Unravelling the complex interplay of factors behind exercise limitations and physical inactivity in COPD

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This review presents the complex interplay of factors influencing exercise limitations and physical inactivity and how clinicians can address these to improve management of these treatable traits in COPD https://bit.ly/4bn6IrU

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Abstract

Exercise limitation and physical inactivity are known treatable traits for people with COPD. Maximising exercise capacity and keeping people physically active improves health status and survival rates among people with COPD. However, managing these two treatable traits can be extremely challenging for clinicians due to the complex intersectionality of factors influencing an individual's capacity, opportunity and motivation to engage in physical activity. This review presents the complex factors influencing exercise capacity ("can do"), levels of physical activity ("do do") and sedentary behaviours amongst people with COPD and provides practical recommendations on how clinicians can address some of these factors in practice. Most importantly, it highlights the importance of referring to pulmonary rehabilitation as a way to improve exercise capacity among people with COPD.

Background

COPD is a heterogeneous and complex disease with wide variability in pulmonary and extrapulmonary manifestations and phenotypes [1]. Until recently, the degree of airflow obstruction (forced expiratory volume in 1 s (FEV_1)) was a cardinal parameter to classify disease severity. However, FEV_1 is not a patient-centred outcome and its relationship with exercise capacity, symptoms, quality of life and physical activity is limited [2].

Treatable traits in COPD

Recently, the concept of treatable traits in patients with COPD has been proposed as a route towards precision medicine [3, 4]. A treatable trait is a recognisable phenotypic or endotypic characteristic that can be assessed and targeted by therapy to improve a clinical outcome [4]. A treatable trait must have three characteristics: it must be 1) clinically relevant, 2) detectable, and 3) treatable [4]. There are many possible treatable traits in patients with chronic airway disease, which can be categorised as pulmonary, extrapulmonary and behaviour/lifestyle concepts, as listed in table 1.

Among treatable traits, there is a strong level of evidence to support the need to address exercise intolerance, physical inactivity and sedentary behaviour among people with COPD to improve survival [8]. The novel concept to categorise individuals into the "can do/can't do" and "do do/don't do" groups can contribute to better understand and manage these traits in COPD [9].

Differences between "can do", "do do" and sedentary behaviours

The "can do/can't do" paradigm reflects exercise capacity and its limitation. Exercise capacity is a concept that defines the physiological boundaries of daily functioning and is assessed by a maximal cardiopulmonary exercise test or a field walking test (*e.g.* 6-min walk test or incremental shuttle walk test) [9, 10]. By contrast, the "do do/don't do" paradigm refers to the physical activity that a person with COPD does or does not do [9]. Physical activity is defined as any voluntary bodily movement executed by skeletal muscles which results in energy expenditure [11]. Most commonly it is considered to reflect the ability of an individual to sustain an activity at the intensity or for the duration that would be expected considering the person's age, sex and general physical condition. Activity is often assessed using diaries, questionnaires or devices that measure motion, such as pedometers or accelerometers.

Exercise capacity and physical activity are separate but related, as exercise capacity is permissive of physical activity. A recent article using these concepts places patients with COPD into four categories: 1) "can do/do do"; 2) "can do/don't do"; 3) "can't do/do do"; and 4) "can't do/don't do". Figure 1 depicts this classification in a sample of 662 COPD patients with spirometry severity ranging from mild to very severe [9]. Thresholds for "can do" and "do do" were a 6-min walk distance above or below 70% of predicted, and steps above or below 5000 per day, respectively. Reasonable numbers of patients are seen in all four quadrants. As might be surmised, those in the "can't do, don't do" quadrant generally had the greatest disease burden, reflected by pulmonary function impairment, comorbid conditions, exacerbation frequency and symptom burden. Conversely, those in the "can do, do do" quadrant (*i.e.* those with higher levels of both exercise capacity and physical activity) had a significantly lower 6-year all-cause mortality risk as compared with people with COPD who were physically inactive [12].

