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Cardiorespiratory fitness, adiposity and incident asthma in adults

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Capsule summary

Our data support that excess fat increases the risk of incident asthma among adults, and this risk might be attenuated by higher fitness. Physical fitness enhancement in overfat people may reduce risk of incident asthma.

Keywords

Aerobic capacity; obesity; fatness; airways diseases; pulmonary function

To the Editor:

Available large-scale prospective studies on adiposity and asthma used body mass index as an indicator of adiposity.[1] Studies involving more accurate measures of adiposity, such as body fat percentage (BF%), are needed to confirm or contrast body mass index - related results. Cardiorepiratory fitness is a strong predictor of morbidity and mortality,[2] and the available literature suggests that moderate-high cardiorespiratory fitness reduces many of the health hazards associated with obesity.[3] The present study aimed: 1) to examine whether cardiorespiratory fitness and/or BF% are associated with subsequent acquisition of asthma in adults; and 2) to test the hypothesis that a high cardiorespiratory fitness level can reduce the risk of incident asthma in individuals with excess adiposity.

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To address these issues, we selected 9,810 individuals free of asthma at baseline (7,712 men) aged 20-82y from the Aerobics Center Longitudinal Study.[2, 4] Baseline asthma was reported by the participants using a standardized medical questionnaire. Participants completed a baseline examination[4] and a follow-up survey by which self-reported physician-diagnosed asthma was identified. The study protocol was approved annually by the Institutional Review Board of the Cooper Institute. (*See Online Repository Material for further information about the study sample, design and procedures*)

Cardiorespiratory fitness was defined as the total time of a symptom-limited maximal treadmill exercise test, using a modified Balke protocol.[4] Low-, moderate-, and high-fitness were defined as the lowest 20%, the next 40%, and the remaining 40% of individuals in each age- and sex-specific distribution of treadmill time. BF% was assessed with hydrostatic weighing, with the sum of 7 skinfold measures, or with both assessments, following standardized protocols.[5] Based on the standard clinical definitions, overfat was defined as having a BF% ≥25% in men and ≥30% in women.

Information on smoking (never, ex-smoker, and current smoker), leisure time physical activity (physically inactive or active), and respiratory symptoms was obtained from a standardized medical questionnaire. A respiratory symptoms index was defined as the presence of one or more of the following respiratory symptoms: chronic cough or phlegm, tuberculosis, bronchitis, pneumonia, emphysema, coughed up blood, or unexplained shortness of breath while sleeping, sitting, or exercising. Participants had complete and valid data for all the study variables previously mentioned. Pulmonary function assessment was carried out in a subset of the participants (86% of the total study sample) and forced expiratory volume in 1 second (FEV_1) was obtained with a Collins 421 Survey spirometer. Hankinson et al.[6] predictive equations for FEV_1 specific for sex, age and height and derived from healthy NHANES-III participants were used. Associations of cardiorespiratory fitness and BF% at baseline with incident asthma, after adjustment for a set of confounders (i.e. age, sex, height, physical activity, smoking and respiratory symptom index) were analyzed by binary logistic regression. Interaction terms for sex were entered into the logistic regression models. No significant sex-interaction was found in the associations between the studied exposures and the outcome. We find that cardiorespiratory fitness reduces some of the health hazards associated with obesity.[3] In order to test this hypothesis for asthma, the associations between cardiorespiratory fitness and asthma were analyzed in the subset of overfat individuals, after adjusting for the confounders. Finally, the main logistic regression models were additionally adjusted for FEV_1, to examine how pulmonary function could affect the associations of fitness and fatness with asthma. The analyses were performed using SAS (Version 9.1, SAS Institute, Cary, North Carolina). For all analyses, the statistical significance level was 5%.

We found an incidence of asthma of 5% over a mean follow-up period of 11.5 years. Both low cardiorespiratory fitness and high BF% were associated with subsequent acquisition of asthma (Table I). However, whereas BF% was associated with asthma independent of cardiorespiratory fitness, the association between cardiorespiratory fitness and asthma did not persist after adjusting for BF% (Table I). When the association between cardiorespiratory fitness and asthma was additionally adjusted for FEV_1 (data not shown), it became non-significant, suggesting that this association was also mediated by FEV_1. High adiposity remained associated with higher risk of asthma after adjustment for FEV_1 though, suggesting that other factors than pulmonary function may explain this association. Further research on this topic is needed to confirm these findings.

