Respiratory Research

RESEARCH

Open Access

Purpose in life and lung function: an individual-participant meta-analysis of six cohort studies

Angelina R. Sutin[1*], Yannick Stephan[2], Martina Luchetti[1], Justin Brown[1], Tiia Kekäläinen[3], André Hajek[4], Brice Canada[5], Sébastien Kuss[5,6] and Antonio Terracciano[1]

Abstract

Background Purpose in life is a psychological resource associated with better health outcomes across adulthood. It is unknown whether it is related to lung function, a key marker of health and longevity. We evaluate the replicability and generalizability of the cross-sectional association between purpose in life and lung function and whether purpose in life is associated with lower risk of developing poor lung function over time.

Methods Participants were from six cohort studies with public data: Health and Retirement Study, Midlife in the United States study, Wisconsin Longitudinal Study, National Health and Aging Trends Study, English Longitudinal Study of Ageing, and Survey of Health, Ageing and Retirement in Europe (total $N = 85{,}190$). Participants reported on their purpose in life, and staff measured their peak expiratory flow with either a peak flow meter or a spirometer. Four cohorts ($N = 11{,}595$) had longitudinal assessments of lung function over up to 12 years. Linear regression was used to test the cross-sectional association between purpose and continuous lung function. Cox regression was used to test the association between purpose and risk of developing predicted lung function < 80% over time, a dichotomous outcome that categorized lung function into performance less than 80% of predicted function (= 1) and at least 80% of predicted function (= 0).

Results In each cohort and aggregated in a random-effects meta-analysis, higher purpose in life was associated with better peak expiratory flow (meta-analytic effect = 0.07, $p < .001$). The association was generally similar across sociodemographic groups (e.g., age, sex). Every standard deviation higher purpose in life was associated with a 10% reduced risk of developing poor lung function over time (meta-analytic hazard ratio = 0.91, 95% confidence interval = 0.88, 0.94, $p < .001$). These associations were attenuated but remained significant accounting for behavioral and clinical risk factors.

Conclusions Purpose in life is associated with healthier lung function, with evidence of replicability and generalizability, and with lower risk of developing poor lung function over time. Lung function may be one mechanism between purpose in life and healthier outcomes in older adulthood.

Clinical trial number Not applicable.

*Correspondence:
Angelina R. Sutin
angelina.sutin@med.fsu.edu

Full list of author information is available at the end of the article

Keywords Purpose in life, Pulmonary function, Lung function, Well-being, Longitudinal, Meta-analysis

Lung function is critical for healthier aging [1]. Although it tends to decline with age, there are tremendous individual differences in this decline [2]. Some differences are explained by behaviors that harm or benefit the lungs, such as smoking and physical activity, respectively [3]. Psychological factors may also contribute to lung function. A meta-analysis of personality traits and lung function, for example, found that individuals higher in neuroticism tended to have worse lung function, whereas individuals higher in extraversion and conscientiousness tended to have better lung function [4]. These associations were not due completely to either behavioral factors (smoking, physical activity) or clinical factors (body mass index [BMI], depression). Other psychological factors known to contribute to health may also be relevant for lung function. In particular, purpose in life, an aspect of well-being that reflects the feeling that one's life is goal-oriented and has direction [5], has been associated consistently with better health outcomes in older adulthood: Individuals higher in purpose carry a lower burden of chronic disease [6], have lower risk of incident dementia [7], and tend to live longer [8]. Purpose is associated with these better outcomes, in part, because individuals higher in purpose are more likely to engage in behaviors that promote healthy aging, including less smoking [9] and greater engagement in physical activity [10].

There is also growing evidence that purpose is associated with numerous aspects of physical function and maintenance of physical function over time in older adulthood. Individuals higher in purpose, for example, have stronger grip strength [11] and walk faster [12] than individuals lower in purpose. Purpose is also associated with lower risk of declines in both grip strength and walking speed over time [13]. Lung function may likewise be an aspect of physical function that benefits from purpose. It may also be one mechanism in the pathway between purpose and the better health outcomes associated with it in older adulthood.

The present research takes a coordinated data analysis approach with an individual-participant meta-analysis to identify replicable associations between purpose in life and lung function and the development of poor lung function over time. Lung function was operationalized as peak expiratory flow (PEF). Although a simple measurement, PEF has been found to be a valid measure of pulmonary function [14]. It has also emerged as a consistent predictor of better outcomes in older adulthood, similar to measures such as Forced Expiratory Volume in 1 s Forced Vital Capacity: Greater PEF is associated with lower risk of incident dementia [15], fewer injurious falls over time [16], and greater longevity [17]. We expect that greater purpose in life will be associated with better lung function when measured concurrently and with lower risk of incident poor lung function when measured longitudinally. We further test whether these associations are accounted for by behavioral (smoking, physical activity) and clinical (BMI, depression) factors known to increase risk for poor lung function [3]. Such factors could be potential confounders or mediators (e.g., higher purpose motivates physical activity, which helps sustain better lung function). We also address whether the associations vary by sociodemographic factors, or whether they generalize across age, sex, race, ethnicity, and education.

Method

Participants and procedure

The present research was a coordinated analysis of six publicly available datasets that had a measure of purpose and a measurement of lung function: the Health and Retirement Study (HRS; https://hrs.isr.umich.edu/), the Midlife in the United States (MIDUS; http://midus.wisc.edu/) study, the Wisconsin Longitudinal Study (WLS; https://www.ssc.wisc.edu/wlsresearch/), the National Health and Aging Trends Study (NHATS; https://www.nhatsdata.org/), the English Longitudinal Study of Ageing (ELSA; https://www.elsa-project.ac.uk/), and the Survey of Health, Ageing and Retirement in Europe (SHARE; http://www.share-project.org/). This research was done in in accordance with the Declaration of Helsinki. Flow chart of participants selected for analysis in each sample is in Supplemental Figures S1 (cross-sectional analysis) and S2 (longitudinal analysis).

The HRS is a study of aging of adults aged 50 years and older living in the United States and their spouse regardless of age. A random half of the HRS sample reported on their purpose in life and had their lung function tested in 2006; the other half was measured in 2008. The 2006/2008 samples were combined as baseline. The lung function measure was repeated every four years. In addition, new participants periodically recruited into HRS to replenish the cohort were included in the cross-sectional and longitudinal analytic samples.

MIDUS is a longitudinal sample of adults living in the United States. Participants from MIDUS II (2004–2006) who completed the lung function measure as part of the Biomarker Project were included in the analysis. A subset of these participants also completed a lung function assessment as part of the Biomarker Project at MIDUS III (2017–2021).