There are many plausible physiological mechanisms that can contribute to people having reduced levels of physical activity in the "don't do" group. While intrapulmonary factors such as expiratory flow limitation may contribute to reductions in physical capacity and physical activity, other extrapulmonary factors, such as larger waist circumference and overweight, have also been found to contribute to reductions in levels of physical activity [9]. Psychological factors such as depression and anxiety can also contribute to the reduction in levels of physical activity [13]. The implications of sedentary behaviours should also be considered as they too can contribute to people being less physically active.

TABLE 1 Possible treatable traits in patients with chronic airway diseases

Pulmonary treatable traits	Extrapulmonary treatable traits	Behaviour/lifestyle-related treatable traits
Airflow limitation	Depression	Suboptimal inhaler technique
Pulmonary hyperinflation	Anxiety	Suboptimal adherence to treatment
Airway inflammation	Osteoporosis	Current smoking
Dyspnoea	Overweight/obesity	Occupational or biomass exposures
Hypoxaemia	Sarcopenia	Side-effects of treatments
Hypercapnia	Deconditioning	Exercise intolerance
Exacerbations	Severe fatigue	Physical inactivity
Emphysema	Frailty	Sedentary behaviour
Pulmonary hypertension	Systemic inflammation	Self-management skills
Bronchiectasis	Anaemia	
Bacterial colonisation	OSAS	
Mucus hypersecretion	Rhinosinusitis	
Cough reflex hypersensitivity	Vocal cord dysfunction	
Dysfunctional breathing	Cardiovascular disease	
	GORD	

OSAS: obstructive sleep apnoea syndrome; GORD: gastro-oesophageal reflux disease. Information from [5–7].

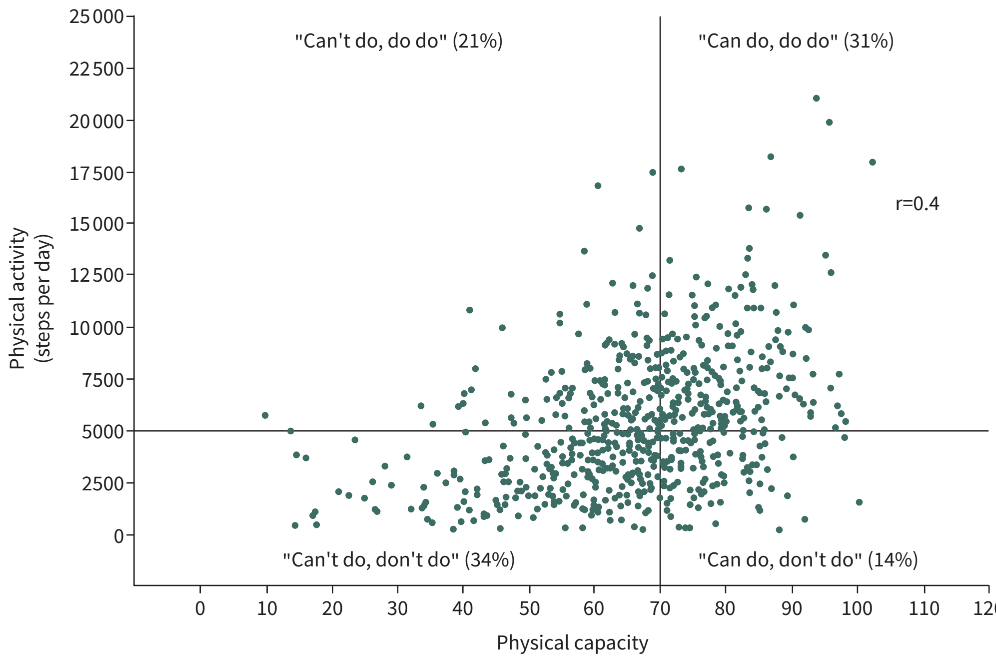

FIGURE 1 Four quadrants of exercise capacity and physical activity. Reproduced from [9] with permission.

