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Brief Communication

Exercise as airway clearance therapy (ExACT) in cystic fibrosis: a UK-based e-Delphi survey of patients, caregivers and health professionals

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ABSTRACT

Replacing traditional airway clearance therapy (tACT) with exercise (ExACT) in people with cystic fibrosis (pwCF) is a top research priority. A UK-based e-Delphi consensus was performed to inform the type(s), duration and intensity of ExACT. The expert panel comprised CF physiotherapists, doctors, pwCF and parents/partners. Exercise ACT was considered to be aerobic activity, of at least 20 minutes duration, and intense enough to elicit deep breathing. Consensus was reached that assessment breaths, coughs and huffs should accompany exercise to remove loose secretions, with support for trials to investigate ExACT versus tACT during times of stable disease but not pulmonary exacerbations.

(100 / 100 words)

Keywords: airway clearance; cystic fibrosis; e-Delphi survey; exercise; physiotherapy

INTRODUCTION

Despite being a standard of care [1] for >60 years, many people with cystic fibrosis (pwCF) perceive little benefit from daily airway clearance therapy (ACT) and evidence of benefit in CF is sparse. With new CF modulators (e.g. Elexacaftor/Tezacaftor/Ivacaftor [ETI]), pwCF are actively seeking to reduce their treatment burden [2]. A top 10 James Lind Alliance research priority for pwCF is the question ‘Can exercise replace chest physiotherapy’ [3]. To operationalise and develop this priority question for a feasibility trial, a benchmark equivalence for exercise as ACT (ExACT) as a comparator to traditional ACT (tACT) was needed. This study aimed, using an e-Delphi survey, to develop consensus recommendations by a CF expert panel of what could be considered a period of exercise equivalent to tACT.

METHODS

A three-round, iterative Delphi was performed to systematically develop consensus among key expert groups regarding ExACT in CF (Online Supplement). Four key expert groups from UK specialist organisations were recruited (1) pwCF; 2) caregivers (parents/partners) of pwCF; 3) doctors (CF specialists); and 4) specialist physiotherapists (Table 1). Ethical approval by the University of Portsmouth Faculty of Science and Health Ethics Committee (SHFEC 2021-047). Participants provided informed consent.

Round 1 statements, developed by the research team, were iteratively tested through specialist organisations to ensure comprehension. Round 1 was in three sections: 1) exercise as ACT, 2) exercise type and duration for ExACT, and 3) exercise intensity for ExACT, with responses repeated for ‘stable’ and ‘unstable’ CF. The survey was conducted using [onlinesurveys.ac.uk](https://www.onlinesurveys.ac.uk) (JISC, Bristol, UK), with links distributed via email. Agreement with each statement was ranked on a scale of 0–9, (0 total disagreement, 9 total agreement). Scores between 7-9 represented good agreement. Statement consensus was defined as >70% (response scores 7-9). For duration of exercise, we sought the modal average from 10-minute time epochs (Online Supplement). Participants responding were provided with individual and summary responses and invited to respond to the subsequent survey. Round 1: 8 statements for ‘exercise as airway clearance’ and ‘exercise intensity’ and 21 pre-defined types ‘exercise type and duration’ to rank. Free-text available. Round 2: 15 statements for ‘*exercise as airway clearance*’ and ‘*exercise intensity*’, including four non-consensual Round 1 statements and 11 new free-text derived statements and 9 additional exercise types. Round 3: 17 statements, including 8 non-

consensual from Round 2 and 9 new from free-text. Quantitative data was exported from JISC into Microsoft Excel[®] and SPSS (Version 27).

