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RESEARCH ARTICLE

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Lung function measurements in the Greenlandic Inuit population: results from the Greenlandic health survey 2017–2019

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ABSTRACT

Background: Little is known about lung function in Inuit. The aim of this study was to describe lung function and the prevalence of obstructive and restrictive lung disease among Inuit in Greenland

Methods: During the 2017–2019 Health Survey, spirometry, with forced expiratory volume in the first second (FEV_1), forced vital capacity (FVC), and FEV_1/FVC ratio in liters (L), and percent of predicted value (pred%) were recorded according to Global Lung function Initiative standard reference values (GLI). Smoking history was obtained. Obstructive spirometry was defined as FEV_1 /FVC <70%. Restrictive spirometry was proposed by FVC < 80% and FEV1/FVC >90%.

Results: Based on validated spirometries, 795/2084 persons were included in this cross-sectional, descriptive study. Of those, 54.6% were current- and 27.7% former smokers. In Inuit, normal lung function was higher than predicted GLI (FEV_1 107.2 pred%/FVC 113.5 pred%). In total, 106 (13.3%) were found to have an obstructive lung function measurement and 11 (1.4%) had a restrictive pattern. Among current smokers, the prevalence of obstructive lung function was 16.4%. An accelerated decline in lung function was observed > 50 years old (y.o), compared to <50 y.o.

Conclusion: This study indicates that Inuit has higher absolute lung function values than standard GLI, despite the large proportion of smokers, which indicate a need for Inuit reference values in the daily clinical praxis. The high prevalence of obstructive lung function and rapid decline in lung function indicates the need for fucus on health issues that may affect lung health in Greenland.

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KEYWORDS
Inuit; lung function; smoking history; obstructive; FEV1/FVC

Introduction

Spirometry is the most frequently used lung function test, used to diagnose chronic obstructive respiratory diseases, such as asthma and chronic obstructive pulmonary disease (COPD), and to monitor respiratory diseases in general [1]. The spirometry reference values for forced expiratory volume in the first second (FEV_1) and the forced vital capacity (FVC) vary with age, height, sex, and ethnicity.

In recent years, reference values have been developed for multiple ethnicities [2].

Previous surveys from Canadian Inuit in 1970–1971 indicated that FEV_1 and FVC of Inuit were higher than predicted compared to Canadians of European descent, relative to age, gender, and height [3]. In addition, a study of lung function in Greenlandic and Danish children and adolescents showed that Inuit children taller than 130 cm had up to 300–400 ml higher FEV_1 and FVC compared to Danes of the same height [4]. High trunk size and environmental factors including food intake and high level of habitual physical activity have been hypothesized to influence the higher FEV_1 and FVC [3–6]. Although it is well known that lung function decreases with age, a follow-up study from Canadian Inuit showed an accelerated loss of lung function from the age of 45, where FVC decreased with 70 ml/year in men and 38 ml/year in women [3].

Obstructive lung disease is described by airflow obstruction defined as FEV_1/FVC ratio <0.70 [7,8]. In asthma, the airflow obstruction is reversible, while in COPD it is fixed [9]. Restrictive lung disease cannot be diagnosed, but suspected, from spirometry values, in patients with low FVC and increased FEV1/FVC [10]

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and may warrant further investigation of possible restrictive lung disease [11].

Smoking is a well-known risk factor for developing COPD and, to a lesser extent, restrictive lung diseases [12]. Previous population surveys from Greenland have shown a high prevalence of smokers. In 2018 52% of the Greenlandic population >15 years of age were current smokers, with 11% of men and 3.8% of women being heavy smokers (15+ cigarettes per day), and, in addition, 24% were former smokers (tobacco abstinent for ≥6 months) [13–16]. Yet, former studies have indicated that despite a high number of smokers among the Inuit in Greenland, only very few Inuit develop COPD [17]. It has been suggested that diet and environmental conditions protect against the loss of lung function [17].