While obviously closely related to physical inactivity, sedentary behaviour is a distinct concept and thereby sits outside this categorisation. Sedentary behaviour is defined as "any waking behaviour characterised by an energy expenditure ⩽1.5 metabolic equivalents (METs), while in a sitting, reclining or lying posture" [14], and independently predicts mortality in COPD [15]. COPD patients are often sedentary, but since patients with asthma, coronary artery disease or diabetes also exhibit this maladaptive behaviour, it is not unique to a specific health condition [16–18]. Even though physical inactivity and sedentary behaviour are distinct concepts, they are strongly correlated [19].

Of note, an individual who is deemed physically active by meeting the American College of Sports Medicine guideline recommendations [20] of 150 min of moderate-to-vigorous activity a week can also fit into a sedentary category, if that person spends most of their waking hours in a sitting, reclining or lying posture while expending ⩽1.5 METs. Of greatest concern are those patients who have both high levels of physical inactivity and sedentary behaviour, as the latter compounds the detrimental effect of physical inactivity [16–18] on health outcomes. Figure 2 illustrates the relationship between physical activity and sedentary behaviour and their effects on health outcomes.

Factors that influence exercise limitation, physical activity and sedentary behaviour

Clinicians endeavouring to facilitate participation in physical activity among their patients with COPD need to understand the complex interlinked nexus of factors that influence the triad of exercise limitation,

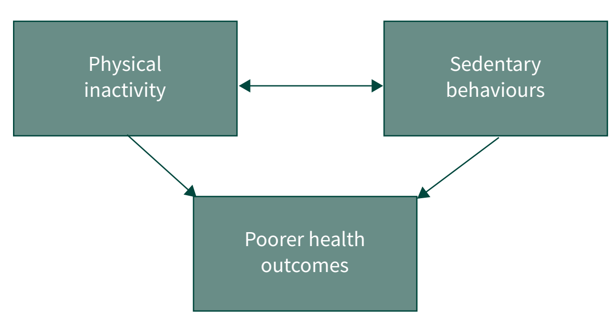

FIGURE 2 Relationship between physical inactivity, sedentary behaviours and health outcomes.

physical inactivity and sedentary behaviour. Different models such as the biopsychosocial model developed by the World Health Organization [21] or the ecological model explained by Bauman *et al.* [22] can be used to highlight the complex interactions between biological, psychological, social and environmental factors (figure 3). Clinicians need to understand that there is a need to address components of each factor, rather than just addressing one factor, to achieve a significant improvement in levels of physical activity.

Individual factors

The heterogeneous pathophysiological abnormalities of COPD lead to physical inactivity and exercise limitation often even before a formal clinical diagnosis is made [23]. Typical pulmonary abnormalities, such as impaired pulmonary gas exchange and gas trapping, increased peripheral airways resistance [24], early airway closure, maldistribution of ventilation [25], reduced diffusing capacity of the lungs for carbon monoxide [26] and inspiratory capacity [27, 28], can be observed even amongst people with early or mild COPD when compared with healthy controls. These features are amplified during exercise [28–31], as observed by a lower peak oxygen consumption and power output [30], and higher physiological dead space, even without the presence of hypoxaemia [28, 30]. These findings highlight why ventilatory inefficiency is a major physiological marker of exercise limitation in early COPD [32].

Many extrapulmonary impairments are already present in the early phases of COPD. Significant reductions in self-reported physical, mental and social status are present, compared with non-COPD individuals [33]. Among individuals with mild COPD, higher levels of fatigue are found in 19% [34], quadriceps muscle weakness in 25% [35–37], and a decrease in cross-sectional area of the quadriceps rectus femoris in 18% [36, 37], respectively. This combination of intra- and extrapulmonary impairments results in a significant reduction in the level of physical activity in COPD patients compared with healthy age-matched controls [38–40]. Exercise intolerance and physical inactivity compound the likelihood of someone engaging in sedentary behaviours as shown in a study which demonstrated a negative correlation between sedentary behaviour and moderate-to-vigorous physical activity among people with COPD [19].

