

The relationship between lung function and cognitive function in older adults: examining differences between men and women

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Abstract

Aims

This study examined the relationship between lung function and cognitive function in older adults. Findings from previous studies are inconsistent and differences between men and women have not been examined.

Methods

Older adults (256 females and 239 males) who completed the 1947 Scottish Mental Survey of childhood intelligence were assessed at age 64. Forced expiratory volume in one second (FEV1) and cognitive ability were evaluated. The relationship between lung function and cognitive function was examined, adjusting for childhood intelligence, education, smoking, height, and weight.

Results

Women had higher scores on tests of memory (Mean = 48.81) and speed of processing (Mean = 45.16) than men (Mean = 41.44 and 41.34, respectively) at age 64. Men had higher inductive reasoning (Mean = 36.51) and FEV1 (Mean = 2.57) scores than women (Mean = 35.03 and 1.92, respectively). Positive associations between lung function and reading (C.R. = 2.51), inductive reasoning (C.R. = 2.41), and processing speed (C.R. = 2.76) were observed for women, but not men.

Discussion

The relationship between lung function and cognitive function differs for men and women. Longitudinal research is needed to explore these differences.

Introduction

Impaired lung function is a clinical indicator of greater mortality risk¹, and may be an indicator of cognitive decline in older adults.² Forced expiratory volume 1 sec (FEV1) is an important indicator of lung function used in previous research to examine relationships between lung and cognitive functions.² The relationship between lung function and cognitive function in older adults varies across studies.³⁻⁵ Confounding variables (e.g. height and smoking) are not statistically controlled in all studies, and differences between men and women have not been examined. The aim of the current study is to examine the relationship between lung function and cognitive function in a large sample of older men and women controlling for height, weight, smoking, education, and childhood intelligence.

Methods

A total of 506 older adults who had participated in the Scottish Mental Survey of 1947 were invited to the current study. Individuals who took part in the original testing in 1947 and who were residents in Grampian were traced using the Community Health Index, General Register Office public records, and National Health Service records. The individual's GP was approached and recruited the participant using a standardised letter. Those whom the GP felt were inappropriate to approach, such as the seriously ill or recently bereaved, were not contacted. Data for 495 participants (256 females and 239 males) were included in the analysis. A detailed description of the sample and measurement procedures have been reported in earlier publications.⁶ A measure of childhood intelligence (age 11±0.5) using the Moray House Test was available for all participants. At age 64, participants received an information leaflet and signed a written consent. Participants completed tests of reading ability (The National Adult Reading Test), inductive reasoning (Raven's Standard Progressive Matrices), processing speed (The Digit Symbol Test) and memory (The Rey Auditory Verbal Learning Test). Height (centimetres) and weight (kilograms) were assessed and forced expiratory volume in one second (FEV1) was measured by a trained research nurse. FEV1 is a validated surrogate measure of lung function⁷ and was measured using a Micro Medical MicroLoop spirometer (Micro Medical Ltd.UK). The number of years of formal education was recorded and smoking was coded as non-smoker (0), ex-smoker (1), or current smoker (2).

Results

Means and Standard Deviations (SDs), t-test differences, and Structural Equation Model (SEM) effects for men and women are reported in Table 1. The SEM examined the effects of height, weight, and smoking on FEV1, and also the effect of FEV1 on cognitive test outcomes while further controlling for the effects of smoking, childhood intelligence, and education. The SEM included cognitive test performance at age 66 and 69, but with non-significant slope variance and FEV1 scores only available at age 64, we report intercept effects at age 64 only. Analysis of t-tests revealed no difference between males and females on tests of childhood intelligence. At age 64, women had significantly higher scores than men on tests of memory and speed of processing, while men had higher inductive reasoning and FEV1 scores. SEM analysis revealed that smoking had a negative effect on lung function for both men and women. Positive associations between lung function and reading, inductive reasoning, and processing speed were observed for women, but not men.

Table 1.

Means and standard deviations (SDs), t-test differences, and Structural Equation Model (SEM) effects and standard errors (SE) for males and females

	Males	Females	t(p)
	<i>Mean (SD)</i>	<i>Mean (SD)</i>	
NART	32.17(8.82)	32.58(8.19)	-0.54(0.59)
AVLT	41.44(9.70)	48.81(8.87)	-8.57(0.00)**
Ravens	36.51(8.11)	35.03(8.87)	1.90(0.01)*
Digits	41.34(10.93)	45.16(11.35)	-3.64(0.00)**
FEV1	2.57(0.63)	1.92(0.45)	12.54(0.00)**
Height	171.86(5.97)	158.95(6.19)	23.58(0.00)**
Weight	79.28(11.34)	68.10(12.77)	10.28(0.00)**
Smoking	0.82(0.72)	0.71(0.79)	1.72(0.09)
Education	11.13(2.28)	11.13(1.90)	0.03(0.98)
Childhood Intelligence	41.33(14.02)	42.89(12.80)	-1.30(0.19)

