

## Research

## Exercise is commonly used as a substitute for traditional airway clearance techniques by adults with cystic fibrosis in Australia: a survey

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## KEY WORDS

Cystic fibrosis  
Exercise  
Physical therapy modalities  
Respiratory therapy



## A B S T R A C T

**Questions:** What airway clearance techniques and exercise regimens are used by adults with cystic fibrosis (CF) in Australia when well or unwell? What proportion of these adults believe that exercise can be used as a substitute for traditional airway clearance techniques, and how have they come to this belief? What type of exercise is used as a substitute for traditional airway clearance techniques? **Design:** Cross-sectional survey at 13 CF centres in Australia, using a purpose-designed questionnaire. **Participants:** Six hundred and ninety-two adults with CF completed the questionnaire. **Outcome measures:** The questionnaire included questions about: the participants' current use of traditional airway clearance techniques and exercise, when well and unwell; and beliefs regarding the use of exercise as a substitute for traditional airway clearance techniques. **Results:** Coughing, huffing and positive expiratory pressure were the most commonly used airway clearance techniques. Walking, jogging and lifting weights were the most commonly used forms of exercise. Overall, 43% of participants believed that exercise could be used as a substitute for traditional airway clearance techniques, with 44% having substituted exercise for traditional airway clearance techniques in the previous 3 months. Personal experience was the most commonly reported factor influencing participants' beliefs about the use of exercise as a substitute for traditional airway clearance techniques. **Conclusion:** Exercise is commonly used as a substitute for traditional airway clearance techniques. Physiotherapists should advise patients that whilst there is some research suggesting a possible mechanism for exercise as a form of airway clearance, there are currently no medium-term to long-term data supporting exercise as a stand-alone form of airway clearance. These results suggest that future research to investigate the clinical effectiveness of exercise as a substitute for traditional airway clearance techniques should be a priority. **Registration:** ACTRN12616000994482. [Ward N, Stiller K, Holland AE, and the Australian Cystic Fibrosis Exercise Survey group (2019) Exercise is commonly used as a substitute for traditional airway clearance techniques by adults with cystic fibrosis in Australia: a survey. *Journal of Physiotherapy* 65:43–50] Crown Copyright © 2018 Published by Elsevier B.V. on behalf of Australian Physiotherapy Association. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

## Introduction

Survival among people with cystic fibrosis (CF) has improved over the last few decades, largely due to an increase in the range of treatment options. As a result, there has been a rise in the complexity

and time-burden of clinical care and self-management. As with any complex treatment regimen for any chronic disease, it is well recognised that treatment adherence varies widely between individuals with CF.<sup>1–4</sup>

There are now more adults with CF who have mild respiratory disease than ever before, with approximately 42% of adult males and 44% of adult females with CF in Australia having normal or only mildly impaired lung function, defined as forced expiratory volume in one second (FEV<sub>1</sub>) > 70% predicted.<sup>5</sup> Historically, people with CF have been advised to perform airway clearance techniques on a daily basis to aid the clearance of thick respiratory secretions. Exercise is also routinely recommended due to its beneficial effects on aerobic exercise capacity, muscle strength, bone mineral density and mental health.<sup>6</sup> Current international guidelines either recommend exercise as an adjunct to, but not a replacement for, traditional airway

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clearance techniques, or do not mention exercise in relation to airway clearance.<sup>7-9</sup>

It is well documented that people with CF have lower adherence to traditional airway clearance techniques than other therapies, with daily adherence as low as 40%.<sup>2,3</sup> There are many reasons for non-adherence with airway clearance techniques, including a sense of feeling well without performing airway clearance techniques, insufficient time, and the perceived effort and energy required.<sup>1</sup> Previous studies have reported that some patients (4 to 80%) consider exercise as a form of airway clearance or that exercising regularly means that they do not need to perform traditional airway clearance techniques.<sup>1,2,10-13</sup> The nature of exercise (type, frequency, duration and intensity) that people with CF do when exercising as a form of airway clearance has yet to be documented. This information would be of value as it would help to inform the exercise prescription chosen for any future studies investigating exercise as a stand-alone airway clearance technique.<sup>14</sup>

The main aims of this study were to identify in adults with CF in Australia: current use of exercise and airway clearance techniques during well and unwell periods; whether exercise is used as a substitute for, or to enhance the effectiveness of, traditional airway clearance techniques; and how their beliefs regarding the use of exercise as a substitute for traditional airway clearance techniques were formed.

Therefore, the research questions for this cross-sectional survey were:

1. What airway clearance techniques and exercise regimens are used by adults with CF in Australia when well or unwell?
2. What proportion of these adults believe that exercise can be used as a substitute for traditional airway clearance techniques, and how have they come to this belief?
3. What type of exercise is used as a substitute for traditional airway clearance techniques?

## Method

### Design

A multicentre cross-sectional survey was undertaken. All centres that provide data about adults with CF to the Australian Cystic

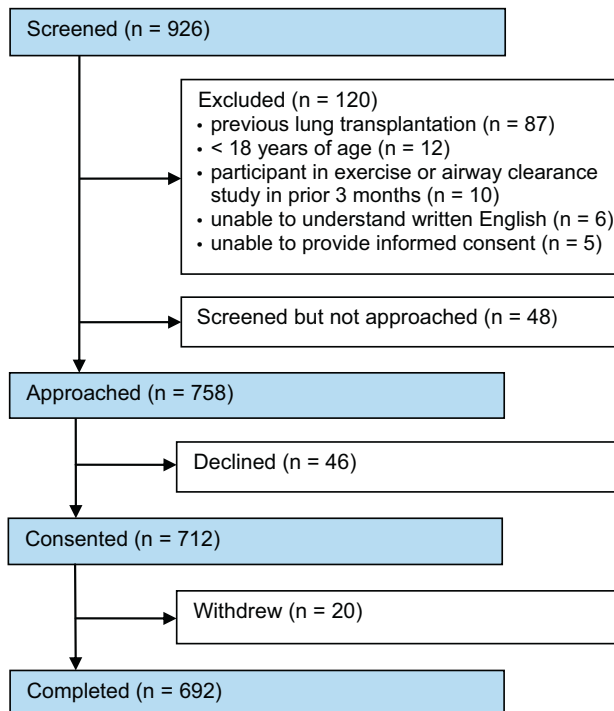


Figure 1. Flow of participants through the study.

