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Brief communication

High fitness levels offset the increased risk of chronic obstructive pulmonary disease due to low socioeconomic status: a cohort study

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ABSTRACT

Objective: Evidence suggests that higher cardiorespiratory fitness (CRF) levels can offset the increased risk of adverse outcomes due to other risk factors. The impact of high CRF levels on the increased risk of chronic obstructive pulmonary disease (COPD) due to low socioeconomic status (SES) is unknown. We aimed to assess the combined effects of SES and CRF on the future risk of COPD.

Methods: We employed a prospective cohort of 2,312 Finnish men aged 42-61 years at study entry Socioeconomic status was self-reported and CRF was objectively assessed using respiratory gas exchange analyzers. Both exposures were categorised as low and high based on median cutoffs. Multivariable-adjusted hazard ratios (HRs) with confidence intervals (CIs) were estimated.

Results: During 26.0 years median follow-up, 120 COPD cases occurred. Low SES was associated with increased COPD risk and high CRF was associated with reduced COPD risk. Compared with high SES-low CRF, low SES-low CRF was associated with an increased COPD risk 2.36 (95% CI: 1.44-3.87), with no evidence of an association for low SES-high CRF and COPD risk 1.46 (95% CI:0.82-2.60).

Conclusion: In middle-aged Finnish men, SES and CRF are each independently associated with COPD risk. However, high CRF levels offset the increased COPD risk related to low SES.

Keywords: socioeconomic status; cardiorespiratory fitness; chronic obstructive pulmonary disease; cohort study

Abbreviations

CI Confidence interval

COPD Chronic obstructive pulmonary disease

CRF Cardiorespiratory fitness

HR Hazard ratio

KIHD Kuopio Ischemic Heart Disease

SD Standard deviation

SES Socioeconomic status

VO_{2peak} Peak oxygen uptake

1. Introduction

Chronic obstructive pulmonary disease (COPD) is a debilitating progressive obstructive inflammatory lung disease.[1] Cigarette smoking is the most common risk factor for COPD; however, up to 65% of COPD cases are not linked to active or second-hand smoking.[2] Other increasingly recognized factors include childhood respiratory infections, indoor and outdoor pollution, and occupational exposure.[3, 4] Chronic obstructive pulmonary disease is incurable but can be prevented through decreased exposure to or modulation of the underlying risk factors.

Several studies have documented a relationship between low SES and increased risk of COPD.[5, 6] Physical activity is well established to have health benefits, including reducing the risk of COPD.[7] Cardiorespiratory fitness (CRF) is a modifiable risk factor that can be improved through increased habitual physical activity and exercise training.[8] High CRF levels are associated with a reduced risk of lung diseases, including incident COPD and death from COPD.[9, 10]

There is a wealth of growing evidence that higher CRF levels have protective effects against the adverse effects of other risk factors.[11-15] Whether the protective effects of CRF extend to attenuating the risk of COPD due to low SES has not yet been explored. We aimed to assess the combined effects of SES and CRF on the risk of incident COPD using a general population-based prospective cohort comprising 2,312 middle-aged Finnish men.

2. Methods

We employed the Kuopio Ischemic Heart Disease (KIHD) risk factor study for the current analysis. This prospective cohort study comprised a representative sample of middle-aged men aged 42-61 years recruited from Kuopio, eastern Finland, with baseline examinations performed from March 1984 through December 1989. The study was approved by the Research Ethics Committee of the University of Eastern Finland approved the study protocol, and each participant provided written informed consent. Participants completed self-reported questionnaires for the assessment of SES and other lifestyle factors. Socioeconomic status was based on a summary index that combined income, education, occupational prestige, material standard of living, and housing conditions. The composite SES index ranged from 0 to 25, with higher values indicating lower SES. Cardiorespiratory fitness

was measured as peak oxygen uptake (VO_{2peak}), which was assessed using respiratory gas exchange analyzers (Medical Graphics, MCG, St. Paul, Minnesota) during cardiopulmonary exercise testing (CPX). The exposures (SES and CRF) were categorized into low and high levels based on the median values as reported previously.[12, 16] All incident cases of COPD that occurred from study entry through 2014 were included. Evaluation of the combined association of SES and CRF with COPD risk was based on the following four groups: high SES-low CRF; high SES-high CRF; low SES-low CRF; and low SES-high CRF. Cox proportional hazards models were used to estimate multivariable-adjusted hazard ratios (HRs) with 95% confidence intervals (CIs) for incident COPD. All statistical analyses were performed using Stata version MP 16 (Stata Corp, College Station, Texas).