RESULTS

An overview of the e-Delphi statements is shown in Table 2. Of 83 Round 1 participants, 60 (72%) contributed to all three rounds (24 physiotherapists (40%), 11 (18%) doctors, 15 (25%) pwCF, and 10 (17%) parents/partners of pwCF). Consensus was reached that the right kind of exercise could act as a form of ACT in pwCF (Statement 1, 75%) and that, if evidence were supportive, it would be adopted into clinical practice (Statement 8, 89%), during stable CF only (Statement 12, 73%). Consensus was also reached that ExACT should be sufficiently intense to cause deep breathing (Statement 15, 90%) or ability to talk in short sentences but not whistle or sing (Statement 17, 77%). Assessment breaths and huffs can identify if secretions are there (Statement 6, 85%) and coughs and huffs must be included to effectively mobilise and clear secretions (Statement 3, 80%). Of the list of exercises developed during Rounds 1 and 2 (Table 3), 14 exercise types did not reach consensus and were removed (Online Supplement). Of these, gymnastics (69%), martial arts (67%), tennis/badminton (67%) were just below consensus level. For most exercise types, the highest proportion of agreement for duration was 21-30-minutes (Online Supplement).

Two statements differed significantly in ranking between subgroups. *‘Coughs and huffs are needed to remove loose secretions in the airway, especially during or after exercise’* was ranked significantly higher by CF physiotherapists than pwCF ($p=0.001$, mean difference: 2.3), CF doctors ($p=0.002$, 2.0) and parents/partners of pwCF ($p=0.01$, 1.3). *‘Coughs and huffs must be included in exercise for it to be effective as a form of airway clearance’* was also ranked significantly higher by CF physiotherapists than pwCF ($p=0.003$, 2.2), CF doctors ($p=0.01$, 2.1) and parents/partners of pwCF ($p=0.04$, mean difference: 3.0). Agreement for all other statements were comparable across groups.

DISCUSSION

This is the first consensus report on the use of ExACT in pwCF. Agreement that ExACT could be used as a substitute for tACT during times of stable CF was demonstrated, however this depends on the type, intensity and duration of exercise. Agreement was established that ExACT should be aerobic activity of >20-minutes in duration, with an intensity that elicits deep breathing. Most exercise types considered equivalent to tACT are weight-bearing (except

swimming) and induce body vibration. Assessment breaths +/- coughs and huffs (during and/or after exercise) are also considered key. These e-Delphi results will allow the development of an exercise compendium to enable a trial of ExACT in pwCF.

A preference for ExACT may already exist in pwCF: 96% report exercising, with 48% omitting tACT if they have exercised [4] and 16% report exercise as their primary ACT (UK CF Registry data). Adherence to tACT in pwCF is as low as 30% [5]. People with CF using exercise as a substitute for tACT have better lung function, lower perceived severity of respiratory disease and sputum load [6]. A recent systematic review [7] recommended huffs with exercise to improve mucus clearance, consistent with this consensus. Traditional ACT is considered burdensome by pwCF [2], as it is time consuming (up to 1-hour/day) [8]. If ExACT can replace tACT, significant time savings may be achievable, as well as additional health benefits.

This panel size ($n=60$) is sufficiently representative to provide consensus recommendations (typically 10-100 experts) and comparable to other respiratory e-Delphi studies [9]. Retention rate (72%) was above that considered acceptable (70%) [10].

In conclusion, this e-Delphi consensus supports ExACT as a potential alternative to tACT and provides evidence for the intervention acuity within a trial setting: aerobic exercise of >20-minutes duration that causes somebody to get out of breath during stable disease.

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agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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TABLES

Table 1. Participant demographics.