Table 1  
Characteristics of the participants.

Characteristics	Participants (n = 692)
Age (yr), mean (SD)	31 (11)
Gender, n male (%) <sup>a</sup>	395 (57)
Body mass index (kg/m <sup>2</sup> ), mean (SD) <sup>b</sup>	22.8 (3.6)
Most recent FEV <sub>1</sub> (l), mean (SD) <sup>b</sup>	2.40 (1.05)
Most recent FEV <sub>1</sub> (% predicted), mean (SD) <sup>c</sup>	63 (23)
Best FEV <sub>1</sub> in the past year (l), mean (SD)	2.62 (1.06)
Best FEV <sub>1</sub> in the past year (% predicted), mean (SD) <sup>d</sup>	69 (23)
Lung disease/symptoms visual analogue scale (0 to 10), mean (SD)	3.8 (2.5)
Sputum volume visual analogue scale (0 to 10), mean (SD) <sup>b</sup>	3.4 (2.2)
<i>Pseudomonas aeruginosa</i> , n (%) <sup>c</sup>	513 (74)
Using dornase alfa, n (%)	435 (63)
Using nebulised saline, n (%)	451 (65)
6.0%	294 (42)
3.0%	78 (11)
0.9%	49 (7)
Antibiotics for respiratory exacerbation in past 3 months, n (%) <sup>d,e</sup>	495 (72)
intravenous	232 (34)
inhaled	312 (45)
oral	377 (55)
Social situation, n (%) <sup>b</sup>	
living with parent(s)	222 (32)
living with partner/spouse with no dependent children	206 (30)
living with partner/spouse and dependent children	140 (20)
living alone	54 (8)
living with friend(s)	46 (7)
living with dependent child/children	5 (1)
other	18 (3)
Employment, n (%)	
working or studying full time	328 (47)
working or studying part time	131 (19)
disability pensioner	90 (13)
disability pensioner and working part time	48 (7)
unemployed	34 (5)
stay-at-home parent	23 (3)
other	38 (5)

<sup>a</sup> n = 689.

<sup>b</sup> n = 691.

<sup>c</sup> n = 690.

<sup>d</sup> n = 688.

<sup>e</sup> Participants were able to select multiple options if applicable.

Fibrosis Data registry participated. Recruitment was open at each centre for 3 months, with all centres commencing recruitment between February and May 2017. Consecutive patients attending for care during the recruitment period were screened for eligibility by the investigators at each site. Participants provided informed consent prior to completing the questionnaire independently.

### Participants

The inclusion criteria were: age  $\geq$  18 years, diagnosis of CF, and attendance at the participating adult CF centre. Exclusion criteria

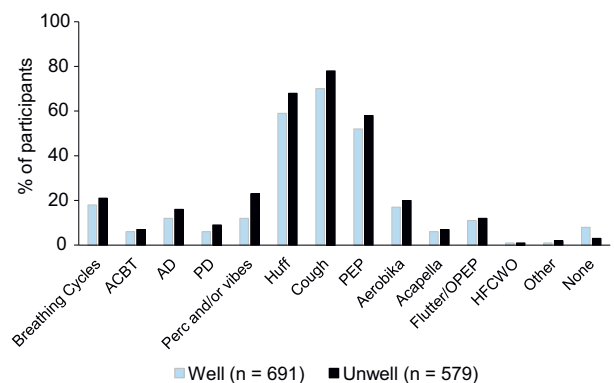
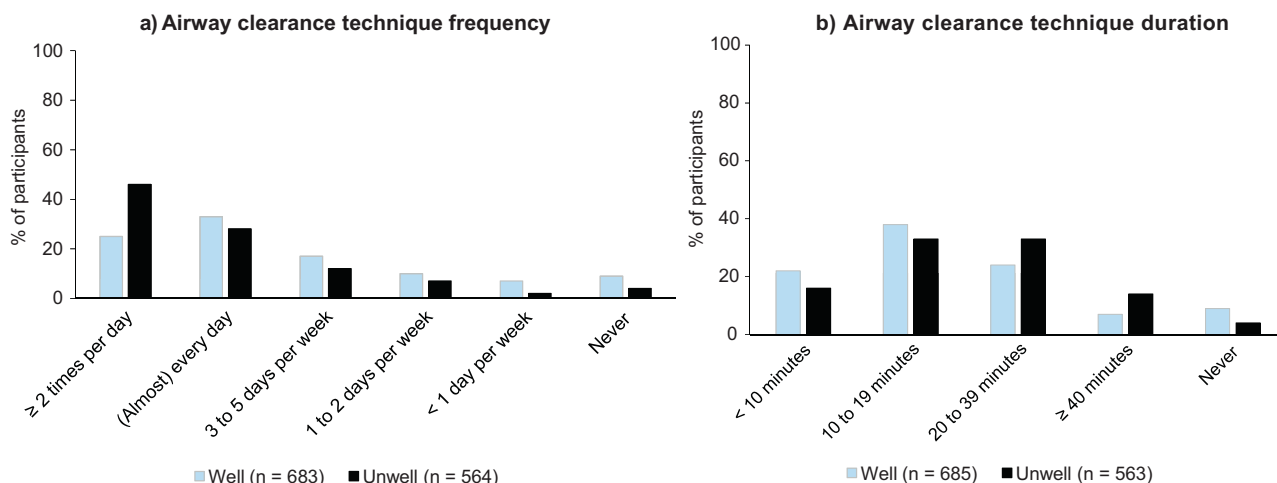


Figure 2. Airway clearance techniques reportedly used over the preceding 3 months for all participants when well and unwell.