3. Results

The mean (standard deviation, SD) age, SES, and CRF of study participants at baseline were 53 (5) years, 8.44 (4.25), and 30.3 (8.0) ml/kg/min, respectively. During a median (interquartile range) follow-up of 26.0 (18.3-28.0) years, 120 incident cases of COPD were recorded. Compared to men with high SES, low SES was associated with an increased risk of COPD after adjustment for age, smoking status, prevalent type 2 diabetes, histories of CHD, asthma, chronic bronchitis and tuberculosis, alcohol consumption, and energy intake (**Figure**). The association remained similar on further adjustment for CRF 2.13 (95% CI: 1.43-3.19). On adjustment for the same covariates above, high CRF was associated with a decreased risk of COPD compared with low CRF (**Figure**). The association was minimally attenuated on further adjustment for SES 0.66 (95% CI: 0.44-0.98). Cumulative hazard curves showed the risk for COPD was highest for the low SES-low CRF group compared with other groups (*p*-value for log-rank test < .001 for all; **Supplementary Material**). Compared with high SES-low CRF, low SES-low CRF was associated with an increased COPD risk in multivariable analysis 2.36 (95% CI: 1.44-3.87), with no significant evidence of an association for low SES-high CRF and COPD risk 1.46 (95% CI:0.82-2.60) (**Figure**).

4. Discussion

Our results show that low SES was associated with an increased risk of COPD, whereas high CRF

levels were associated with a decreased risk of COPD. New findings based on the combined associations of SES and CRF with the risk of COPD showed that COPD risk was increased in men with low SES and low CRF, but the increased COPD risk due to low SES was attenuated by high CRF levels. These findings align with previous reports showing that higher CRF levels attenuate or offset the increased risk of adverse outcomes due to other risk factors.[11-13]

Underlying reasons for the association between low SES and high COPD risk include risk factors for COPD, which are prevalent in people from low socioeconomic positions; these include lower levels of literacy, limited access to health care, unhealthy risk behaviours such as regular smoking and excessive alcohol consumption, increased population density,[17] higher prevalence of comorbid conditions,[18, 19] chronic inflammation, poor air quality, and lowered immunity.[20, 21] Like other chronic health outcomes, the protective effects on COPD are likely to be via regular exercise or physical activity. The effects of physical activity on COPD may be exerted through its anti-inflammatory potential[22] and preventing lung function decline.[23]

This is the first evaluation of the combined effects of SES and CRF on the risk of COPD. Other strengths include the prospective cohort design with over two decades of follow-up, zero loss to follow-up, the representative cohort of middle-aged Finnish men, and the use of the gold standard of VO_2 measurement of CPX to estimate CRF. The modest effects seen in the high SES-high CRF and low SES-high CRF groups could be attributed to inadequate power to demonstrate an association given the low event rates in these groups. Even though caution is still needed in interpreting the current findings, one needs to consider the emerging evidence showing that higher CRF levels can offset the adverse effects of other risk factors.[11-15] Other limitations included the use of self-reported questionnaires in assessing SES; inability to generalise the findings to women, younger and older age groups, and other ethnicities; and the potential for reverse causation, residual confounding, and regression dilution bias.

5. Conclusion

Socioeconomic status and CRF are each independently associated with COPD risk in middle-aged Finnish men. However, high CRF levels offset the increased COPD risk related to low SES.

Declaration of competing interest

None

Data availability

The data used for this study are available from the corresponding author upon reasonable request.

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CRediT authorship contribution statement

Setor K. Kunutsor: Conceptualization, Methodology, Data curation, Formal analysis, Investigation, Writing – review & editing. Sae Young Jae: Conceptualization, Methodology, Investigation, Writing – review & editing. Timo H. Mäkikallio: Conceptualization, Methodology, Writing – review & editing. Sudhir Kurl: Conceptualization, Methodology, Data curation, Investigation, Writing – review & editing. Jari A. Laukkanen: Conceptualization, Methodology, Data curation, Investigation, Writing – review & editing.

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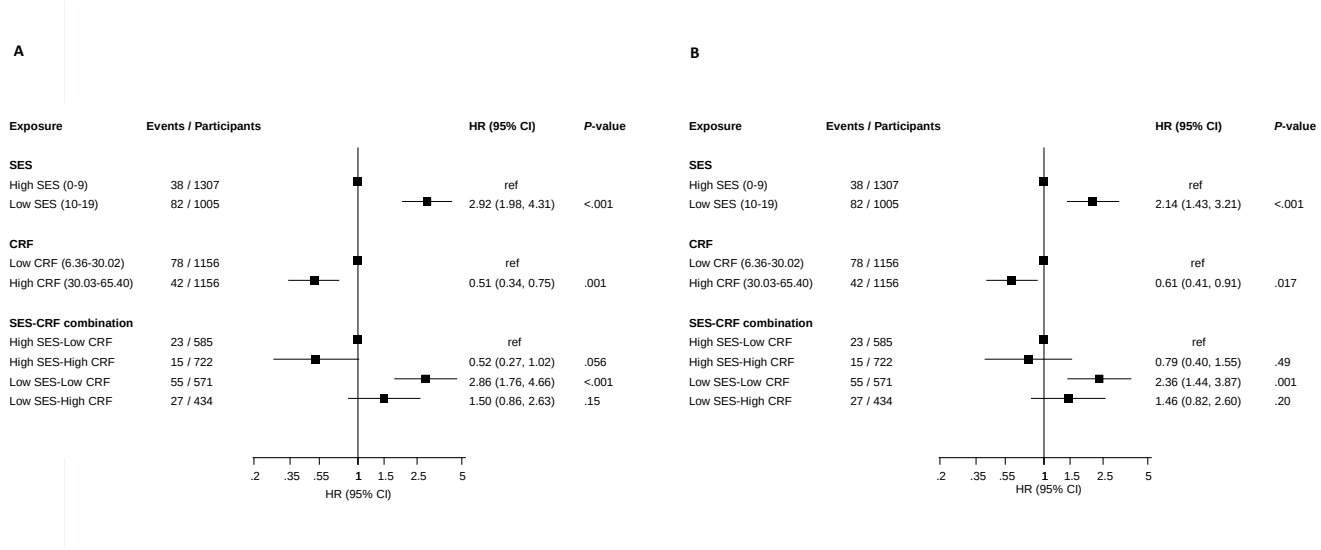
Figure title and legend