Variable	<i>n</i> (%) = 83 (100.0) or mean (SD)	
Gender	Female (<i>n</i> = 51 [61.4])	-
Expert group	Physiotherapist - paediatrics (<i>n</i> = 16 [19.3]) Physiotherapist – adults (<i>n</i> = 13 [15.7]) Doctor – paediatrics (<i>n</i> = 11 [13.8]) Doctor - adults (<i>n</i> = 6 [7.3])	Person with CF (<i>n</i> = 23 [27.7]) Parent or partner of an adult with CF (<i>n</i> = 12 [14.6]) Parent or partner of a child/adolescent (< 18 years) with CF (<i>n</i> = 2 [2.4])
Age (years)	43.0 (11.7)	-
Geographical location (closest city)	Birmingham (<i>n</i> = 3 [3.6]) Nottingham (<i>n</i> = 2 [2.4]) Salisbury (<i>n</i> = 1 [1.2]) Leicester (<i>n</i> = 3 [3.6]) Edinburgh (<i>n</i> = 2 [2.4]) Cambridge (<i>n</i> = 4 [4.8]) Liverpool (<i>n</i> = 2 [2.4]) Cardiff (<i>n</i> = 8 [9.8]) Sunderland (<i>n</i> = 1 [1.2]) York (<i>n</i> = 1 [1.2]) Reading (<i>n</i> = 1 [1.2]) Exeter (<i>n</i> = 2 [2.4]) Plymouth (<i>n</i> = 2 [2.4]) Norwich (<i>n</i> = 1 [1.2]) Newport (<i>n</i> = 1 [1.2])	Portsmouth (<i>n</i> = 5 [6.0]) Truro (<i>n</i> = 4 [4.8]) Sheffield (<i>n</i> = 1 [1.2]) Southampton (<i>n</i> = 9 [10.8]) London (<i>n</i> = 5 [6.0]) Wakefield (<i>n</i> = 1 [1.2]) Norwich (<i>n</i> = 1 [1.2]) Glasgow (<i>n</i> = 7 [8.4]) Manchester (<i>n</i> = 2 [2.4]) Oxford (<i>n</i> = 2 [2.4]) Brighton and Hove (<i>n</i> = 5 [6.0]) Southend-on-Sea (<i>n</i> = 1 [1.2]) Newcastle-upon-Tyne (<i>n</i> = 2 [2.4]) Bristol (<i>n</i> = 1 [1.2]) Belfast (<i>n</i> = 2 [2.4])
Experience working with people with CF (years)	<i>Doctors</i> 1-3 (<i>n</i> = 1 [6.3]) 4-5 (<i>n</i> = 0) 6-9 (<i>n</i> = 0) 10+ (<i>n</i> = 16 [94.1])	<i>Physiotherapists</i> 1-3 (<i>n</i> = 3 [10.3]) 4-5 (<i>n</i> = 5 [17.2]) 6-9 (<i>n</i> = 7 [24.1]) 10+ (<i>n</i> = 14 [48.3])

Note: CF, cystic fibrosis

Table 2. Statements relating to exercise as airway clearance therapy in cystic fibrosis from the ‘*exercise as airway clearance*’ and ‘*exercise intensity*’ domains that reached overall panel consensus agreement.

Consensus Statements		Median	IQR	Proportion of scores ranked 7-9 (%)
<i>Exercise as airway clearance</i>	1 The right kind of exercise can loosen and move secretions in a similar way to chest physiotherapy in people with cystic fibrosis ¹	8	6.5 – 9	74.7
	2 Coughs and huffs are needed to remove loose secretions in the airway, especially during or after exercise ¹	8	7 – 9	79.5
	3 Coughs and huffs must be included in exercise for it to be effective as a form of airway clearance ³	8	7 – 9	80.0
	4 Coughs and huffs should also be used regularly during exercise to ensure that any secretions mobilised are effectively cleared ³	8	6 – 8	71.7
	5 Coughs and huffs should also be used in the recovery period after an exercise session, to ensure that any secretions mobilised are effectively cleared ³	8	7 – 9	81.7
	6 Assessment breaths and huffs can be used in people with cystic fibrosis to help see if secretions are there ³	8	7 – 9	85.0
	7 Assessment breaths, coughs and huffs can be used in people with cystic fibrosis before exercise to help see if secretions are there ³	7	6 – 9	71.7
	8 If evidence were supportive, I would be happy for exercise to replace chest physiotherapy for airway clearance during stable cystic fibrosis periods ¹	9	8 – 9	89.1
	9 How often airway clearance should be undertaken depends on the individual (e.g. whether they are productive, lung function) ²	9	8 – 9	86.6
	10 It is important for people with cystic fibrosis to keep their chest as clear as possible. Regular clearance will help this ²	9	8 – 9	92.5
	11 People with cystic fibrosis should try to do something at least once a day that helps clear their airways ²	9	7 – 9	88.0
	12 A combination of exercise and traditional chest physiotherapy methods are important during a cystic fibrosis chest exacerbation ³	8	6 – 9	73.4
	13 People with cystic fibrosis should try to do something at least once a day that helps clear their airways, if they have chest symptoms and feel as though mucus needs moving ²	9	9 – 9	92.6
<i>Exercise intensity</i>	14 For exercise to be used for airway clearance, exercise intensity is key ²	8	7 – 9	85.1
	15 For exercise to be used for airway clearance, the intensity must be such that the person is deep breathing during exercise ²	8	7 – 9	89.6
	16 Whatever type of exercise is used for airway clearance, it needs to be at a moderate-intensity depending on the individual’s fitness and health ²	8	7 – 9	80.6
	17 Exercise should be undertaken at a level that means, although able to talk in short sentences, the person could not whistle or sing ¹	8	7 – 9	77.1