ACBT = Active Cycle of Breathing Technique, AD = autogenic drainage, PD = postural drainage, Perc and vibes = percussion and/or vibrations, PEP = positive expiratory pressure, OPEP = oscillating positive expiratory pressure, HFCWO = high-frequency chest wall oscillation.



**Figure 3.** Reported (a) frequency and (b) duration of airway clearance techniques for all participants when well and unwell over the preceding 3 months.

were: inability to provide informed consent; being critically unwell or receiving end-of-life care; inability to understand written English; previous lung transplantation; or participation in an interventional study of exercise or an airway clearance technique in the previous 3 months.

**Outcome measures**

A purpose-designed questionnaire was developed by the investigators. The draft questionnaire underwent several rounds of pilot testing, with two to three young adults with CF involved in each round. The feedback on the questionnaire’s clarity, ease of completion and content was used to make further refinements. The final questionnaire comprised seven sections. The participant completed six sections, which elicited: demographic data; symptom severity; current airway clearance techniques and exercise use during both well and unwell periods; and beliefs and practices regarding exercise as a form of airway clearance. Perceived severity of lung disease/symptoms was marked on a 10-cm visual analogue scale ranging from 0 ‘not severe at all’ to 10 ‘extremely severe’. Estimated daily sputum volume was marked on a similar scale from 0 ‘no sputum’ to 10 ‘extreme amount’. After this, the site investigator checked for missed questions and then entered the participant’s clinical data in the seventh section. The full questionnaire is available in Appendix 1 on the eAddenda.

**Data analysis**

The raw data were entered into an electronic spreadsheet<sup>a</sup> for data cleaning prior to importing into statistical software<sup>b</sup> for analysis. Demographic data were summarised with descriptive statistics. Responses about the types of airway clearance techniques and exercise used were summarised as number (%) of respondents. Responses about the frequency and duration of those regimens have been categorised and then also reported as number (%) of respondents. For the questions examining airway clearance techniques and exercise regimens when participants had been unwell, percentages were calculated based on the number of participants indicating that they had been unwell in the preceding 3 months, as elicited by the questionnaire. Participants’ beliefs were grouped into the following categories for analysis: agreed/strongly agreed, neutral, and disagreed/strongly disagreed. Correlations were determined using either Pearson’s or Spearman’s correlations depending on normality of the data distribution. T-tests and ANOVAs were used to determine differences between groups. Categorical data were analysed using Chi-square and Tukey post-hoc comparisons. Significance was determined as *p* < 0.05.

**Results**

**Compliance with the study protocol**

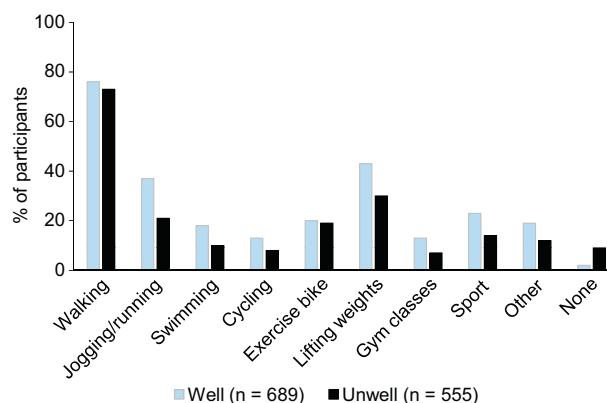
Of the 806 eligible patients screened, 758 were approached regarding participation. The remaining 48 (6%) eligible patients were not approached due to the competing clinical requirements of the investigators, meaning that these patients left their appointments prior to being approached regarding study participation.

**Flow of participants through the study**

Figure 1 summarises the flow of participants through the study. One hundred and twenty patients were excluded, most often because they had undergone a lung transplant. Of the 758 patients approached for participation in the study, 712 provided informed consent, with 692 completing the questionnaire (completion rate = 91%). Twenty patients chose to withdraw after consenting to participate.

**Characteristics of the participants**

The characteristics of the participants are summarised in Table 1. Based on the most recent spirometry, 127 (18%) participants had severe lung disease (FEV<sub>1</sub> < 40% of predicted), 278 (40%) had moderate lung disease (FEV<sub>1</sub> = 40 to 69% of predicted), 190 (27%) had mild lung disease (FEV<sub>1</sub> = 70 to 89% of predicted), and 95 (14%) had normal lung function (FEV<sub>1</sub> ≥ 90% of predicted).