WLS is a longitudinal study of adults who graduated from a Wisconsin high school in 1957 (respondent sample) and a selected sibling (sibling sample). WLS participants reported on their purpose in life and had their lung function measured in 2011. The WLS respondent and sibling samples were combined, and a control variable distinguishing the two samples was included in every analysis of WLS.

NHATS is a study of adults in the United States aged 65 and older enrolled in Medicare. Participants reported on their purpose and had their lung function measured at wave 2 in 2012. Their lung function was subsequently measured annually. In addition, new participants periodically recruited into NHATS to replenish the cohort were included in the cross-sectional and longitudinal analytic samples.

ELSA is a study of adults aged 50 years and older living in England and their spouse regardless of age. ELSA participants reported on their purpose and had their lung function measured in 2004. The lung function measure was repeated every two years. In addition, new participants periodically recruited into ELSA to replenish the cohort were included in the cross-sectional and longitudinal analytic samples.

SHARE is a study of adults aged 50 years and older living in Europe and their spouse regardless of age. SHARE participants reported on their purpose and had their lung function measured at wave 6 in 2015.

These six cohorts were chosen because of the availability of both purpose in life and an assessment of lung function. Within each cohort, all participants with data necessary for analysis were included in the analytic sample (see Analytic Strategy below). No other exclusion criteria were applied to the analytic sample.

Measures

Purpose in life

Purpose in life was measured with a version of the Purpose in Life subscale of the Ryff Scales of Psychological Well-Being in HRS, MIDUS, and WLS. Items were rated on a scale from 1 (*strongly disagree*) to 6 (*strongly agree*) in HRS and WLS and from 1 (*strongly disagree*) to 7 (*strongly agree*) in MIDUS. NHATS measured purpose with a single item ("My life has meaning and purpose.") on a scale from 1 (*agree a lot*) to 3 (*agree not at all*). In ELSA and SHARE, purpose was measured with an item ("I feel that my life has meaning.") from the Pleasure scale of the control-autonomy-pleasure-self-realization scale (CASP-19) of quality of life in older adulthood [18] on a 4-point scale from 1 (*never*) to 4 (*often*). Items were reverse scored when necessary, so that higher scores indicated greater purpose in life in every sample.

Peak expiratory flow

A peak flow meter was used to assess PEF in HRS, MIDUS, WLS, NHATS, and SHARE; a spirometer was used in ELSA. The best of three trials was used in HRS, MIDUS, WLS, NHATS, and ELSA; the best of two trials was used in NHATS and SHARE. PEF was recorded in L/min in HRS, MIDUS, WLS, NHATS, and SHARE and in L/seconds in ELSA. The raw metric from the best trial was used, as was the proportion of predicted PEF, calculated using the Nunn and Gregg [19] formula. For some analyses, participants were categorized into PEF < 80% of the predicted value (= 1) versus PEF ≥ 80% of the predicted value (= 0) at each assessment. PEF < 80% is considered poor lung function, whereas PEF ≥ 80% is considered healthy lung function [19].

Covariates. Sociodemographic covariates were age (in years), sex (0 = male, 1 = female), race, ethnicity, and education. Race was categorized into two dummy-coded variables that compared Black/African American participants (= 1) and otherwise/unknown participants (= 1) compared to white (= 0) in HRS, MIDUS, and NHATS and one dummy-coded variable that compared people of color (= 1) and white (= 0) participants in ELSA; ELSA does not publicly release more specific racial/ethnic information about participants. SHARE does not collect data on race/ethnicity and WLS is white. Hispanic ethnicity (0 = no/unknown, 1 = yes) was available in HRS, MIDUS, and NHATS. Education was reported in years in HRS and WLS, on a scale from 1 (*no school/some grade school*) to 12 (*doctorate or professional degree*) in MIDUS, from 1 (*no schooling completed*) to 9 (*master's, professional, or doctoral degree*) in NHATS, from 1 (*no qualification*) to 7 (*NVQ4/NVQ5/Degree or equivalent*) in ELSA, and from 0 (*none*) to 6 (*ISCED-97 code 6*) in SHARE. Height in meters was included as a covariate because taller individuals have greater lung capacity. Behavioral covariates were ever smoker (0 = never smoker, 1 = former or current smoker) and physical activity. In HRS and ELSA, physical activity was measured with two items on the frequency of vigorous and moderate physical activity on a scale from 1 (*hardly ever or never*) to 4 (*more than once a week*). In MIDUS, physical activity was measured with four items on vigorous and moderate leisure physical activity in the summer and winter months on a scale from 1 (*never*) to 6 (*several times a week or more*). In NHATS, physical activity was measured with an item on vigorous activities in the last month (0 = no, 1 = yes). In WLS, physical activity was measured as the hours per month spent doing vigorous or light physical activities. In SHARE, physical activity was measured with two items on moderate and vigorous physical activity on a scale from 1 (*hardly ever or never*) to 4 (*more than one a week*). Clinical covariates were body mass index derived from height and weight (kg/m^2) and severe depressive symptoms. Severe depressive symptoms in HRS and ELSA were measured with an 8-item version of the Center for Epidemiological Studies Depression (CESD), with distress classified as ≥ 3 [20]. Severe depressive symptoms were measured in MIDUS with the Composite International Diagnostic Interview Short Form (CIDI-SF), and distress was defined as four or more symptoms of depressed affect felt most or all day for at least two weeks [21]. Severe depressive symptoms in WLS were measured as the number of days in the past week each of the 20 items on the CESD were experienced (possible range 0-140), with severe distress categorized at a score of 34. Severe depressive symptoms were measured in NHATS with the Patient Health Questionnaire-2, with distress classified as ≥ 3 [22]. SHARE measured psychological distress with the EURO-D scale [23] and defined distress as a score ≥ 4 [24]. In all samples, severe depressive symptoms were coded as exceeding the threshold (= 1) or not exceeding the threshold (= 0).