Note: Median is scored on a scale of 0 to 9, where 0 represents total disagreement and 9 represents total agreement. Scores between 7 and 9 were considered to represent good agreement. Consensus was achieved when > 70% of participants scored between 7 and 9 on any statement. IQR = interquartile range. ¹ denotes consensus agreement was reached in Round 1, ² denotes consensus agreement was reached in Round 2, ³ denotes consensus agreement was reached in Round 3.

Table 3. Types of exercise considered as options for exercise airway clearance therapy during times of stable cystic fibrosis.

Exercise type	Median agreement	IQR agreement	Proportion of scores ranked 7-9 (%)	Mode	Median duration (minutes)	IQR duration (minutes)
<i>Consensus reached as options for ExACT</i>						
Aerobics	8	7 – 9	84.3	25	35	25-45
Basketball / netball / volleyball	8	7 – 9	79.0	25	35	25-45
Body combat	8	7 – 9	80.7	25	30	25-42.5
Boxing	8	7 – 9	84.3	25	25	25-37.5
Circuit training / CrossFit	8	7 – 9	89.5	25	25	25-45
Cycling	8	7 – 9	82.4	25	35	25-55
Dance	8	6 – 9	73.7	55	35	25-55
Football / hockey (field, roller, ice) / rugby	8	7 – 9	80.7	55	45	25-55
High-intensity interval training (HIIT)	9	8 – 9	91.2	25	25	25-35
Rowing	8	7 – 9	78.9	25	35	25-55
Running / jogging / orienteering	8	8 – 9	84.3	25	30	25-37.5
Skipping	8	8 – 9	89.5	25	25	25-35
Squash	8	7 – 9	84.2	25	35	25-45
Swimming	8	6 – 9	73.6	25	35	25-55
Trampolining	8	7 – 9	80.7	25	35	25-45
<i>Consensus not reached as options for ExACT</i>						
Climbing	7	5 – 8	57.9	-	-	-
Gardening	4	2 – 6	17.6	-	-	-
Gymnastics	7	5 – 8	68.5	-	-	-
Horse riding	6	4 – 8	40.3	-	-	-
Kayaking	7	5 – 8	57.9	-	-	-
Martial arts (judo, karate, etc)	7	6 – 8	66.7	-	-	-
Mountaineering	7	5 – 8	50.9	-	-	-
Surfing / paddling	7	5 – 8	50.9	-	-	-
Table tennis	6	4 – 8	49.2	-	-	-
Tennis / badminton	8	6 – 9	66.7	-	-	-
Walking at a fast pace	7	5 – 8	52.7	-	-	-
Weight (resistance) training	6	4 – 8	45.6	-	-	-
Wii Fit (or other online exercise)	6	4 – 8	49.1	-	-	-
Yoga	5	3 – 7	28.1	-	-	-

Note: Modes were selected based on being performed at a moderate-high intensity that makes the person breathe deeply and with assessment breaths, coughs and coughs. Median agreement is scored on a scale of 0 to 9, where 0 represents total disagreement and 9 represents total agreement. Scores between 7 and 9 were considered to represent good agreement. Consensus was achieved when > 70% of participants scored between 7 and 9 on any statement. N.B. ExACT, exercise as airway clearance therapy; IQR, interquartile range.