**Figure 4.** Reported exercise types for all participants when well and unwell over the preceding 3 months.

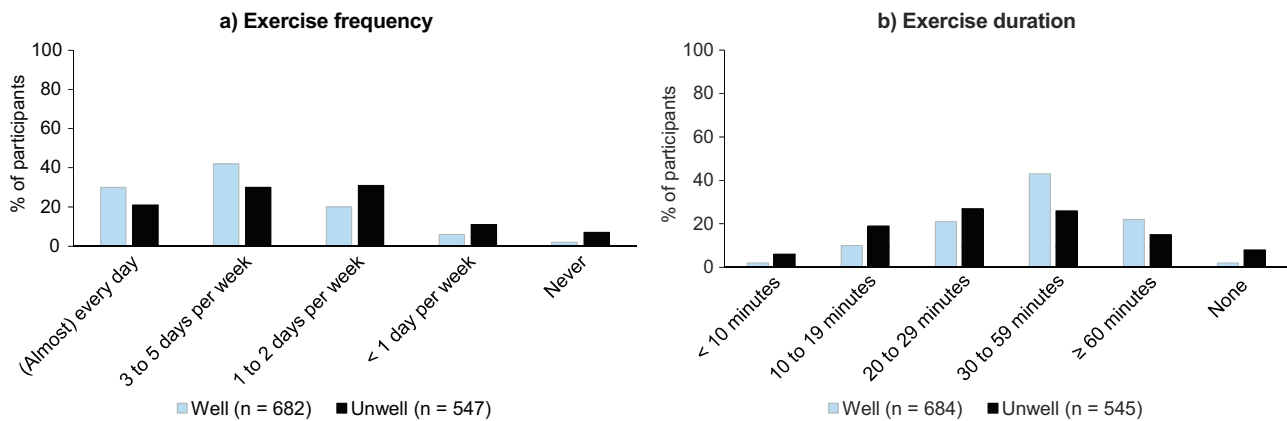


Figure 5. Reported (a) frequency and (b) duration of exercise for all participants when well and unwell over the preceding 3 months.

### Airway clearance techniques and exercise regimens

The most commonly used airway clearance techniques were coughing, huffing and positive expiratory pressure during both well and unwell periods (Figure 2). A total of 396 (58%) participants were performing an airway clearance technique most days when well (Figure 3). Walking, lifting weights and jogging/running were the most commonly reported forms of exercise performed when well and unwell (Figure 4). The majority of participants reported using more than one form of exercise when both well and unwell: 546 (79%) when well and 315 (57%) when unwell. The recommended frequency of exercising (ie, at least three times per week)<sup>15</sup> was achieved by 490 (72%) of participants when they were well, with exercise duration most often 30 to 59 minutes (n = 293, 43%) (Figure 5). Reduced chest congestion and less coughing were the most commonly reported benefits for both airway clearance techniques and exercise (Table 2). The use of huffing to clear respiratory secretions during exercise was reported by 371 (54%) participants, with 218 (61%) only doing so when they felt the need. See Appendix 2 on the eAddenda for

Table 2 Participant-reported respiratory symptom benefits from performing airway clearance techniques and exercise over the preceding 3 months.

Reported benefits	Airway clearance techniques	Exercise
	(n = 691)	(n = 682)
Identified respiratory symptom benefits, n (yes (%))		
yes	574 (83)	533 (78)
no	73 (11)	130 (19)
not applicable	44 (6)	19 (3)
Symptom benefits, n (%)		
less coughing	318 (46)	272 (40)
less chest congestion	405 (59)	355 (52)
less likely to cough up sputum	227 (33)	170 (25)
less short of breath	223 (32)	223 (33)
less chest pain	61 (9)	74 (11)
less chest tightness	211 (31)	212 (31)
less wheeze	178 (26)	136 (20)
other	26 (4)	60 (9)
Time to onset, n (%)		
within a few minutes of starting	89 (13)	66 (10)
by end of treatment	224 (32)	189 (28)
within 30 minutes of finishing	157 (23)	143 (21)
> 30 minutes after finishing	61 (9)	80 (12)
other	13 (2)	13 (2)
unsure	13 (2)	23 (3)
Duration of benefits, n (%)		
< 30 minutes	10 (1)	6 (1)
30 to 59 minutes	16 (2)	21 (3)
1 to 2 hours	74 (11)	71 (10)
3 to 12 hours	263 (38)	201 (29)
> 12 hours	87 (13)	127 (19)
unsure	103 (15)	95 (14)

further analyses of airway clearance techniques and exercise practices, the perceived benefits, and the use of huffing during exercise.

### Beliefs about exercise and its relationship to airway clearance

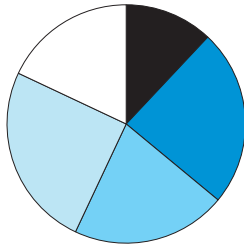
Almost half of the participants (n = 296, 43%) agreed or strongly agreed that exercise could be used as a substitute for traditional airway clearance techniques, and 456 (66%) participants believed that exercising before or during traditional airway clearance techniques could enhance their effectiveness (Figure 6). The most commonly reported reasons underlying participants' beliefs about exercise and its role in airway clearance were: personal experience (n = 584, 85%), advice from an unspecified health professional (n = 83, 12%), advice from physiotherapists (n = 51, 7%), and advice from doctors (n = 29, 4%). Multiple reasons for their beliefs were provided by 144 (21%) participants. Tukey post-hoc analysis (Table 3) revealed that participants who agreed/strongly agreed that exercise could be used as a substitute for traditional airway clearance techniques had significantly higher FEV<sub>1</sub> % predicted (mean 68%, SD 23) than those who were neutral (62%, SD 22) or disagreed/strongly disagreed (58%, SD 23),  $p < 0.049$ . Those who disagreed/strongly disagreed had a significantly higher perceived daily sputum volume (mean 4.0, SD 2.0) than those who were neutral (3.2, SD 2.2) or agreed/strongly agreed (3.0, SD 2.2),  $p < 0.001$ .

A significant association was demonstrated between participants' beliefs about exercise being an alternative to traditional airway clearance techniques and the adoption of this in clinical practice. The proportion of participants who had used exercise as a substitute for traditional airway clearance techniques was higher in the agreed/strongly agreed group (68%) compared with the neutral group (42%) or the disagreed/strongly disagreed group (16%),  $p < 0.001$ . Participants who agreed/strongly agreed that exercise could enhance the effectiveness of traditional airway clearance techniques were more likely to have used exercise to improve the effectiveness of their traditional airway clearance techniques in the previous 3 months (68%) than those who were neutral (33%) or disagreed/strongly disagreed (47%),  $p < 0.001$ .