Analytic strategy

The same analytic strategy was applied to each sample. The same coding scheme for all dichotomous variables was used in every sample; all continuous predictors were standardized within each sample to a mean of zero and standard deviation (SD) of one so that coefficients can be interpreted as a one-SD difference in the continuous predictor. After selecting participants with purpose in life and PEF measurements, the percent of missing data for the sociodemographic covariates (age, sex, race) ranged from 0% (MIDUS) to 4% (SHARE). Missing education (< 1% in each sample) was imputed with multiple imputation because so few participants were missing education. The multiple imputation was based on all available sociodemographic variables and 10 datasets were imputed. Listwise deletion was used for cases with missing data on the other sociodemographic covariates. Linear regression was used to test the cross-sectional association between purpose in life and maximum PEF, controlling for the sociodemographic covariates and height. Sample was included in WLS to account for the two-sample structure (0 = respondents; 1 = siblings). Linear regression was also used to test the association between purpose and proportion of predicted PEF, controlling for race, ethnicity, and education (age, sex, and height were not included as covariates because these factors were included in the calculation of proportion of predicted PEF). Logistic regression was used to test the likelihood of having predicted PEF < 80% controlling for the sociodemographic covariates. Each analysis was then repeated including the behavioral and clinical factors as additional covariates. To test moderation by sociodemographic factors, an interaction term between purpose and each factor was added to the basic model for max PEF, controlling for the main effects and other sociodemographic covariates. For each analysis, the association was summarized with a random-effect meta-analysis; the association for each cohort was entered once in each meta-analysis. The variance estimation method used was Restricted Maximum Likelihood. Heterogeneity was evaluated with the Q-statistic and I^2. Data from the individual cohorts were analyzed with IBM SPSS 29.0.1. The meta-analyses were run with Comprehensive Meta-Analysis and STATA.

The longitudinal association between purpose in life and risk of developing poor lung function was tested with survival analysis in HRS, MIDUS, NHATS, and ELSA. This analysis was not conducted in the WLS and SHARE because these samples did not include repeated assessments of peak expiratory flow. Participants with healthy lung function (PEF ≥ 80% of predicted value) at baseline were selected for the longitudinal analysis. Time was coded as years between baseline and the first instance of PEF < 80%. Participants who did not develop poor lung function over the follow-up were censored at their last available assessment. Cox regression was used to test purpose in life as a predictor of incident poor lung function. The first model controlled for sociodemographic factors and height. The second model further adjusted for the behavioral and clinical covariates. The associations for both models were summarized with a random-effect meta-analysis. Heterogeneity was evaluated with the Q-statistic and I^2.

To evaluate the statistical significance of the meta-analyses, p was set to < 0.01 to balance concerns over type 1 and type 2 errors. The p-value is also reported to three decimals places to allow readers to make their own judgements.

Results

Descriptive statistics for all study variables are in Table 1. Across the six samples, there were 85,190 participants who ranged in age from 18 to 107.

Results of the cross-sectional analysis are in Table 2. The meta-analysis indicated a significant association between purpose and lung function: Participants with greater purpose in life had stronger lung function (Fig. 1). This association was significant in each sample, as well as the meta-analysis. There was significant heterogeneity across samples ($Q = 16.90$, $p < .001$, $I^2 = 70.41\%$). Purpose in life was likewise associated with greater proportion of predicted PEF, in the meta-analysis and every individual study, and lower likelihood of having proportion of predicted PEF < 80%. There was significant heterogeneity for both proportion of predicted PEF ($Q = 32.97$, $p < .001$, $I^2 = 84.84\%$) and predicted PEF < 80% ($Q = 25.84$, $p < .001$, $I^2 = 80.65$).

The association between purpose in life and all the PEF outcomes (max PEF, proportion of predicted PEF, predicted PEF < 80%) was slightly attenuated but remained significant when smoking, physical activity, BMI, and severe depressive symptoms were added as additional covariates. This adjusted association was significant in

Table 1 Descriptive statistics for study variables in each cohort

Variable	HRS	MIDUS	WLS	NHATS	ELSA	SHARE
Age (years)	64.66 (10.52)	55.18 (11.80)	70.53 (4.13)	76.53 (7.62)	65.42 (8.93)	66.12 (9.48)
Age range	18–104	34–84	40–92	65–107	52–92	27–102
Sex (female)	59.6% (9006)	54.4% (565)	53.3% (3918)	56.8% (5559)	54.5% (3384)	57.0% (26033)
Race (Black)	15.7% (2374)	2.5% (26)	--	20.7% (2025)	--	--
Race (Otherwise identified)	6.5% (983)	4.5% (47)	--	2.9% (286)	1.4% (84)	--
Hispanic (yes)	10.5% (1592)	3.5% (36)	--	5.8% (569)	--	--
Education[a]	12.86 (3.02)	7.73 (2.44)	13.93 (2.44)	5.21 (2.20)	3.47 (2.23)	11.19 (4.34)
Height (m)	1.66 (0.10)	1.69 (0.09)	1.68 (0.09)	1.67 (0.10)	1.66 (0.09)	1.68 (0.09)
Purpose in life[b]	4.66 (0.92)	5.63 (0.92)	4.64 (0.79)	2.82 (0.43)	3.57 (0.72)	3.59 (0.69)
Baseline maximum PEF (L/min)	377.76 (130.79)	422.05 (129.07)	406.75 (132.77)	327.12 (134.77)	375.85 (142.19)	352.93 (154.78)
Baseline PEF prop	0.78 (0.21)	0.82 (0.19)	0.85 (0.21)	0.72 (0.24)	0.76 (0.22)	0.72 (0.28)
Incident PEF@80	37.1% (2406)	52.7% (547)	--	76.9% (7523)	41.8% (687)	--
Body mass index (kg/m^2)	28.40 (5.65)	29.22 (6.02)	29.75 (5.58)	27.83 (5.72)	27.98 (4.89)	27.09 (4.58)
Ever smoker (yes)	53.3% (8059)	44.8% (465)	52.9% 3803)	51.3% (5014)	63.0% (3909)	45.3% (20700)
Physical activity[c]	2.62 (1.01)	3.45 (1.31)	19.75 (26.46)	0.38 (0.48)	2.62 (0.92)	2.99 (0.94)
Probable depression (yes)	19.5% (2952)	13.2% (137)	10.8% (770)	13.3% (1289)	19.7% (1211)	25.1% (11397)
Time (years)	7.71 (3.88)	11.65 (1.33)	--	3.46 (2.46)	6.52 (1.93)	--
N	15,112	1038	7355	9780	6205	45,700