Figure. Separate and combined associations of socioeconomic status and cardiorespiratory fitness with risk of chronic obstructive pulmonary disease

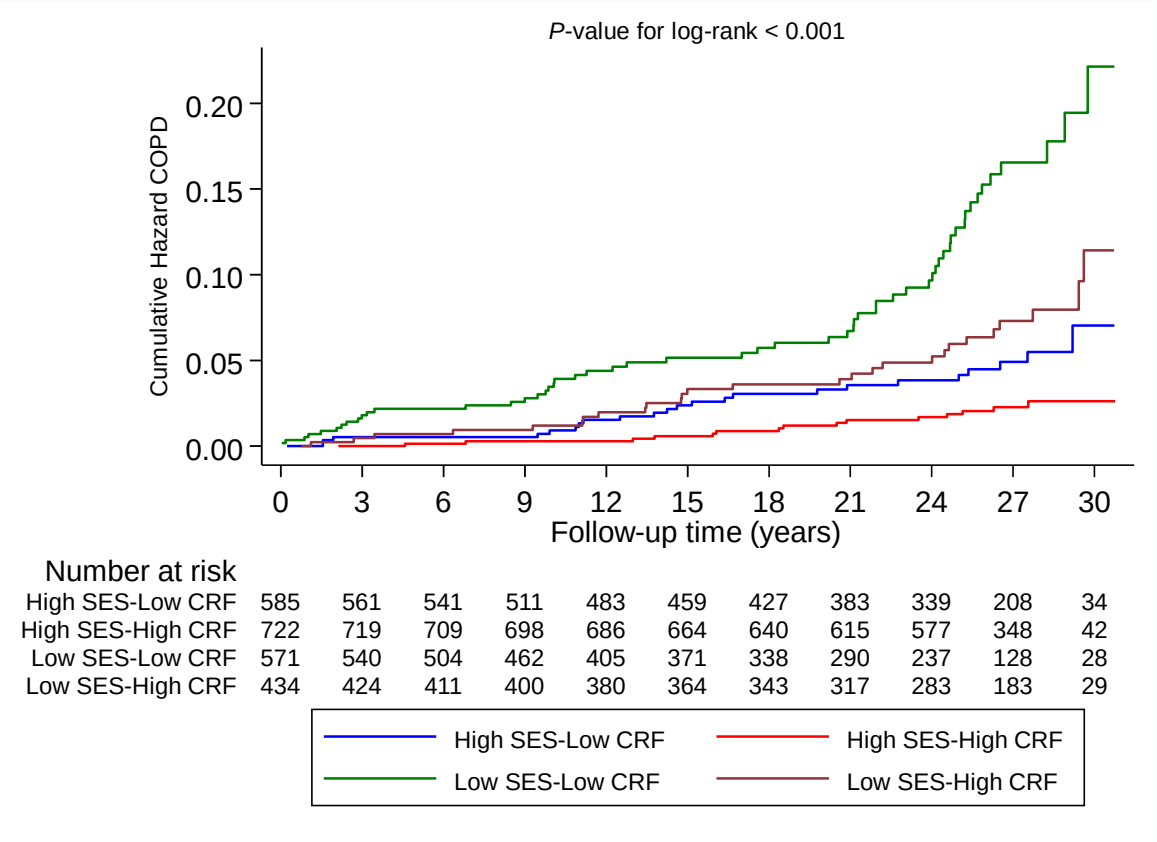


CI, confidence interval; CRF, cardiorespiratory fitness; HR, hazard ratio; ref, reference; SES, socioeconomic status

A: Adjusted for age

B: Adjusted for age, smoking status, history of type 2 diabetes, prevalent coronary heart disease, history of asthma, history of chronic bronchitis, history of tuberculosis, alcohol consumption, and energy intake

Supplementary Material. Cumulative Kaplan-Meier curves for COPD during follow-up according to combined categories of SES and CRF



COPD, chronic obstructive pulmonary disease; CRF, cardiorespiratory fitness; SES, socioeconomic status