### Use of exercise as a substitute or alternative to traditional airway clearance techniques

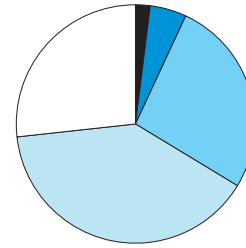
Three hundred (44%) participants reported having used exercise as a substitute for traditional airway clearance techniques over the past 3 months. Figure 7 presents the types, frequencies and durations of exercise reported by participants when using exercise as a substitute for traditional airway clearance techniques. Participants who reported using exercise as a substitute for traditional airway clearance techniques were asked to identify the single most effective form of exercise and, of the 174 participants who did so, 53 (30%) reported that jogging/running was the most effective, followed by sport

a) Exercise can be used as a substitute or alternative to traditional airway clearance techniques (n = 686)



■ strongly disagree ■ disagree ■ neutral ■ agree □ strongly agree

b) Exercising before/during traditional airway clearance techniques makes the techniques more effective (n = 687)



■ strongly disagree ■ disagree ■ neutral ■ agree □ strongly agree

**Figure 6.** Participants' beliefs about exercise and its relationship to traditional airway clearance techniques, indicated by the degree of agreement with statements (a) and (b).

(n = 25, 14%), other (n = 20, 11%) and swimming and walking fast (each n = 17, 10%). When exercising as a substitute for traditional airway clearance techniques, the majority of participants reported exercising at moderate to strong perceived exertion intensity and experiencing moderate to severe shortness of breath (Table 4). When participants who used exercise as a substitute to traditional airway clearance techniques were unwell, 63 (21%) stopped using exercise as a substitute for traditional airway clearance techniques, 45 (15%) continued using exercise as their only airway clearance technique, and 187 (63%) continued using exercise as an alternative to traditional airway clearance techniques but also added in a traditional airway clearance technique whilst unwell.

Participants who reported using exercise as a substitute for traditional airway clearance techniques had: significantly higher FEV<sub>1</sub> % predicted (mean 68%, SD 22) than the other participants (60%, SD 24),  $p < 0.001$ ; significantly lower perceived severity of respiratory disease (3.4 cm, SD 2.3) than the other participants (4.2 cm, SD 2.5),  $p < 0.001$ ; and significantly lower sputum load (3.1 cm, SD 2.2) than other participants (3.6 cm, SD 2.2),  $p = 0.002$ . There was no association between the CF centre the participants attended and their use of exercise as a substitute for traditional airway clearance techniques ( $p = 0.354$ ). The proportion of participants who reported not using any traditional airway clearance techniques when well was significantly higher in the subgroup that reported using exercise as a substitute for traditional airway clearance techniques (10% versus 6%,  $p = 0.048$ ).

### Exercise to improve the effectiveness of traditional airway clearance techniques

In the preceding 3 months, 394 (57%) participants reported using exercise to improve the effectiveness of their traditional airway clearance techniques, with 342 (87%) using more than one form of exercise (Figure 8). Participants were evenly divided between those who exercised before versus after airway clearance techniques: n = 106 (27%) and n = 107 (27%), respectively. There were 18 (5%) who reported exercising during their airway clearance techniques to

improve the techniques' effectiveness. Despite this, 144 (37%) reported exercising at a time unrelated to their airway clearance techniques and 19 (5%) did not indicate when they exercised in relation to the techniques. The majority of participants reported exerting themselves moderately to strongly when using exercise to improve airway clearance effectiveness (Table 5).

### Discussion

This is the first study that has investigated the airway clearance techniques and exercise practices of adults with CF across Australia. It is also believed to be the first multicentre study to carry out an in-depth investigation of the current practices of adults with CF regarding the use of exercise as a substitute for traditional airway clearance techniques. It was found that 43% of participants believed that exercise could be used as a substitute for traditional airway clearance techniques and 44% of participants had used exercise as a substitute for such techniques in the preceding 3 months.

The proportion of participants reporting using exercise as a substitute for traditional airway clearance techniques in this study is much higher than that reported in the majority of previous studies, where rates have generally been  $< 30\%$ .<sup>1,2,10,13,16</sup> Current international guidelines recommend exercise as an adjunct to traditional airway clearance techniques or do not mention exercise in relation to them.<sup>8,9,15</sup> Whilst several short-term studies provide a potential physiological rationale for using exercise as a form of secretion clearance, to date there is no medium-term to long-term evidence supporting the clinical efficacy of such practice.<sup>17-19</sup> Given that nearly half of the participants in this study were already choosing to substitute exercise for traditional airway clearance techniques, further research investigating the clinical efficacy of exercising as a substitute for traditional airway clearance techniques over the medium to longer term should be considered a high priority.