Note. HRS = Health and Retirement Study. MIDUS = Midlife in the United States study. WLS = Wisconsin Longitudinal Study. NHATS = National Health and Aging Trends Study. ELSA = English Longitudinal Study of Ageing. SHARE = Survey of Health, Ageing and Retirement in Europe. A Education was reported in years in HRS and WLS, on a scale from 1 (*no school/some grade school*) to 12 (*doctorate or professional degree*) in MIDUS, from 1 (*no schooling completed*) to 9 (*master's, professional, or doctoral degree*) in NHATS, from 1 (*no qualification*) to 7 (*NVQ4/NVQ5/Degree or equivalent*) in ELSA, and from 0 (*none*) to 6 (*ISCED-97 code 6*) in SHARE. [b] The purpose scale ranged from 1 (*strongly disagree*) to 6 (*strongly agree*) in HRS and WLS, from 1 (*strongly disagree*) to 7 (*strongly agree*) in MIDUS, from 1 (*agree not all*) to 3 (*agree a lot*) in NHATS, and from 1 (*never*) to 4 (*often*) in ELSA and SHARE. [c] Physical activity ranged from 1 (*hardly ever or never*) to 4 (*more than once a week*) in HRS, ELSA, and SHARE, from 1 (*never*) to 6 (*several times a week or more*) in MIDUS, from 0 (*no*) to 1 (*yes*) in NHATS, and hours per month in WLS

all individual samples except MIDUS (max PEF, proportion of predicted PEF) and ELSA (proportion of predicted PEF). There was significant heterogeneity across samples for each outcome (max PEF: Q = 14.48, p =.013, I^2 = 65.47%; proportion of predicted PEF: Q = 23.38, p <.001, I^2 = 76.62; predicted PEF < 80%: Q = 23.26, p <.001, I^2 = 78.50).

There was little evidence of moderation by sociodemographic factors. The meta-analyses of interaction terms between purpose and the sociodemographic factors were not significant (Supplemental Table S1). Some interactions were significant in individual samples but did not replicate across samples. These null associations indicate that the association between purpose in life and lung function was similar across age, race, ethnicity, and education. The one exception was for sex. The meta-analysis indicated a significant interaction between purpose and sex on lung function (b=-0.03, p <.001); the interaction was significant in HRS, WLS, NHATS, and SHARE. The interaction indicated that the association was stronger among females than males. To better understand the association, we reran the analysis in each sample stratified by sex (Supplemental Table S2). The association was significant for both sexes but slightly stronger among females (b = 0.09, p <.001) than males (b = 0.08, p <.001).

The results of the longitudinal analysis are in Table 3. Based on the meta-analysis, every standard deviation higher in purpose in life was associated with a 10% reduced likelihood of developing poor lung function over the follow-up (Fig. 2). This association was significant in HRS and NHATS but not MIDUS or ELSA. There was no significant heterogeneity across samples (Q = 1.66, p =.664, I^2 = 0%). The association was slightly attenuated with the addition of the behavioral and clinical covariates but remained significant in the meta-analysis. As with the first model, the association was significant in HRS and NHATS but not MIDUS or ELSA. There was no significant heterogeneity across samples (Q = 1.35, p =.718, I^2 = 0%).

Discussion

This individual-participant meta-analysis found a replicable association between purpose in life and lung function: Participants who reported greater purpose in life had healthier peak expiratory flow (either in the raw metric or proportional value) when measured concurrently and maintained their healthier lung function over time when measured longitudinally. The association was similar across sociodemographic groups, with a slightly stronger association among females (although the coefficient was essentially the same for males). Both the cross-sectional and longitudinal associations remained significant when further controlling for behavioral and clinical risk factors, which indicates that the association is not due only to shared risk factors and that there may be other mechanisms in the pathway between purpose and PEF.

Table 2 *Cross-sectional association between purpose in life and peak expiratory flow*

Sample	Model 1			Model 2		
	N	β/OR (95% CI)	p	N	β	p
	Maximum PEF					
HRS	15,112	0.07	< 0.001	14,807	0.04	< 0.001
MIDUS	1038	0.06	0.006	936	0.04	0.080
WLS	7355	0.08	< 0.001	6411	0.05	< 0.001
NHATS	9780	0.07	< 0.001	9616	0.05	< 0.001
ELSA	6205	0.04	< 0.001	6135	0.02	0.016
SHARE	45,700	0.09	< 0.001	45,126	0.07	< 0.001
Meta-analysis	85,190	0.07	< 0.001	83,031	0.05	< 0.001
	Proportion of Predicted PEF					
HRS	15,112	0.10	< 0.001	14,807	0.06	< 0.001
MIDUS	1038	0.08	0.006	936	0.06	0.081
WLS	7355	0.10	< 0.001	6411	0.06	< 0.001
NHATS	9780	0.10	< 0.001	9616	0.07	< 0.001
ELSA	6205	0.06	< 0.001	6135	0.02	0.110
SHARE	45,700	0.12	< 0.001	45,126	0.08	< 0.001
Meta-analysis	85,190	0.10	< 0.001	83,031	0.06	< 0.001
	Proportion of Predicted PEF < 80%					
HRS	15,112	0.86 (0.83, 0.89)	< 0.001	14,807	0.92 (0.89, 0.96)	< 0.001
MIDUS	1038	0.86 (0.75, 0.98)	0.023	936	0.85 (0.73, 0.98)	0.025
WLS	7355	0.81 (0.77, 0.85)	< 0.001	6411	0.86 (0.82, 0.92)	< 0.001
NHATS	9780	0.86 (0.82, 0.91)	< 0.001	9616	0.90 (0.86, 0.94)	< 0.001
ELSA	6205	0.85 (0.80, 0.90)	< 0.001	6135	0.90 (0.84, 0.95)	< 0.001
SHARE	45,700	0.79 (0.77, 0.81)	< 0.001	45,126	0.84 (0.82, 0.86)	< 0.001
Meta-analysis	85,190	0.84 (0.80, 0.87)	< 0.001	83,031	0.88 (0.84, 0.92)	< 0.001

Note. PEF = peak expiratory flow. HRS = Health and Retirement Study. MIDUS = Midlife in the United States study. WLS = Wisconsin Longitudinal Study. NHATS = National Health and Aging Trends Study. ELSA = English Longitudinal Study of Ageing. SHARE = Survey of Health, Ageing and Retirement in Europe. Coefficients are either standardized βs linear regression (Maximum PEF, Proportion of Predicted PEF) or odd ratios (OR) and 95% confidence intervals (CI) from logistic regression (Proportion of Predicted PEF < 80%). Model 1 controlled for age, sex, race, ethnicity, height and education and Model 2 was Model 1 with the addition of behavioral (smoking, physical activity) and clinical (body mass index, depression) factors. Proportion of predicted PEF controlled for race, ethnicity, and education. All analyses of WLS also included a control variable for sample type (respondent/sibling). Sample size is smaller for Model 2 because of missing data on the behavioral and clinical covariates

