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The association between leisure-time physical activity and lung function in older adults: The English longitudinal study of ageing

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A B S T R A C T

The longitudinal association between physical activity and lung function is unclear. Therefore, we examined said association over eight years. This study included data from 2966 participants in English Longitudinal Study of Ageing (63 ± 7 years [mean ± SD]), a prospective study of initially healthy, community dwelling adults. Physical activity was assessed using an interview and lung function using a spirometer at baseline (2004–5) and follow-up (2012 – 13). General linear regression was used to assess associations between activity and lung function. Logistic regression was used to assess the odds of new cases of abnormal lung function. Some 14% of participants were defined as physically inactive at baseline, 50% were classified into the moderate group, and 36% into the vigorous group. In comparison with remaining inactive at follow-up, remaining active was positively associated with forced vital capacity (FVC) (β = 0.09, 95% confidence interval [CI]: 0.01, 0.17; $p = 0.02$) and forced expiratory volume in one second (FEV-1) (β = 0.09, 95% CI: 0.02, 0.15; $p = 0.01$) after adjustment for baseline lung function score and other covariates. Using the fifth centile to define the lower limit of normal (that is, − 1.64 z scores), there were lower odds of incident abnormal lung function in participants who remained physically active compared to those who remained inactive (FVC odds ratio = 0.31, 95% CI: 0.17, 0.55. FEV-1 odds ratio = 0.43, 95% CI: 0.26, 0.72). Similar associations were observed in those who became active. This study suggests that remaining physically active or becoming active in older age is positively associated with lung function and reduced odds of abnormal lung function.

1. Introduction

The World Health Organization estimates that 65 million people have moderate to severe chronic obstructive pulmonary disease (COPD) and that more than three million people die per year because of the disease (World Health Organization, 2017a). Smoking is the main risk factor for COPD in high- and middle-income countries (World Health Organization, 2017b). Physical inactivity may also be a risk factor for COPD (Garcia-Aymerich et al., 2007; Behrens et al., 2014). Exercise training is recommended in the management of COPD (World Health Organization, 2017c). However, the role of physical activity in the primary prevention of COPD is unclear (Watz et al., 2014; Global Initiative for Chronic Obstructive Lung Disease (GOLD), 2017). In the 2014 European Respiratory Society statement on physical activity in COPD (Watz et al., 2014), five longitudinal studies were identified and each study showed an inverse association between physical activity and lung function decline in at least one population subgroup or physical activity variable (Garcia-Aymerich et al., 2007; Pelkonen et al., 2003; Jakes et al., 2002; Cheng et al., 2003; Garcia-Aymerich et al., 2008). Nonetheless, the inverse association between physical activity and lung function decline was described as inconsistent (Watz et al., 2014). Selection bias, lack of adjustment for potential confounders, and lack of consideration of changes in physical activity in two of the five studies were identified as key limitations (Watz et al., 2014). There was no discussion of the role of physical activity in primary prevention in the 2017 Global Initiative for Chronic Obstructive Lung Disease (Global Initiative for Chronic Obstructive Lung Disease (GOLD), 2017). It is clear that more research is needed to understand the relationship between physical activity and lung function. In this study, we used a large population sample of community dwelling older adults to examine associations between changes in physical activity and lung function using contemporary spirometry prediction equations.

2. Methods

2.1. Participants

The English Longitudinal Study of Ageing (ELSA) is an ongoing

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cohort study that contains a nationally representative sample of community dwelling men and women born on or before 29 February 1952 (Steptoe et al., 2013). Data collected at wave two (2004–5) were used as the baseline for the present analysis as this was the first time clinical information was gathered. A clinical assessment was repeated eight years later (wave 6; 2012–13). Participants were excluded if they had eye or chest surgery during the three weeks prior to the assessment, or if they had been hospitalised for heart disease or stroke in the previous six weeks, or if they were pregnant, or if they had a tracheostomy. We also excluded participants reporting lung diseases. The London Multi-Centre Research Ethics Committee approved the study and participants gave written informed consent.

2.2. Physical activity

Self-reported physical activity was assessed at baseline. The interview included questions on the frequency of participation in moderate- and vigorous-intensity activities during leisure time (more than once per week; once per week; one to three times per month; hardly ever). As previously described (Hamer et al., 2009), physical activity was then categorised into three groups: inactive (no moderate or vigorous activity); moderate activity at least once per week (but no vigorous); and vigorous activity at least once per week. The physical activity measure has demonstrated face validity in predicting various health outcomes (Hamer et al., 2009; Hamer et al., 2014). The same physical activity questions were asked six years later at wave 5 (2010 − 11) enabling us to model physical activity change. A binary physical activity variable (inactive or moderate versus vigorous activity) was created and change in physical activity over six years (waves 2 to 5) was categorised into four groups: remained inactive, became inactive, became active, or always active.