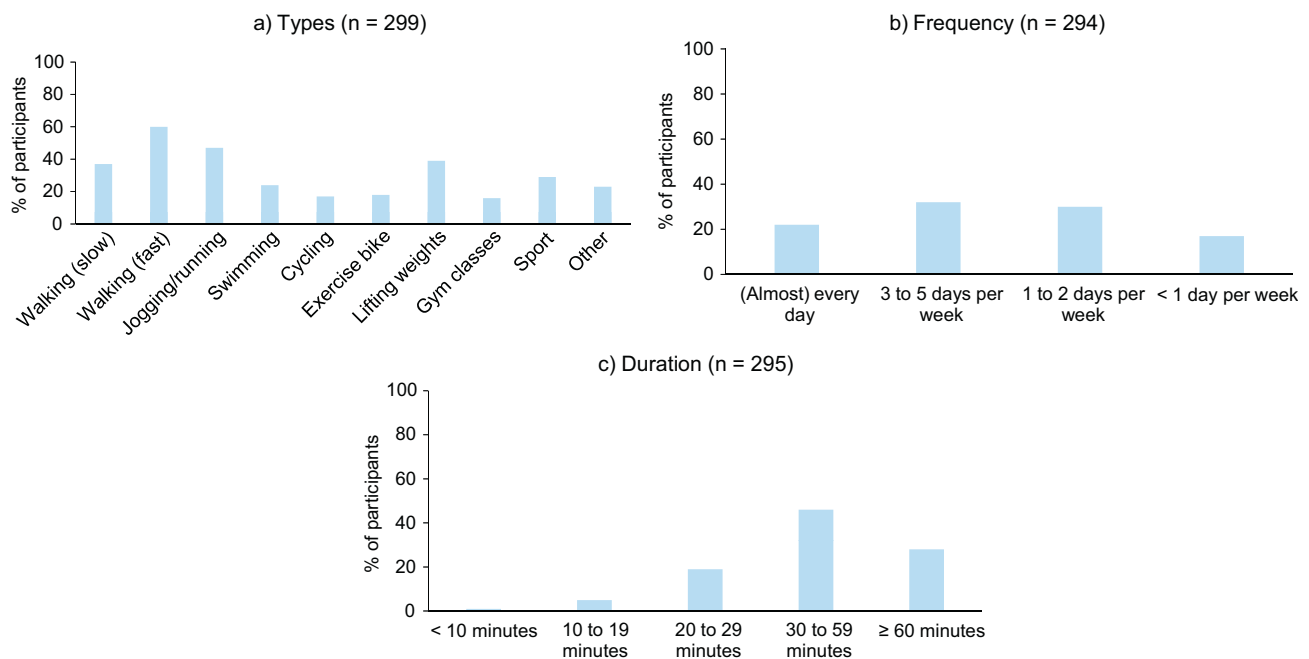
Walking fast or jogging were the two most commonly reported types of exercise that participants used as a substitute for traditional airway clearance techniques. Whilst lacking medium-term to long-term data to support this practice, several short-term crossover trials have suggested that walking/jogging may have a role in promoting secretion clearance.<sup>17,18,20</sup> Walking/jogging may increase expiratory airflow and have a beneficial effect on sputum mechanical impedance.<sup>17</sup> Lifting weights was the third most commonly reported type of exercise used as a substitute for traditional airway clearance techniques in this study. We are unaware of any research investigating the effect of lifting weights on secretion clearance, and further investigation into the clinical effectiveness of this practice may be warranted.

Prior to the study it was anticipated that patients' beliefs and practices regarding the use of exercise as a substitute to traditional airway clearance techniques may have been influenced by the clinical advice imparted from their treating multidisciplinary team. However, the most common reason stated by participants for their beliefs about the suitability of exercise as a substitute for traditional airway

**Table 3**  
Relationship of disease characteristics to beliefs about using exercise as a substitute for traditional airway clearance techniques.

Disease severity marker	Belief about whether exercise can substitute for traditional airway clearance techniques	Mean (SD)
FEV <sub>1</sub> (% predicted)	disagree/strongly disagree	58 (23)
	neutral	62 (22)
	agree/strongly agree	68 (23) <sup>a</sup>
Participant-perceived severity (0 to 10)	disagree/strongly disagree	4.4 (2.4)
	neutral	3.8 (2.4)
	agree/strongly agree	3.3 (2.5)
Participant-perceived sputum volume (0 to 10)	disagree/strongly disagree	4.0 (2.0) <sup>a</sup>
	neutral	3.2 (2.2)
	agree/strongly agree	3.0 (2.2)

<sup>a</sup> Significant difference ( $p < 0.05$ ) when compared to the 'neutral' respondents.



**Figure 7.** Reported exercise routines when exercising as a substitute for traditional airway clearance techniques: a) type of exercise, b) frequency and c) duration of exercise sessions.

clearance techniques was personal experience. These beliefs were widespread across Australia and independent of the CF centre that the participant attended. Given that a sizeable cohort of patients are already choosing to use walking/jogging as a substitute for traditional techniques based on personal experience and in view of the physiological data suggesting a potential mechanism of action, it would seem appropriate that walking/jogging be the forms of exercise used for studies investigating the impact on clinical outcomes such as lung function and exacerbation rate.

The results of this study have several implications for clinical practice. It is evident from this study that a large number of people with CF are choosing to use exercise as a substitute for traditional airway clearance techniques, based largely on their personal experience. Therefore, when prescribing new exercise regimens to people with CF, in addition to outlining the non-respiratory benefits of exercise (eg, muscle strength, bone mineral density), clinicians should also advise patients that whilst there is some research suggesting a possible mechanism for exercise as a form of airway clearance, there are currently no medium-term to long-term data supporting exercise as a stand-alone form of airway clearance. Similarly, when reviewing an individual's current exercise regimen, specific questioning should occur to determine if the individual is using exercise as a substitute for airway clearance techniques, and if so, further education should be provided by the clinician regarding the evidence for this practice. When a person chooses to use exercise as a substitute for airway clearance techniques when well, clinicians should also take the time to discuss that he/she may

need to use traditional airway clearance techniques when unwell to improve airway clearance.

Another clinical implication relates to the finding that personal experience of participants was such a dominant driver of their decision-making. A total of 7% of participants reported that advice from a physiotherapist was a basis for their beliefs, as opposed to 85% who cited personal experience. This finding highlights that clinicians should take the time to explore a patient's beliefs and personal experience as part of the process for prescribing new or modified exercise and airway clearance techniques regimens. Despite this study relying on participant self-report, which may have over-estimated adherence, a notable number of participants were not achieving the current recommended frequency of airway clearance techniques and exercise. Whilst clinicians consider longer term outcomes, such as rate of lung function decline and respiratory exacerbation rates, to be highly important when prescribing airway clearance techniques and exercise, patients may consider outcomes with a more immediate benefit, such as reducing the time burden of treatment or immediate symptom relief, as being more important when deciding on their therapeutic regimen. However, there are no studies demonstrating the outcomes that people with CF value most highly. It is clear from this study that clinicians should explore a patient's underlying beliefs, values and previous personal experience regarding airway clearance techniques and exercise in order for the treatment regimen to be optimised to achieve both short-term (eg, reduced time burden, immediate symptom relief) and long-term term goals (eg, reduced rate of decline in lung function) for both the patient and the clinician.