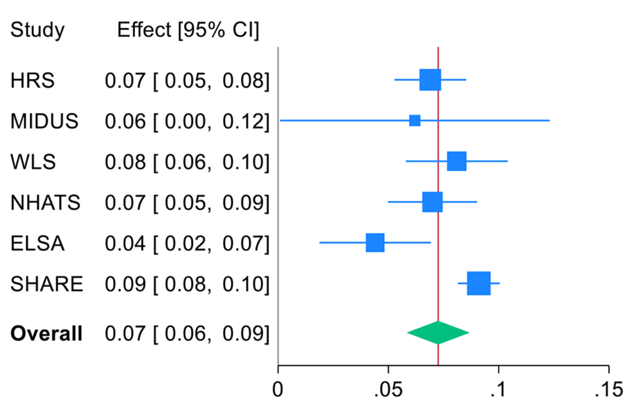

Fig. 1 Forest plot of the cross-sectional association between purpose in life and maximum peak expiratory flow in the six samples. Coefficients are standardized beta coefficients

Lung function is emerging as a core aspect of physical function that contributes to multiple aspects of health across the lifespan [2]. Healthy lung function ensures sufficient oxygen circulates throughout the body, whereas restricted lung function that impedes oxygen flow can cause damage to bodily systems. The greater oxygen to all parts of the body may be one reason why better lung function is associated with better outcomes, from fewer falls to better cognitive function. Healthier lung function may be a mechanism to better long-term health outcomes, in part, through healthier inflammatory profiles [25]. In addition to morbidity and mortality, PEF is related to aerobic capacity and the energy available for daily activities. Even without lung disease, poor PEF can impact mobility and functional independence [26]. Importantly, there are factors related to the rate of decline in PEF. Such factors can be targeted by intervention to improve PEF and associated outcomes, ranging from functional independence to longevity.

There is growing evidence that psychological factors, in addition to behavioral and clinical factors, are associated with lung health [4]. The present research adds purpose in life as a psychological resource that supports better lung function. Purpose in life is an aspect of eudaimonic well-being that has been implicated in sustaining better health [27]. Individuals with more purpose value their

Table 3 Longitudinal association between purpose in life and incident poor lung function

Sample	Model 1				Model 2			
	N	HR	95% CI	*p*	N	HR	95% CI	*p*
HRS	6480	0.89	0.86, 0.93	< 0.001	6380	0.91	0.88, 0.96	< 0.001
MIDUS	346	0.95	0.76, 1.18	0.626	325	0.95	0.74, 1.21	0.666
NHATS	3124	0.93	0.88, 0.98	0.008	3086	0.94	0.88, 0.99	0.022
ELSA	1645	0.93	0.86, 1.01	0.095	1632	0.96	0.88, 1.05	0.423
Meta-analysis	11,595	0.91	0.88, 0.94	< 0.001	11,423	0.93	0.90, 0.96	< 0.001

Note. Poor lung function is < 80% of expected value based on the Nunn & Gregg formula (see Method). HR = hazard ratio. CI = confidence interval. HRS = Health and Retirement Study. MIDUS = Midlife in the United States study. WLS = Wisconsin Longitudinal Study. NHATS = National Health and Aging Trends Study. ELSA = English Longitudinal Study of Ageing. SHARE = Survey of Health, Ageing and Retirement in Europe. Model 1 controlled for age, sex, race, ethnicity, height and education. Model 2 was Model 1 with the addition of behavioral (smoking, physical activity) and clinical (body mass index, depression) factors. Proportion of predicted PEF controlled for race, ethnicity, and education. All analyses of WLS also included a control variable for sample type (respondent/sibling)

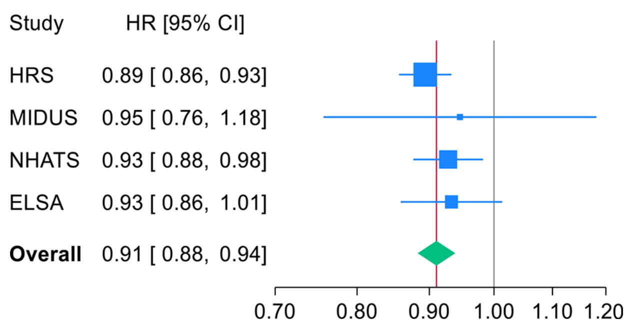

Fig. 2 Forest plot of the longitudinal association between purpose in life and risk of incident poor lung capacity in the four longitudinal samples. Coefficients are hazard ratios

health [28] and engage in a variety of behaviors to protect it [29]. These motives and behaviors culminate in better physical function that extends to the lungs.

There are several mechanisms that may explain why purpose is associated with better lung function. The present research included four such potential mechanisms, two behavioral (smoking, physical activity) and two clinical (BMI, depression). Individuals higher in purpose are less likely to smoke [9] and more likely to engage in more frequent physical activity [10]. Purpose is likewise associated with lower BMI [29] and less depressed affect [30]. These behavioral and clinical factors are implicated in lung function [3]. Accounting for these factors in the model slightly attenuated the association between purpose and lung function, but the association remained significant. This pattern indicates that these factors are likely to be in the pathway from purpose to lung function but also do not explain all the association.

Several other factors may act as mediators in this pathway. Purpose in life, for example, is associated consistently with more social integration [31], and stronger social integration has been associated with better lung function [32]. Individuals higher in purpose also have healthier immune and inflammatory profiles [33], which are likewise associated with lung function [34]. Individuals with more purpose in life are more likely to engage in preventive health behaviors, such as getting the vaccine for COVID-19 [35], that may help prevent infections that could damage the lungs. Finally, purpose in life is closely related to conscientiousness [36], which is the tendency to be self-disciplined, organized and responsible, and a personality trait related to better lung function [4]. As such, individuals higher in purpose may prioritize health in such a way that optimizes lung function and helps to maintain it over time. Lung function is influenced by various factors throughout life, including early life exposures and later behavioral, clinical, and environmental factors in adulthood [37]. As such, having a sense of purpose in life may serve as a resource for multiple factors that contribute to lung function over the life course. Due to the correlational nature of the data in the current study, however, there is also the possibility of reverse causality: Poor lung function may reduce purpose in life. The longitudinal association reduces this concern, but part of the association may still be due to it.