Indigenous people from Canada have similar risk factors for lung impairment as Inuit from Greenland (high incidence of lower respiratory tract infections, tuberculosis, and bronchitis), and their estimated incidence of interstitial lung diseases (ILD) was found to be 2.3-fold higher incidence than Canadians of European descents [4,18]. No data exist on the incidence or prevalence of restrictive lung diseases in Greenland.

There are no previous studies that have systematically described the lung function of adult Inuit in Greenland, which account for about 50.000 of Greenland's 56.000 inhabitants [19]. Nor are there any systematic reports of the prevalence of obstructive- nor restrictive lung diseases in the Inuit population in Greenland, despite the high prevalence of smokers in Greenland.

Therefore, the primary aim of this study was to describe lung function, in terms of FEV_1, FVC, in liters, percent of predicted value (pred%) and *z*-scores, as well as FEV_1/FVC-ratio among Inuit from Greenland. Furthermore, the secondary aim was to describe the prevalence of obstructive lung disease and potential restrictive lung diseases. Lastly, the third aim was to examine the prevalence of smokers, among people with obstructive spirometry.

Methods

Health surveys and data collection

Spirometries were obtained during a countrywide cross-sectional study in Greenland in 2018 [20]. A team of trained personnel recruited participants and performed the tests on site in Nuuk and the remote rural areas. Patient interviews were conducted in Greenlandic (98%) or Danish.

Data on patient sex, age, and smoking status including pack-years [21] were collected through interviews. Age groups for men and women were formed for every decade. From the clinical examination height (meters), weight (kilograms), and lung function status were included in this analysis. The data collection is described in detail elsewhere [17].

Spirometry was performed as a field test, using an EasyOne Air-Spirometer (NDD, medical technologies, Zürich, Switzerland). Data on FEV_1 and FVC in liters (L) and percentage of expected value (pred%) were recorded, using Global Lung Function Initiative Standard reference values (GLI) for Caucasians [22], and FEV_1/FVC ratio was calculated, based on the GLI predictive model equation:

$$Y = a + b \cdot H + c \cdot A + \text{spline} + d_1 \cdot \text{group}$$

where Y is the dependent variable; H standing height in cm; A is age and a-d ethnicity-specific coefficients, relating to height and age, and group an ethnicity variable, with Caucasian as reference, hence 1 [2].

The *z*-scores were calculated using the GLI Lung Function Calculator (ersnet.org).

The highest FEV_1 and FVC were used in the analysis. Obstructive spirometry was defined as FEV_1/FVC ratio <70% according to the ATS/ERS guidelines [23].

Restrictive spirometry was suspected by restrictive patterns with decreased FVC below 80 pred% and FEV1/FVC >90% [11]. Results were divided into overall, normal, obstructive, and restrictive spirometry subgroups. A manual validation for inclusion of spirometries in the final analysis was performed by two independent evaluators. Inclusion criteria were immediate forced expiration after the maximum inhalation; no cough detected within the first second; forced expiration continued for 6 sec or till the expired volume stabilized. Repeatability should be met: The differences in FVC-and FEV_1 <150 ml between the best two curves. Spirometries were also excluded if the Valsalva maneuver was used during the procedure or air waste at the mouthpiece was detected. In case the two independent evaluators did not agree about the validity of the spirometry, the individual cases were discussed, and consent was reached.

Smoking data were collected through questionnaires

Current smokers were defined as smoking at least one cigarette per day. Current smokers were divided in current smokers smoking up to 14 cigarettes per day (Smokers14) and heavy smokers were defined as 15+

cigarettes per day. Other smokers were defined as social smokers, former smokers (tobacco abstinence >6 months), and never smokers (defined as never smokers) [24].

Waste analysis

Waste-analysis of discarded spirometries was carried out, comparing sex-distribution, age, BMI, smoking status (never smokers; former smokers and current smokers), and number of pack-years of the patients whose spirometries were included, and those who were excluded from the final study population.