This study had several limitations. First, whilst the protocol was for consecutive recruitment, 6% of screened patients were not invited to participate, as they left their appointment prior to being approached, due to the competing clinical demands of the investigators. This was unlikely to be related to the patients' clinical status or use of airway clearance techniques or exercise. Second, the study relied upon participants' self-reporting and, given that patients with CF may overstate their level of adherence, the data presented may represent an over-estimation.<sup>21</sup> Third, as with most questionnaire-based studies, there was a variable degree of missing data. However, given the relatively small amount of missing data for any one individual question relative to the total sample size, it is felt that missing data were unlikely to have made a large impact on the results and conclusions from this study. Finally, as this study only

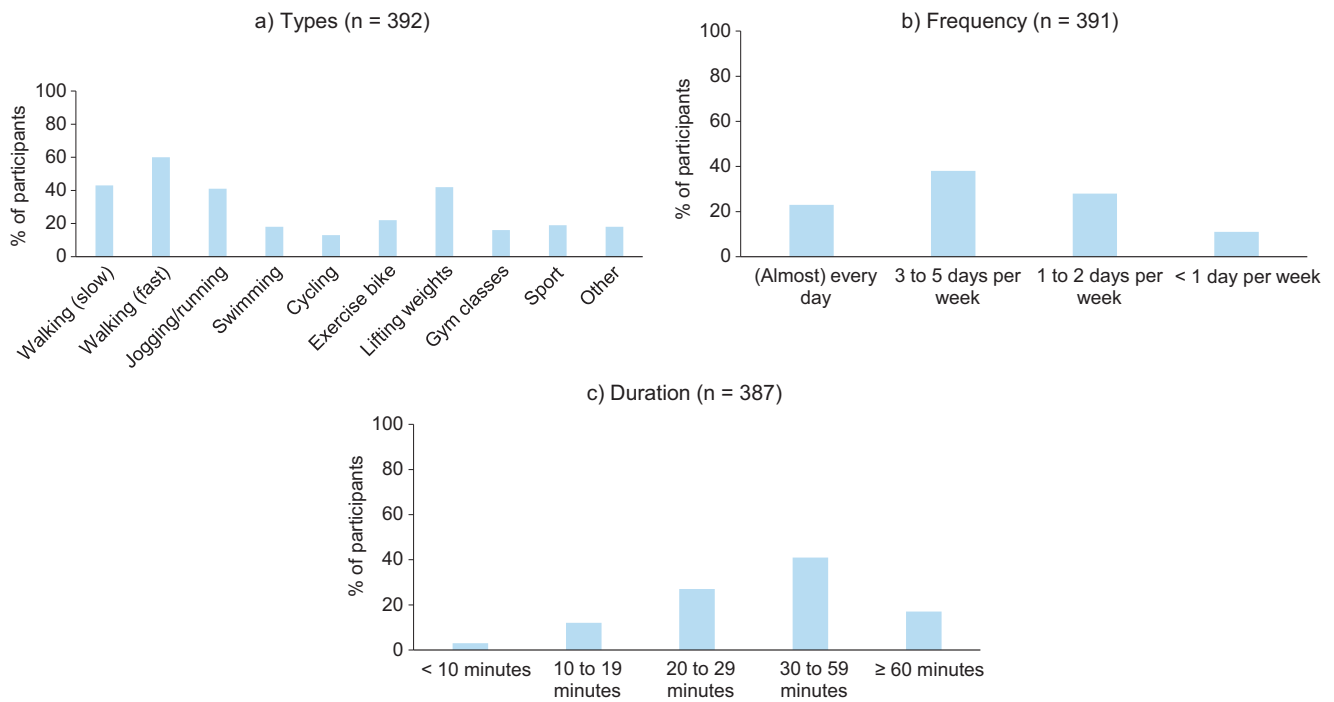
**Table 4**

Shortness of breath and perceived exertion reported by participants who used exercise as a substitute for traditional airway clearance techniques.

Perceived exercise intensity	n (%)
Shortness of breath <sup>a</sup>	
very, very slight to slight	122 (42)
moderate to severe	158 (54)
very severe to maximal	12 (4)
Rating of perceived exertion <sup>b</sup>	
very, very weak to weak	11 (4)
moderate to strong	200 (67)
very strong to maximal	87 (29)

<sup>a</sup> n = 292.

<sup>b</sup> n = 298.



**Figure 8.** Reported exercise routines when exercising to improve the effectiveness of traditional airway clearance techniques: a) types of exercise, b) frequency and c) duration of exercise sessions.

recruited patients from Australian CF centres, the international applicability of these results is unclear.

This is the first study to explore airway clearance techniques and exercise regimens adopted by adults with CF across Australia and their beliefs and practices in relation to the use of exercise as a substitute for traditional airway clearance techniques. Exercise was used as a substitute for traditional airway clearance techniques by 44% of participants. Given the high prevalence of exercise as a substitute for traditional airway clearance techniques in routine clinical care, further research must be undertaken as a priority to investigate the clinical efficacy of this practice.

**Table 5**

Shortness of breath and perceived exertion reported by participants who used exercise to improve the effectiveness of traditional airway clearance techniques.

Perceived exercise intensity	n (%)
Shortness of breath <sup>a</sup>	
very, very slight to slight	136 (35)
moderate to severe	229 (59)
very severe to maximal	21 (5)
Rating of perceived exertion <sup>b</sup>	
very, very weak to weak	28 (7)
moderate to strong	285 (74)
very strong to maximal	74 (19)

<sup>a</sup> n = 386.

<sup>b</sup> n = 387.

**What was already known on this topic:** Current international guidelines either recommend exercise as an adjunct to, but not a replacement for, traditional airway clearance techniques.