In a model of purpose and health, better lung function and maintaining healthier lung function over time may be one mechanism between purpose and better outcomes. Purpose is conceptualized as a psychological resource that helps to sustain better health over time [27]. And, indeed, individuals with more purpose are at lower risk of developing chronic diseases such as dementia [7] and depression [38], are better able to manage diseases such as diabetes [39], and ultimately are more likely to live longer [8] than individuals lower in purpose. Better lung function is protective against the development of numerous diseases [1] and promotes greater longevity [17]. Given that purpose helps maintain healthy lung function over time and the role of lung function in long-term outcomes, it may function as a mechanism between purpose and better health. There are also likely to be bidirectional associations between purpose and lung function. That is, greater lung function may help individuals to sustain their purpose. PEF is an indicator of aerobic and energetic capacity [40], which may help to sustain purpose-driven activities, particularly in older adulthood.

The moderation analysis indicated that the association between purpose and lung function was similar across sociodemographic groups, which suggests generalizability. There was one exception: Sex moderated the association between purpose and PEF. Supplemental analysis that stratified the samples by sex indicated that the association was significant for both males and females, but slightly stronger among females. Although statistically significant, the magnitude of the difference in the association was very modest, which suggests more similarity than difference. Overall, this work demonstrates the importance of examining associations in multiple cohorts to identify consistent moderation, particularly because interaction terms are difficult to replicate.

It is important to note that there was significant heterogeneity in the meta-analyses of the cross-sectional associations. This heterogeneity could be due, in part, to differences in the measurement of purpose across samples. It could also be due to differences in the measurement of PEF across samples (e.g., best of two versus three trials, differences in the instrument to measure PEF). Despite these differences, however, the association was in the same direction and significant in each sample; the heterogeneity reflects differences in the strength of the association across samples. There was no heterogeneity in the meta-analysis of longitudinal associations, perhaps due to the fewer cohorts included in this analysis than the cross-sectional analysis.

The present study had several strengths, including the objective measurement of lung function, the inclusion of six samples that spanned two continents, and the longitudinal measurement of lung function in four of the six samples. There are also limitations that could be addressed in future research. Although PEF is a validated, objective measurement of lung function, future research could use more sophisticated and detailed measurements of lung health. The measurement of the mechanisms was also imprecise; more detailed assessments of smoking and physical activity may be needed to fully test these factors as mechanisms. There could also be potential unmeasured confounders not included in the current analysis that could contribute to both purpose in life and lung function and thus account for the association (e.g., environmental pollutants, occupational exposures). Likewise, purpose in life was measured with different items across studies and there were differences in how PEF was measured across studies, which may have contributed to the heterogeneity in the cross-sectional analyses. This research was observational, so it is difficult to draw causal conclusions. Purpose in life is malleable [41, 42], and future work could test whether experimental manipulations of purpose lead to better lung function. PEF can also be improved [43], and it could be important to evaluate whether interventions that enhance PEF could also increase purpose in life. There was heterogeneity in the results from the cross-sectional analyses, which could be explained by differences across the samples (e.g., age, location, etc.). Of note, however, the associations were consistent across samples that used different measures of purpose. The samples primarily included older adults. It is thus unclear whether the associations generalize to younger populations who may have different exposures and stressors than adults older than 50. Finally, the samples were from predominantly high-income countries. Research with more diverse samples from lower- and middle-income countries, which may have differences in environmental exposures and healthcare access compared to high-income countries, is needed to fully evaluate generalizability.

These limitations suggest important directions for future research. First, it will be necessary to standardize the assessment of both purpose in life and PEF across samples to facilitate comparability. It is of note that the associations were similar despite differences in measurement across cohorts in the present study, which indicates that the findings are not dependent on any particular measure of purpose or PEF protocol assessment. Still, greater harmonization will help to reduce heterogeneity. Second, lung function measurements could be broadened to include other measures, such as forced expiratory volume in one second (FEV1) and forced vital capacity (FVC). PEF was used in the cohorts included in the present analysis because it could be implemented more broadly and more reliably than these other measures [44]. It will be important in future work to replicate the associations with other measures of lung function. Third, we tested behavioral and clinical factors that are theoretically hypothesized to mediate the association between purpose and lung function. Other possible mediators should be tested in future research, including social integration, immune function, and inflammatory markers. Fourth, expanding the samples to include younger adults, as well as older adults, would help better establish generalizability across the adult lifespan and test for additional moderators that may change with age, including employment/retirement status and stressful life events. Finally, expanding the research design to include samples from low- and middle-income countries would also help better establish generalizability, and experimental designs are needed to establish causality.

Still, the present research indicates that purpose in life is associated consistently with better lung health. It suggests that purpose is one psychological resource that may help maintain healthier lung function over time in older adulthood. These findings contribute to theoretical models of purpose in life and health and suggest lung function may be one mechanism between purpose and better health outcomes. Clinically, these findings suggest that purpose in life can be used to identify who is at risk for declines in lung function, beyond traditional behavioral and clinical risk factors. It also provides the basis for experimental work to test whether increasing purpose improves lung function, which would have direct translational benefits for patients.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12931-025-03247-0.

Supplementary Material 1

Acknowledgements

We gratefully acknowledge the parent studies whose public data made this work possible: Health and Retirement Study (HRS): The Health and Retirement Study is sponsored by the National Institute on Aging (NIA-U01AG009740) and conducted by the University of Michigan. Midlife in the United States (MIDUS): MIDUS is sponsored by the MacArthur Foundation Research Network on Successful Midlife Development (MIDUS I), the National Institute on Aging (P01-AG020166; MIDUS II), and grants from the General Clinical Research Centers Program (M01-RR023942, M01-RR00865) and the National Center for Advancing Translational Sciences (UL1TR000427). Wisconsin Longitudinal Study Graduate and Sibling samples (WLSG and WLSS): Since 1991, the WLS has been supported principally by the National Institute on Aging (AG-9775, AG-21079, AG-033285, and AG-041868), with support from the Vilas Estate Trust, the National Science Foundation, the Spencer Foundation, and the Graduate School of the University of Wisconsin-Madison. Since 1992, data have been collected by the University of Wisconsin Survey Center. The National Health and Aging Trends Study (NHATS) is sponsored by the National Institute on Aging (grant number U01AG032947) through a cooperative agreement with the Johns Hopkins Bloomberg School of Public Health. English Longitudinal Study of Ageing (ELSA): Funding for the English Longitudinal Study of Ageing is provided by the National Institute of Aging [grants 2RO1AG7644-01A1 and 2RO1AG017644] and a consortium of UK government departments coordinated by the Office for National Statistics. The content is solely the responsibility of the authors and does not represent the official views of the parent studies or funders. We gratefully acknowledge funding for SHARE (see http://www.share-project.org/organisation/funding.html) from the European Commission (https://ec.europa.eu/info/research-and-innovation_en?lg=en; Horizon 2020), the US National Institute on Aging (https://www.nia.nih.gov/), and national sources, especially the German Federal Ministry of Education and Research (https://www.bmbf.de/bmbf/en/home/home_node.html).