	Effect(SE)	C.R.(p)	Effect(SE)	C.R.(p)
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Paths to FEV1

Height	0.027(0.01)	3.61**	0.03(0.00)	6.75**
Weight	0.004(0.004)	1.05(0.29)	-0.00(0.00)	-1.93(0.05)
Smoking	-0.20(0.06)	-3.62**	-0.17(0.03)	-5.07**

Paths to Raven's (Inductive Reasoning)

FEV1	0.94(0.74)	1.28(0.20)	2.55(1.06)	2.41(0.02)*
Smoker	-0.11(0.61)	-0.18(0.86)	-0.16(0.58)	-0.27(0.79)
Education	0.77(0.21)	3.63**	1.06(0.26)	4.05**
Childhood Intelligence	0.29(0.03)	8.40**	0.35(0.04)	8.86**

Paths to Digits (Processing Speed)

FEV1	1.45(1.09)	1.33(0.18)	4.07(1.48)	2.76(0.01) *
Smoking	-1.80(0.90)	-2.01(0.05)	-0.93(0.82)	-1.14(0.25)
Education	0.50(0.31)	1.60(0.11)	0.39(0.37)	1.07(0.29)
Childhood Intelligence	0.32(0.05)	6.25**	0.42(0.06)	7.74**

Paths to NART (Reading Ability)

FEV1	0.91(0.60)	1.52(0.13)	2.11(0.84)	2.51(0.01)*
Smoking	0.83(0.50)	1.67(0.10)	1.19(0.46)	2.57(0.01)*
Education	0.63(0.17)	3.64**	0.94(0.21)	4.53**
Childhood Intelligence	0.43(0.03)	15.36**	0.36(0.03)	11.45**

Paths to AVLT (Memory)

FEV1	-1.8(1.04)	-1.73(0.08)	0.29(1.25)	0.23(0.82)
Smoking	-0.67(0.86)	-0.78(0.43)	-0.06(0.69)	-0.08(0.93)
Education	0.67(0.30)	2.23(0.03)*	0.36(0.31)	1.17(0.24)
Childhood Intelligence	0.20(0.05)	4.10**	0.30(0.05)	6.54**

Note. AVLT = Auditory Verbal Learning Test; NART = National Adult Reading Test; Ravens = Raven's Standard Progressive Matrices; Digits = The Digit Symbol Test; FEV1 = Forced expiratory volume 1 sec; * $p < .05$; ** $p < .01$

Discussion

Statistically controlling for the effects of smoking, height, weight, childhood intelligence, and education, a relationship between lung function and cognitive function was observed for measures of processing speed, inductive reasoning, and reading ability. However, these effects are observed only among women. Future studies should examine how the relationship between lung function and cognitive function changes over time. These relationships are likely to be complex in longitudinal studies focused on older adults, given that sex differences in lung function and responses to exercise may also change over time.⁸⁻⁹ Also, longitudinal trajectories of cognitive change can differ for men and women.¹⁰ Causal pathways from pollution-induced impaired lung function to neurodegenerative disease appear plausible,¹¹ and future longitudinal research may wish to incorporate analysis of environmental factors including air quality and variation across regions in the link between lung function and cognitive function.

Sex differences in lung function and in performance on cognitive tests observed in the current study are consistent with previous research findings. Typically, men perform better on lung function tests¹ and women perform better on some cognitive tests, especially those requiring verbal skills.¹⁰ In relation to lung function, even after statistically controlling for height, studies

report that FEV1 was higher in men than in women.⁸ Some reports highlight the potential for more complex interactions, including findings which suggests that abdominal obesity has a stronger inverse association with FEV1 in men than in women¹² and that smoking has greater adverse effects on lung function in women than in men.¹³ In the current study, the negative effects of smoking on FEV1 are significant for both men and women. There is only one difference in path effects: smoking is related to higher reading ability for women, but not men. At the same time, the effects of smoking on cognition are not seen for memory, processing speed, and inductive reasoning, and it is possible that the positive effect of smoking on reading ability in women is a spurious effect, given the multivariate and complex nature of the model. Further research would be needed to examine these effects.

In conclusion, lung function is an important predictor of health status and health risk in older adults, and it may also be important to measure in intervention studies designed to enhance or maintain cognitive functioning or delay the onset of age- and disease-related cognitive decline.

Declarations of Conflicts of Interest:

None declared.

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