**What this study adds:** Almost half of adults with CF use exercise as a substitute for traditional airway clearance techniques, based on their personal experience. Physiotherapists should advise patients that whilst there is some research suggesting a possible mechanism for exercise as a form of airway clearance, there are currently no medium-term to long-term data supporting exercise as a stand-alone form of airway clearance. Physiotherapists should explore a patient's beliefs and personal experience as part of the process for prescribing new or modified exercise and airway clearance regimens.

**Footnotes:** <sup>a</sup> Excel 2013, Microsoft Corporation, WA, USA. <sup>b</sup> SPSS Version 24, IBM Corporation, NY, USA.

**eAddenda:** Appendices 1 and 2 can be found online at DOI: <https://doi.org/10.1016/j.jphys.2018.11.006>.

**Ethics approval:** The study was approved by the following ethics committees: Royal Adelaide Hospital Human Research Ethics Committee, La Trobe University Science, Health and Engineering College Human Ethics Sub-Committee, Sir Charles Gairdner and Osborne Park Health Care Group Human Research Ethics Committee, Human Research Ethics Committee (Tasmania) Network, and ACT Health Human Research Ethics Committee.

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## References

- Abbott J, Dodd M, Bilton D, Webb A. Treatment compliance in adults with cystic fibrosis. *Thorax*. 1994;49:115–120.
- Conway S, Pond M, Hamnett T, Watson A. Compliance with treatment in adult patients with cystic fibrosis. *Thorax*. 1996;51:29–33.
- Llorente R, Garcia C, Martin J. Treatment compliance in children and adults with cystic fibrosis. *J Cyst Fibros*. 2008;7:359–367.
- Sawicki G, Ren C, Konstan M, Millar S, Pasta D, Quittner A. Treatment complexity in cystic fibrosis: Trends over time and associations with site-specific outcomes. *J Cyst Fibros*. 2013;12:461–467.
- Cystic Fibrosis Australia. 15th Annual Report Australian Cystic Fibrosis Data Registry, 2012.

6. Dwyer T, Elkins M, Bye PT. The role of exercise in maintaining health in cystic fibrosis. *Curr Opin Pulm Med*. 2011;17:455–460.
7. Button B, Holland A. Physiotherapy for Cystic Fibrosis in Australia: A Consensus Statement. 2008. [http://www.thoracic.org.au/magesDB/wysiwyg/PhysiotherapyforCysticFibrosisinAustralia\\_1.pdf](http://www.thoracic.org.au/magesDB/wysiwyg/PhysiotherapyforCysticFibrosisinAustralia_1.pdf). (accessed 5/7/2014).
8. Flume P, Robinson K, O'Sullivan B, et al. Cystic fibrosis pulmonary guidelines: airway clearance therapies. *Respir Care*. 2009;54:522–537.
9. Daniels T, Morrison L, Harnett N, Lewis S. Standards of Care and Good Clinical Practice for the Physiotherapy Management of Cystic Fibrosis. 2017. <https://www.cysticfibrosis.org.uk/the-work-we-do/clinical-care/consensus-documents#>. (accessed 23/7/2018).
10. Flores J, Teixeira F, Rovedder P, Ziegler B, Dalcin R. Adherence to airway clearance therapies by adult cystic fibrosis patients. *Respir Care*. 2013;58:279–285.
11. Myers L, Horn S. Adherence to chest physiotherapy in adults with cystic fibrosis. *J Health Psychol*. 2006;11:915–926.
12. White D, Stiller K, Haensel N. Adherence of adult cystic fibrosis patients with airway clearance and exercise regimens. *J Cyst Fibros*. 2007;6:163–170.
13. Hoo Z, Daniels T, Wildman M, Teare M, Bradley J. Airway clearance techniques used by people with cystic fibrosis in the UK. *Physiother*. 2015;101:340–348.
14. Rowbotham N, Smith S, Leighton P, Rayner OC, Gathercole K, Elliott ZC, et al. The top 10 research priorities in cystic fibrosis developed by a partnership between people with CF and healthcare providers. *Thorax*. 2018;73:388–390.
15. Button B, Wilson C, Dentice R, Cox NS, Middleton A, Tannenbaum E, et al. Physiotherapy for cystic fibrosis in Australia and New Zealand: a clinical practice guideline. *Respirol*. 2016;21:656–667.
16. Carr L, Smith R, Pryor J, Partridge C. Cystic fibrosis patients' views and beliefs about chest clearance and exercise - a pilot study. *Physiother*. 1996;82:621–627.
17. Dwyer TJ, Alison JA, McKeough ZJ, Daviskas E, Bye PT. Effects of exercise on respiratory flow and sputum properties in patients with cystic fibrosis. *Chest*. 2011;139:870–877.
18. Dwyer TJ, Zainuldin R, Daviskas E, Bye PT, Alison JA. Effects of treadmill exercise versus Flutter on respiratory flow and sputum properties in adults with cystic fibrosis: a randomised, controlled, cross-over trial. *BMC Pulm Med*. 2017;17:14.
19. Reix P, Aubert F, Werck-Gallois M, Toutain A, Mazzocchi C, Moreux N, et al. Exercise with incorporated expiratory manoeuvres was as effective as breathing techniques for airway clearance in children with cystic fibrosis: a randomised crossover trial. *J Physiother*. 2012;58:241–247.
20. Dwyer TJ, Daviskas E, Zainuldin M, Verschuer J, Eberl S, Bye P, et al. Effects of exercise and PEP on mucociliary clearance in adults with cystic fibrosis. 9th Australasian Cystic Fibrosis Conference. Melbourne, Australia, 2011:OP12.
21. Quittner A, Modi A, Lemanek K, Levers-Landis C, Rapoff M. Evidence-based assessment of adherence to medical treatments in pediatric psychology. *J Pediatric Psychol*. 2008;33:916–936.