Author contributions

ARS designed the project, analyzed the data, interpreted the results, and drafted the manuscript. JB acquired and prepared the data for analysis. YS, ML, TK, AH, BC, SK and AT assisted in design, interpretation of the data, and contributed to substantively revising the manuscript. All authors reviewed the manuscript and approved it for submission.

Funding

Research reported in this publication was supported by the National Institute on Aging of the National Institutes of Health under Award Number R01AG074573. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health. The funder had no role in study design, analysis, interpretation, preparation of the manuscript for publication, or the decision to publish.

Data availability

Data are available from the parent studies: Health and Retirement Study: https://hrs.isr.umich.edu/about; Midlife in the United States: https://www.midus.wisc.edu; Wisconsin Longitudinal Study: https://wls.wisc.edu; National Health and Aging Trends Study: https://www.nhats.org/researcher/nhats; English Longitudinal Study of Ageing: https://www.elsa-project.ac.uk; Survey of Health, Ageing and Retirement in Europe: https://share-eric.eu.

Declarations

Ethics approval and consent to participate

This research used deidentified publicly available data, which is not defined as human subjects and thus does not require ethics approval or consent to participate because consent was obtained from the parent studies.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Author details

[1]Florida State University College of Medicine, 1115 W. Call Street, Tallahassee, FL 32306, USA
[2]Euromov, University of Montpellier, Montpellier, France
[3]Laurea University of Applied Sciences, Vantaa, Finland
[4]Department of Health Economics and Health Services Research, University Medical Center Hamburg-Eppendorf, Hamburg Center for Health Economics, Hamburg, Germany
[5]L-VIS, University of Lyon 1, Lyon, France
[6]Health Research and Innovation Department, Clariane, France

Received: 22 January 2025 / Accepted: 20 April 2025
Published online: 02 May 2025

References

1. Bowdish DME. The aging lung: is lung health good health for older adults? Chest. 2019;155(2):391–400. https://doi.org/10.1016/j.chest.2018.09.003.
2. Agusti A, Faner R. Lung function trajectories in health and disease. Lancet Respir Med. 2019;7(4):358–64. https://doi.org/10.1016/S2213-2600(18)30529-0.
3. Beller J, Safieddine B, Sperlich S, Tetzlaff J, Geyer S. Time trends in limited lung function among German middle-aged and older adults. Sci Rep. 2024;29(1):5036. https://doi.org/10.1038/s41598-024-55624-2.
4. Stephan Y, Sutin AR, Luchetti M, Aschwanden D, Caille P, Terracciano A. Personality associations with lung function and dyspnea: evidence from six studies. Respir Med. 2023;208:107127. https://doi.org/10.1016/j.rmed.2023.107127.
5. Ryff CD. Happiness is everything, or is it? Explorations on the meaning of psychological well-being. J Pers Soc Psychol. 1989;57:1069–81.
6. Musich S, Wang SS, Kraemer S, Hawkins K, Wicker E. Purpose in life and positive health outcomes among older adults. Popul Health Manag. 2018;21(2):139–47. https://doi.org/10.1089/pop.2017.0063.
7. Sutin AR, Luchetti M, Aschwanden D, Stephan Y, Sesker AA, Terracciano A. Sense of meaning and purpose in life and risk of incident dementia: new data and meta-analysis. Arch Gerontol Geriatr 23. 2023;105:104847. https://doi.org/10.1016/j.archger.2022.104847.
8. Cohen R, Bavishi C, Rozanski A. Purpose in life and its relationship to all-cause mortality and cardiovascular events: A meta-analysis. Psychosom Med. 2016;78(2):122–33. https://doi.org/10.1097/PSY.0000000000000274.
9. Weston SJ, Hill PL, Mroczek DK. Associations for sense of purpose with smoking and health outcomes among adults with diabetes. Int J Behav Med. 2024;31(4):538–48. https://doi.org/10.1007/s12529-023-10191-0.
10. Sutin AR, Stephan Y, Kekäläinen T, Luchetti M, Terracciano A. Purpose in life and accelerometer-measured physical activity among older adults. Psychol Health Apr. 2025;18(1):126–40. https://doi.org/10.1080/08870446.2023.2200414.
11. Sutin AR, Luchetti M, Stephan Y, Mansor N, Kekäläinen T, Terracciano A. Purpose in life and grip strength: an individual-participant meta-analysis of 115,972 participants from 24 countries across four continents. Geroscience. 2024. https://doi.org/10.1007/s11357-024-01335-5.
12. Sutin AR, Cajuste S, Stephan Y, Luchetti M, Kekäläinen T, Terracciano A. Purpose in life and slow walking speed: cross-sectional and longitudinal associations. Geroscience. 2024. https://doi.org/10.1007/s11357-024-01073-8.
13. Kim ES, Kawachi I, Chen Y, Kubzansky LD. Association between purpose in life and objective measures of physical function in older adults. JAMA Psychiatry. 2017;74(10):1039–45. https://doi.org/10.1001/jamapsychiatry.2017.2145.