Statistical analyses

Data were analyzed by using Statistical Package for the Social Sciences (SPSS) (version 27; IBM SPSS inc., Chicago, IL, USA).

The baseline characteristics and lung function measures of the total study population and all subpopulations and were presented in %, for categorical variables, (sex, smoker/non-smoker), non-normally distributed data with medians (interquartile ranges (IQR) (age) and normally distributed with means (Standard deviations (SD)), (The remaining baseline characteristics and lung function measures) Bayesian statistics were used to evaluate distribution prior to measurements of continuous variables.

Comparative analyses of the baseline characteristics were carried out with chi-square test for categorical data, Mann–Whitney for non-normally distributed and two-tailed *t*-test for normally distributed data. Anticipating a bilinear correlation between age and FEV_1 in liters, a local polynomial regression analysis was carried out to minimize the risk of statistical interference [25,26].

Linear regression models were used to investigate the correlation between height and FEV1 as well as weight and FEV1 in men and women, respectively.

The prevalence of obstructive and restrictive lung function was calculated. In addition, the prevalence of people with a smoking history in those with obstructive lung function was calculated.

Waste analysis was carried out with a description of categorical and mean (SD) values, respectively, and comparative analyses were carried out with chi-square tests, two-tailed *t*-tests on FEV1%, FVC% and FEV1/FVC, as well as FEV1,- FVC,- and FEV1/FVC *z*-scores were carried out on excluded spirometries versus included spirometries,

Sensitivity analysis was carried out on FEV1%, FVC % and FEV1/FVC, as well as FEV1,- FVC,- and FEV1/FVC *z*-scores from excluded spirometries except those with poor technique, compared to included spirometries.

Bonferroni's test was carried out, with an alpha value of 0.05. The number of included variables included in this study is 15, which leads to a corrected p-value (0.05/15) of 0.003.

Results

In this cross-sectional, descriptive study a total of 2084 spirometries were collected from the Greenlandic population from August 2017-January 2019. Of those, 795 were included after validation. Figure 1 demonstrates the causes of exclusion.

Table 1 shows baseline characteristics and lung function levels in the cohort and subpopulations. Sex was equally distributed in the total and normal subpopulation. Age ranged from 15 to 84 years old (y.o.) in the cohort.

Lung function

As shown in Table 1, in the cohort the mean (SD) FEV_1 was 3.12 L/104.50 pred% (0.86/17.20). The mean FVC from the cohort was 4.04 L/113.09 pred% (1.07/17.25).

In patients with normal lung function, according to GLI, all *z*-scores were positive. FEV1/FVC is presented in Appendix 2.

Figure 2 shows in cohort that males have higher FEV_1 compared to females. A lung function decline was seen every decade. A marked increase in reduction of FEV_1 in liters was seen after the age of 50 y.o. in both sexes, wherein males have higher tendency to loss of FEV_1 in liters after the age around 70 y.o. Detailed description of lung function in relation to age and sex is included in Appendix 1.

Figure 3 shows the linear correlation between FEV1 and height in women (A) and men (B). The figure demonstrates a rather substantial proportion of Inuit are of limited height, and that there may be a slight tendency for FEV1 to be high, in relation to height in people of lower height.

Obstructive spirometry

The prevalence of obstructive lung in this cohort was 13.3% (106/795). Men with obstructive lung function had more, but not significantly more, pack-years than women ($p = 0.02$). The prevalence of obstructive lung function in people with a smoking history was 13.8% (90/651).