2.3. Lung function

Lung function was assessed using a spirometer at baseline (Escort, Vitalograph, Bucks, UK) and follow-up (NDD Easy On-PC, ndd Medical Technologies, Inc., Massachusetts, US). Forced expiratory volume in one second (FEV-1) and forced vital capacity (FVC) were assessed, as described in detail elsewhere (ELSA, 2004). The nurse instructed the participant to perform a forced expiratory manoeuvre: the participant was told to stand up and remove any tight clothing; the participant was told, “You must try to blow out as much air as possible as hard and as fast as you can”; the nurse demonstrated the correct technique using a mouthpiece not connected to the spirometer and emphasised that the lips should be firmly wrapped around the mouthpiece; the nurse demonstrated a blow, pointing out afterwards the need for a full inspiration, a vigorous start to the exhalation, and sustained expiration; the participant was allowed at least one practice blow and was given feedback and encouragement as necessary. The protocol required three successful measurements to be completed and the highest satisfactory score was used. An unsatisfactory attempt was defined in the protocol (ELSA, 2004). Briefly, an unsatisfactory blow included any of the following: an unsatisfactory start with excessive hesitation; laughing or coughing, especially during the first second; a Valsalva manoeuvre; leakage of air around the mouthpiece; obstruction of the mouthpiece by tongue or teeth; obstruction of the spirometer flowhead outlet by hands. *Z*-scores were calculated using the Global Lung Function 2012 Equations (Quanjer et al., 2012), which adjust for the heterogeneity of between-subject variability according to sex, ethnic group, age and lung function parameters. A z-score of zero would be assigned to a participant reaching their predicted lung function value, and the use of the 5th centile has been recommended to define the lower limit of normal (that is, − 1.64 z-scores).

2.4. Covariates

Nurses measured participants' body weight without shoes and in light clothing to the nearest 0.1 kg using electronic scales (THD-305 scales, Tanita Europe, Amsterdam, The Netherlands), and height was measured in the Frankfurt plane using a stadiometer. Body mass index (BMI) was calculated as weight (kilograms)/height (meters) squared. Handgrip strength (kg) of the dominant hand was assessed using the Smedley hand-held dynamometer (Stoelting Co, IL, USA), using the average of three measurements. Participants were required to hold the device at a right angle to their body and exert maximum force for a couple of seconds when instructed. Health-related questions included cigarette smoking (current, previous or non-smoker), social occupational class (managerial and professional; intermediate; semi-routine and routine occupations), and clinician diagnosed cardiovascular diseases.

2.5. Analysis

Three sets of primary analyses were conducted to examine associations between physical activity and lung function, all using general linear regression. Firstly, the cross-sectional association between physical activity and lung function (z-score) at baseline was examined. The models were adjusted for age, sex, smoking (current, previous or non-smoker), social occupational class (managerial and professional; intermediate; semi-routine and routine occupations), BMI, grip strength, and self-reported physician diagnosis of cardiovascular disease at baseline. Secondly, the longitudinal association between physical activity at baseline lung function at follow-up was examined. Since we were interested in the variability between repeated measures of subjects, not in the variability between subjects we modelled the raw scores in these analyses (not *Z*-scores). The models were adjusted for the same set of covariates described above, with the addition of the respective lung function data at baseline to model change. Lastly, we examined the association of change in physical activity on lung function at follow-up using linear regression adjusting for the covariates described above. In separate analyses, logistic regression was used to investigate the odds of new cases of abnormal lung function. The fifth centile was used to define the lower limit of normal (that is, − 1.64 z-scores), and we examined the association between change in physical activity and incident cases of abnormal lung function. Covariates were selected a priori based on evidence linking these covariates to both physical activity and ageing outcomes (Hamer et al., 2009; Hamer et al., 2014). One set of secondary analyses was conducted to examine effect modification by sex and smoking. All analyses were conducted using SPSS (IBM inc, version 22) with statistical significance $p < 0.05$.

3. Results

At baseline, 4348 participants provided a lung function measure although 1382 were lost to follow-up leaving a final analytic sample of 2966 (1358 men; 63 ± 7 years of age at baseline [mean ± SD]). Compared to the analytic sample, those who were excluded recorded poorer lung function (FEV-1 z-score: − 0.75 vs. -0.58, $p < 0.001$; FVC z-score: − 0.53 vs. -0.32, $p < 0.001$), were older (67.5 vs. 63.3 yrs., $p < 0.001$), had higher BMI (28.2 vs. 27.9 kg.m-2, $p = 0.023$), lower grip strength (28.7 vs. 31.4 kg, $p < 0.001$), a higher prevalence of inactivity (22.1 vs. 13.0%, $p < 0.001$), and CVD (27.4 vs. 21.5%, $p < 0.001$). The characteristics of the sample at baseline are presented in Table 1. Some 12% of men and 15.5% of women were categorised as physically inactive; some 49% of men and 51.5% of women were classified into the moderate physical activity group; and, some 39% of men and 33% of women were classified into the vigorous physical activity group.

There was a reduction in absolute FEV-1 (2.52 ± 0.82 vs. 2.30 ± 0.72 L, $p < 0.001$) and FVC values (3.41 ± 1.04 vs.