14. Hansen MRH, Schmid JM. Screening for impaired pulmonary function using peak expiratory flow: performance of different interpretation strategies. Respir Med Res. 2023;83:101015. https://doi.org/10.1016/j.resmer.2023.101015.
15. Donahue PT, Xue QL, Carlson MC. Peak expiratory flow predicts incident dementia in a representative sample of U.S. Older adults: the National health and aging trends study (NHATS). J Gerontol Biol Sci Med Sci. 2023;78(8):1427–35. https://doi.org/10.1093/gerona/glac235.
16. Trevisan C, Rizzuto D, Ek S, et al. Peak expiratory flow and the risk of injurious falls in older adults: the role of physical and cognitive deficits. J Am Med Dir Assoc. 2020;21(9):1288–e12944. https://doi.org/10.1016/j.jamda.2019.11.013.
17. Eekhoff EMW, van Schoor NM, Biedermann JS, et al. Relative importance of four functional measures as predictors of 15-year mortality in the older Dutch population. BMC Geriatr. 2019;25(1):92. https://doi.org/10.1186/s12877-019-1092-4.
18. Hyde M, Wiggins RD, Higgs P, Blane DB. A measure of quality of life in early old age: the theory, development and properties of a needs satisfaction model (CASP-19). Aging Ment Health. 2003;7(3):186–94. https://doi.org/10.1080/1360786031000101157.
19. Nunn AJ, Gregg I. New regression equations for predicting peak expiratory flow in adults. BMJ. 1989;22(6680):1068–70. https://doi.org/10.1136/bmj.298.6680.1068.
20. Bergmans RS, Zivin K, Mezuk B. Depression, food insecurity and diabetic morbidity: evidence from the health and retirement study. J Psychosom Res. 2019;117:22–9. https://doi.org/10.1016/j.jpsychores.2018.12.007.
21. Kessler RC, Andrews G, Mroczek D, Ustun B, Wittchen H. The world health organization composite international diagnostic interview Short-Form (CIDI-SF). Int J Meth Psychiatric Res. 1998;7:171–85.
22. Kroenke K, Spitzer RL, Williams JB. The patient health Questionnaire-2: validity of a two-item depression screener. Med Care. 2003;41(11):1284–92. https://doi.org/10.1097/01.MLR.0000093487.78664.3C.
23. Prince MJ, Reischies F, Beekman AT, et al. Development of the EURO-D scale–a European, union initiative to compare symptoms of depression in 14 European centres. Br J Psychiatry. 1999;174:330–8. https://doi.org/10.1192/bjp.174.4.330.
24. Castro-Costa E, Dewey M, Stewart R, et al. Prevalence of depressive symptoms and syndromes in later life in ten European countries: the SHARE study. Br J Psychiatry. 2007;191:393–401. https://doi.org/10.1192/bjp.bp.107.036772.
25. Ma YH, Shen LX, Li YZ, et al. Lung function and risk of incident dementia: A prospective cohort study of 431,834 individuals. Brain Behav Immun. 2023;109:321–30. https://doi.org/10.1016/j.bbi.2023.02.009.
26. Mathis LM, Sun N, Ho SK, et al. Associations between peak expiratory flow and community mobility loss among older adults in the united States. J Am Geriatr Soc. 2025. https://doi.org/10.1111/jgs.19367.
27. McKnight PE, Kashdan TB. Purpose in life as a system that creates and sustains health and well-being: an integrative, testable theory. Rev Gen Psychol. 2009;13:242–51. https://doi.org/10.1037/a0017152.
28. Sutin AR, Luchetti M, Stephan Y, Terracciano A. Sense of purpose in life and motivation, barriers, and engagement in physical activity and sedentary behavior: test of a mediational model. J Health Psychol. 2022;27:2068–78. https://doi.org/10.1177/13591053211021661.
29. Kim ES, Shiba K, Boehm JK, Kubzansky LD. Sense of purpose in life and five health behaviors in older adults. Prev Med. 2020;139:106172. https://doi.org/10.1016/j.ypmed.2020.106172.
30. Boreham ID, Schutte NS. The relationship between purpose in life and depression and anxiety: A meta-analysis. J Clin Psychol. 2023. https://doi.org/10.1002/jclp.23576.
31. Sutin AR, Luchetti M, Aschwanden D, et al. Sense of purpose in life and concurrent loneliness and risk of incident loneliness: an individual-participant meta-analysis of 135,227 individuals from 36 samples. J Affect Disord. 2022;309:211–20. https://doi.org/10.1016/j.jad.2022.04.084.
32. Crittenden CN, Murphy MLM, Cohen S. Social integration and age-related decline in lung function. Health Psychol. 2018;37(5):472–80. https://doi.org/10.1037/hea0000592.
33. Sutin AR, Stephan Y, Luchetti M, Terracciano A. Purpose in life and markers of immunity and inflammation: testing pathways of episodic memory. J Psychosom Res. 2023;174:111487. https://doi.org/10.1016/j.jpsychores.2023.111487.
34. Nerpin E, Jacinto T, Fonseca JA, Alving K, Janson C, Malinovschi A. Systemic inflammatory markers in relation to lung function in NHANES. 2007–2010. Respir Med. 2018;142:94–100. https://doi.org/10.1016/j.rmed.2018.07.011.
35. Hill PL, Burrow AL, Strecher VJ. Sense of purpose in life predicts greater willingness for COVID-19 vaccination. Soc Sci Med. 2021;284:114193. https://doi.org/10.1016/j.socscimed.2021.114193.
36. Anglim J, Horwood S, Smillie LD, Marrero RJ, Wood JK. Predicting psychological and subjective well-being from personality: A meta-analysis. Psychol Bull. 2020;146(4):279–323. https://doi.org/10.1037/bul0000226.
37. Melén E, Faner R, Allinson JP, et al. Lung-function trajectories: relevance and implementation in clinical practice. Lancet. 2024;403(10435):1494–503. https://doi.org/10.1016/S0140-6736(24)00016-3.
38. Wood AM, Joseph S. The absence of positive psychological (eudemonic) well-being as a risk factor for depression: a ten year cohort study. J Affect Disord. 2010;122(3):213–7. https://doi.org/10.1016/j.jad.2009.06.032.
39. Hafez D, Heisler M, Choi H, Ankuda CK, Winkelman T, Kullgren JT. Association between purpose in life and glucose control among older adults. Ann Behav Med. 2018;52(4):309–18. https://doi.org/10.1093/abm/kax012.
40. Farkhooy A, Bodegård J, Erikssen JE, et al. Cross-sectional and longitudinal analyses of the association between lung function and exercise capacity in healthy Norwegian men. BMC Pulm Med. 2018;18(1):118. https://doi.org/10.1186/s12890-018-0655-z.
41. Manco N, Hamby S. A meta-analytic review of interventions that promote meaning in life. Am J Health Promot. 2021;35(6):866–73. https://doi.org/10.1177/0890117121995736.
42. Park CL, Pustejovsky JE, Trevino K, et al. Effects of psychosocial interventions on meaning and purpose in adults with cancer: A systematic review and meta-analysis. Cancer. 2019;125(14):2383–93. https://doi.org/10.1002/cncr.32078.
43. Menezes KK, Nascimento LR, Avelino PR, Alvarenga MTM, Teixeira-Salmela LF. Efficacy of interventions to improve respiratory function after stroke. Respir Care. 2018;63(7):920–33. https://doi.org/10.4187/respcare.06000.
44. Crimmins E, Guyer H, Langa K, Ofstedal M, Wallace R, Weir D. Documentation of physical measures, anthropometrics, and blood pressure in the Heath and retirement study. 2008.

Publisher's note