | 51 (29.5) | 48 (64.9) | 10 (66.7) |
| CAT Score—mean (SD) | 12.0 (9.2) | 9.5 (7.7) | 16.9 (10.0) | 19.3 (11.1) |
| Screening Spirometry | | | | |
| FEV-1 litres | 2.56 (1.06) | 2.87 (1.07) | 1.86 (0.72) | 1.78 (0.79) |
| % predicted FEV-1 | 94.89 (21.6) | 104.87 (14.12) | 71.79 (17.95) | 66.21 (18.36) |
| FEV-6 | 3.14 (1.02) | 3.41 (0.97) | 2.52 (0.86) | 2.67 (0.91) |
| Ratio | 0.81 (0.10) | 0.84 (0.07) | 0.75 (0.11) | 0.66 (0.09) |
| Clinic spirometry | | | | |
| FEV-1 | – | – | – | 1.92 (0.68) |
| % predicted FEV-1 | – | – | – | 70.06 (17.28) |
| FVC | – | – | – | 3.24 (1.04) |
| % predicted FVC | – | – | – | 94.22 (18.19) |
| Ratio | – | – | – | 0.60 (0.11) |

Abbreviations: CAT: COPD Assessment Test; FEV-1: forced expiratory volume in 1 second; FEV-6: forced expiratory volume in 6 seconds; FVC: forced vital capacity; SD: standard deviation.

*a1-5 Likert Scale where 1 = ‘not at all aware’ and 5 = ‘very aware’.
Early initiation of COPD treatment has never conclusively been demonstrated to alter disease trajectory or long-term outcomes. However, a recent randomised trial conducted in China suggested that Tiotropium might reduce the rate of lung function decline in mild COPD patients compared to placebo. This was also observed in a sub-group analysis of young COPD patients participating in UPLIFT. If confirmed in further cohorts this would strengthen the argument for early COPD diagnosis through screening.

Participants diagnosed with COPD in this study had a mean age of 64 years and mean FEV-1 of 70% predicted. The majority of confirmed COPD cases (78%) had moderate or severe airflow obstruction on spirometry (GOLD grade 2-3) suggesting that community-based screening initiatives identify patients with a spectrum of disease severities. The COPD patients that we identified were symptomatic with a mean CAT score of 19 suggesting moderate symptom burden with 6 participants having CAT scores in the severe or very severe range. Irrespective of impact on disease trajectory, there is potential to improve individual participant’s symptoms and quality of life with inhaled therapies and pulmonary rehabilitation.

Screening is not recommended in asymptomatic individuals. However, it is recognised that individuals with COPD modify their behaviour to minimise symptoms and that this begins prior to diagnosis. This has been observed in the form of reduced physical activity. It is therefore important to consider what is meant when categorising an individual as ‘asymptomatic’. Not having previously reported symptoms to a health care provider does not imply a lack of symptoms. Indeed, an individual perceived lack of symptoms does not mean that they have not altered their behaviour to maintain status quo. Further research is essential to explore the impact of COPD screening and early initiation of therapy on symptoms, physical activity, quality of life and health-care utilisation.

Smoking cessation is associated with a plethora of health benefits and could be considered a valuable outcome for case finding initiatives. The effect of spirometry screening on smoking cessation remains unclear. A randomised trial undertaken in general practices in England found that informing smokers of their ‘lung age’ in addition to advice and smoking cessation referral was associated with significantly improved quit rates at 1 year. However, other trials have found no benefit. Twenty-four per cent of individuals taking part in this screening initiative were current smokers with 61% of current smokers being screen-negative. Although concerns that normal spirometry may reduce individuals motivation to stop smoking are not evidence-based, further research is required to assess the impact of normal spirometry on smoking behaviour. All smokers participating in screening events were provided with education and
smoking cessation support including referral to the local smoking cessation service irrespective of their screening result. Of the current smokers that were screen-positive, two-thirds did not attend their 1-stop clinic appointment. Targeting smoking cessation in this cohort is therefore challenging.

FEV-1/FEV-6 measurement was well tolerated by healthcare professionals and participants. The sensitivity and specificity of an FEV-1/FEV-6 ratio of <0.72 to predict airflow obstruction on conventional spirometry (FEV-1/FVC <0.7) were lower in this study than previously reported.15 The ROCs of FEV-1/FEV-6 in this cohort suggest that a higher cut-point of 0.76 would improve performance. However, the small number of participants with both screening and diagnostic spirometry results available and the fact that this population were preselected based on FEV-1 and FEV-1/FEV-6 criteria limits the generalisability of this finding and our ability to comment on its performance at a population level.

Inclusion of individuals with FEV-1 <80% predicted irrespective of the forced expiratory ratio ensured participants with abnormal lung function were not missed and resulted in other causes for respiratory symptoms to be identified and treated (eg, obesity, heart failure and obstructive sleep apnoea). It could be argued that using fixed spirometry cut points to define individuals as screen-positive or to confirm airflow obstruction on spirometry is invalid in a population setting and that using lower limits of normal or z-scores would be preferred. However, this practice is not yet widely established in a primary care setting. Indeed, relying on spirometry in isolation to diagnose COPD is flawed in clinical practice given the variable quality in a real-world setting. As such, we opted to adopt a pragmatic approach to COPD diagnosis that we believe reflects current practice within the United Kingdom and is supported by international guidelines.8

Previously reported methods of COPD screening have utilised questionnaires and measures of air flow limitation either in isolation or combined.16 A combined approach appears to perform better than either alone when identifying individuals with COPD that are likely to benefit from existing therapies.17 However, there remains no gold standard method for COPD screening in a population setting.

When considering the limitations of this study it is important to understand that it is not designed to assess the merits of COPD screening. Instead, it aims to characterise the population participating in a screening initiative, describe participant flow through the pathway and assess the symptom burden of participants. In this regard, the main limitation is that it was conducted in a single city with high levels of deprivation and high smoking prevalence. This limits the generalisability to other areas with different population characteristics.

In conclusion, the COPD diagnosis rate in this community-based COPD screening initiative was comparable to that observed using a targeted, case finding approach of at risk individuals identified through primary care records. Further research is needed to assess the impact of COPD case finding on patient outcomes. However, we demonstrate that community-based screening identifies individuals with a spectrum of disease severity and prominent symptoms that warrant treatment.

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CONFLICTS OF INTEREST

The authors report no conflicts of interest.

AUTHOR CONTRIBUTIONS

Study design: Crooks, Thompson, Platten, Evans, Faruqi
Data acquisition and/or analysis: Crooks, Thompson, Cummings, Watkins, Jackson, Platten, Evans, Faruqi
Manuscript drafting, revision and final approval: Crooks, Thompson, Cummings, Watkins, Jackson, Platten, Evans, Faruqi

ETHICS

Informed consent was provided by all participants. Formal research ethics committee approval was not required for this clinical service evaluation using anonymised data.

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