One prospective study [7] observed that a high cardiorespiratory fitness level in children was associated with a lower risk of incident asthma at late adolescence. The relationships between cardiorespiratory fitness and adult-onset asthma or the combined effect of fitness and fatness on incident asthma have not been studied. A major finding of this study was that having a high cardiorespiratory fitness level reduced by half the risk of incident asthma in overfat individuals, while no effect was observed in normal-fat individuals (Table II). These findings suggest that high cardiorespiratory fitness might be less beneficial in individual with a low risk of incident asthma, i.e. normal-fat adults, than in those with a higher risk of incident asthma, i.e. overfat adults. Only a high level of cardiorespiratory fitness, not a moderate level, seemed to attenuate the risk of developing asthma. (*See Online Repository Material for further information about additional analyses and potential underlying mechanisms for the observed findings*)

To deal with possible misclassification of chronic obstructive pulmonary disease, we performed the analyses controlling for a respiratory symptoms index, defined as the presence of one or more respiratory problems associated with chronic obstructive pulmonary disease – chronic cough or phlegm, bronchitis, emphysema and/or unexplained shortness of breath while sleeping, sitting, or exercising. The associations of asthma with either cardiorespiratory fitness or BF% persist after accounting for this index (Table I).

In this study, as in most large-scale prospective studies,[8] asthma incidence was assessed as self-reported physician-diagnosed asthma. Although the accuracy of self-reported physician-diagnosed asthma in this study is not known, persons in this highly educated cohort have previously shown high sensitivity and specificity at reporting pathological conditions, such as hypertension (98% and 99%, respectively).[9] We believe that large misclassification errors due to using self-report physician-diagnosed asthma data is unlikely in this population. The present study allowed us to relate baseline cardiorespiratory fitness and BF% to subsequent acquisition of asthma. However, mechanisms by which changes in cardiorespiratory fitness and BF% levels can influence asthma risk are not known and should be addressed in future studies. Our study lacks information about the atopic status of the participants, presence of rhinitis or allergic disease, related biomarkers such as serum IgE or Leptin levels. Also, we did not collect information about wheeze at the follow-up, which is a respiratory symptom often related with asthma. On the other hand, the fact that nearly 10,000 individuals were evaluated using objective and accurate measures of cardiorespiratory fitness and BF%, and followed-up for an average period of eleven years is a strength of this study.

In conclusion, the results of this prospective study suggest that the association between adiposity and the risk of incident asthma is consistent after adjustment for all the variables studied, including smoking, physical activity, cardiorespiratory fitness, and pulmonary function; whereas the association between cardiorespiratory fitness and asthma is mediated by adiposity and pulmonary function. However, we found that the higher risk of incident asthma observed in overfat men and women might be lowered by half if a high cardiorespiratory fitness level is achieved. These findings may have important implications for physicians and for future disease prevention policies.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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Abbreviations used

BF%	body fat percentage
FEV_1	forced expiratory volume in 1 second

TABLE I

Multivariate associations of cardiorespiratory fitness, body fat percentage and incident asthma.

Predisposing factors	Cases (n)	Model 1* OR (95% CI)	Model 2† OR (95% CI)
Cardiorespiratory fitness			
Low	69 (1075)	1 (Reference)	1 (Reference)
Moderate	173 (3586)	0.77 (0.57-1.03)	0.82 (0.61-1.11)
High	218 (5149)	0.68 (0.50-0.93)	0.79 (0.57-1.09)
Body fat %			
Normal-fat	315 (7262)	1 (Reference)	1 (Reference)
Overfat	145 (2548)	1.45 (1.17-1.79)	1.38 (1.10-1.72)

OR, odds ratio; CI, confidence interval.

*Model 1 adjusted for: age, sex, height, physical activity, smoking and respiratory symptom index.

†Model 2 adjusted for all the variables in model 1 plus %BF (for cardiorespiratory fitness) or cardiorespiratory fitness (for %BF).

TABLE II

Associations between cardiorespiratory fitness and incident asthma stratified by normal-fat and overfat.

	Cases (n)	Multiple-adjusted * OR (95% CI)
	Normal-fat individuals	
Cardiorespiratory fitness		
Low	26 (473)	1
Moderate	97 (2275)	0.85 (0.54-1.33)
High	192 (4514)	0.93 (0.59-1.46)
	Overfat individuals	
Cardiorespiratory fitness		
Low	43 (602)	1
Moderate	76 (1311)	0.78 (0.52-1.16)
High	26 (635)	0.51 (0.30-0.88)

OR, odds ratio; CI, confidence interval.

*Adjustment for potential risk factors: age, sex, height, physical activity, smoking and respiratory symptoms (presence of one or more of the respiratory symptoms indicated in Table I).