Concerns about respiratory symptoms, fear of exercising and movement, and lack of belief in the individual's capabilities to exercise or partake in physical activities all lead to physical inactivity and prolonged sedentary behaviour [41]. These factors also negatively impact exercise capacity regardless of respiratory disease severity. For example, people 7–14 days post-onset of an exacerbation of COPD adopt sedentary behaviours due to the low perceived capability and self-efficacy of performing physical activity, limited understanding of the disease and physical activity concepts, lack of transference from health

FIGURE 3 Model of determinants to physical activity. Information from Bauman *et al.* [22].

knowledge to actions, and poor adherence to movement-related advice from physiotherapists [42]. The emotional responses towards the "dyspnoea spiral" or "vicious circle for dyspnoea–inactivity" are also well documented and represent why patients with COPD adopt a sedentary lifestyle and reduced level of physical activity to avoid exertional dyspnoea [13, 30, 43]. Furthermore, anxiety and depression have also been found to be associated with a reduction in levels of physical activity irrespective of severity of COPD [44].

Interpersonal factors

Societal and cultural factors are often interlinked and form a complex intersectionality that exists within society, shaping an individual's attitudes and behaviours towards physical activity and sedentary behaviours. Societal factors also influence determinants of health [45]. These factors include social-class, gender, race/ethnicity, income distribution and educational status [46], and can directly impact the likelihood of an individual engaging in healthy behaviour. For example, the risk of being diagnosed with a respiratory disease is 14 times higher in an individual from the lowest socioeconomic group compared with the highest, this is probably related to long-term environmental exposures which led to the disease [47]. Participation in pulmonary rehabilitation is also impacted, with people from socially deprived areas having a 79% higher risk of not completing pulmonary rehabilitation than those from the least deprived areas in England and Wales [48]. In addition to socioeconomic factors, it has been established that women are in general less active than men [49]. Barriers such as concerns over body image, lack of social support and fear of being seen as participating in an activity outside of societal expectations are some of the factors as to why women do not engage in exercise and physical activity as much as men [49].

People often underestimate the relevance of cultural factors on health as they misinterpret the definition of culture [50]. Culture is conceptual and goes beyond ethnicity and religion. It encompasses the values, behaviours, ideas, philosophies, personal beliefs and the way of life of an individual [51]. While the evidence around the impact of cultural factors on management of respiratory health is limited, there are a number of studies that have explored factors as to why people from culturally diverse groups tend not to engage in physical activity [52, 53]. These studies suggest that the perspective of how individuals define exercise differs, and culture is an integral factor in influencing the decision to participate in exercise and physical activity. For example, while swimming in an outfit that reveals the arms and legs can be perceived as socially acceptable to the majority of people in Australia, Europe and North America, such outfits could be deemed inappropriate for women from the Jewish or Muslim religions, which in turn can deter participation [53, 54].

Gender identity is another example of a cultural factor potentially impacting participation in physical activity. Those with an alternative gender identity, such as nonbinary or transgender, may not feel safe to engage in physical activities, as 40–79% of people self-identified from gender diverse backgrounds reported being exposed to homophobic verbal and/or physical abuse [55–57].

Environmental factors

The environment in which an individual lives intersects with societal and cultural factors influencing activity. A person living in a low economic area may have poor access to facilities to engage in exercise and physical activities. While living in rural or remote areas can create genuine barriers to participation in supervised exercise [58, 59], access to appropriate facilities can also be an issue in metropolitan areas. Factors such availability of adequate infrastructure, such as lighting, pathways and community areas for exercise [60, 61], as well as weather [62] are all environmental factors that can influence likelihood to engage in exercise and physical activities. Indeed, a recent study confirmed that people with COPD are less active on rainy days and more active on warmer and sunnier days [63]. Access to safe environments to promote physical activity must become a priority for the healthcare system and society.

Practical recommendations for the future

There is a spectrum of interventions that we can consider integrating into our clinical practice to improve exercise capacity, facilitate an increase in physical activity, and reduce sedentary behaviour. The following practical recommendations, summarised in table 2, can help to move patients from a "can't do, don't do" to a "can do, do do" state.

The key to move a patient from "don't do" to "do do" is to improve their level of physical activity. It is crucial to look beyond the "one-size-fits-all" principle and identify key features in each patient that need to be addressed. This can start as a thorough assessment to identify pulmonary, extrapulmonary and behavioural treatable traits, including exercise capacity and physical activity. This assessment should be undertaken early in the disease, since several treatable traits are already present at this stage [5, 64]. For the

TABLE 2 Practical recommendations to enhance exercise capacity, promote physical activity and reduce sedentary behaviours in people with COPD

Assessment
Include assessments of extrapulmonary and behavioural treatable traits when assessing patients with COPD, including those with mild disease
Objectively assess exercise capacity, levels of physical activity and time spent in sedentary behaviour for all patients with COPD
Adopt patient-centred communication skills with patients and their families, and collaborate with them to understand and troubleshoot ways to increase levels of physical activity
Facilitation of exercise capacity and physical activity
Refer patients to pulmonary rehabilitation
Promote the importance of physical activity earlier in the disease trajectory
Engage both the interdisciplinary team and the end-user when designing activities to facilitate increase in physical activity
Encourage patients to "move more and sit less" early in the disease

pulmonary rehabilitation intervention, clinicians should consider the use of a core outcomes set to assist with the objective analysis of treatable traits [65].

Clinicians should also consider how various factors, highlighted in figure 3, can impact on individuals, in order to work collaboratively with the patient in identifying solutions to barriers to engaging in physical activity. These include initiating discussions with patients and working collaboratively to formulate strategies to increase physical activity. Engaging family members, whenever appropriate, is also vital as loved ones can aid in the promotion of physical activity [66]. Healthcare providers also need to be more proactive in encouraging patients to participate in pulmonary rehabilitation. While the effect of pulmonary rehabilitation on levels of physical activity appears limited [67, 68], there remains no doubt that pulmonary rehabilitation is highly effective in addressing multiple treatable traits in patients with COPD [67, 69] and should be recommended to eligible patients.

Finally, when engaging patients in physical activity, clinicians need to ensure the use of plain language and attentive listening skills to encourage patient-centred communication [70]. Clinicians should also consider adopting a multidimensional approach involving both providers and recipients of health in an authentic co-design process to devise implementation strategies that can better improve engagement of people in physical activity. A deeper analysis of the individual components of rehabilitation in terms of reach, acceptability, sustainability, maintenance and effectiveness needs to be considered. The creation of tools to measure beliefs related to physical activity and perceived importance, new culturally and societally aligned models of rehabilitation, and sustainable solutions to provide easy and safe access to an environment that enables physical activity also need to be prioritised.

Clinicians also need to reflect on their own current practices, be proactive in having discussions with their patients about psychological, societal, cultural and environmental factors that can impact on a patient's behaviour and demonstrate a willingness to facilitate engagement in exercise and physical activity. The promotion of public strategies such as "move more and sit less" to patients with COPD should also be encouraged, as these strategies promote a reduction in sedentary behaviour through increasing light-intensity activities.

Summary and conclusions

Exercise capacity and physical activity are known treatable traits for people with COPD. Maximising exercise capacity and keeping people physically active improves health status and survival rates among people with COPD. However, managing these two treatable traits can be extremely challenging for clinicians due to the complex intersectionality of factors influencing an individual's capacity, opportunity and motivation to engage in physical activity. This review presents these complex factors influencing exercise capacity ("can do"), levels of physical activity ("do do") and sedentary behaviours amongst people with COPD and provides practical recommendations on how clinicians can address some of these factors in clinical practice. As exercise limitation and physical inactivity have detrimental effects on health outcomes, increasing exercise capacity and physical activity needs to be a focus in the treatment of patients with COPD. A collaborative approach in which patients and clinicians work in partnership to identify factors that negatively impact exercise limitation and physical inactivity, and devise strategies to address these treatable traits (including timely referral to pulmonary rehabilitation) offers a promising path towards improving health outcomes in COPD.

Key points

- Exercise limitation and physical inactivity are treatable traits for people with COPD.
- Patients who meet guidelines' recommendations for moderate-to-high levels of physical activity can also have increased sedentary behaviour.
- Complex interactions between biological, psychological, social and environmental factors impact levels of physical activity.
- A collaborative approach between patients, families and healthcare providers is necessary to identify and address factors that impact exercise limitation and physical inactivity.

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