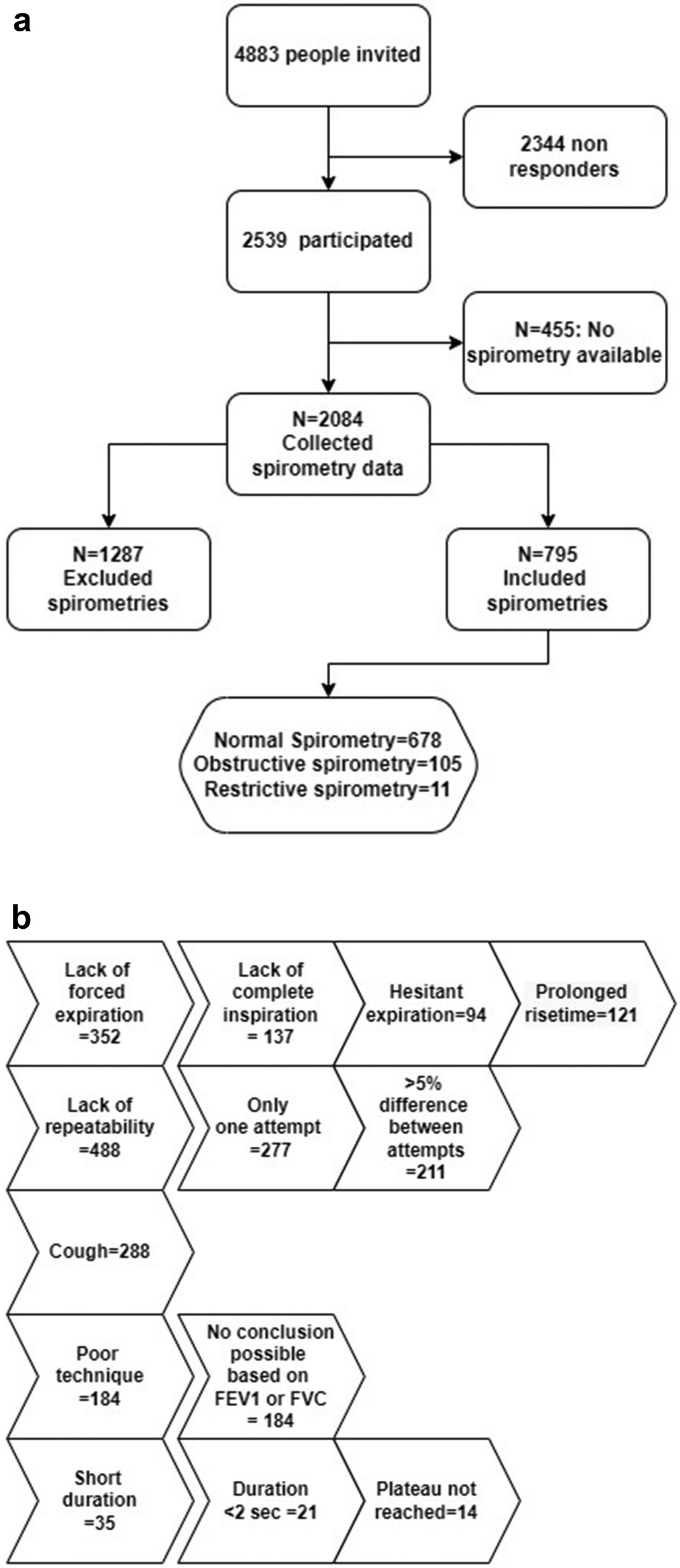

Figure 1. Data collection process (a) and a detailed description of reasons for excluding data (b).

Table 1. Baseline data and results of lung function.

Baseline characteristics	(*N* = 795)	Normal subpopulation (*N* = 678)	Obstructive subpopulation (*N* =106)	*p*-Value	Restrictive subpopulation (*N* = 11)	*p*-Value
Female, %	418(52.6)	370(46.5)	41(38.7)	0.002	7(63.6)	0.549
Male, %	377(47.4)	308(38.7)	65(61.3)		4(36.4)	
Age, years, median, (IQR)	47(35–56) [15–84]	44(33–56) [15–84]	58 [27-]56) [19–84]	0.0001	61 [28-]70) [25–80]	0.046
Height, m	1.64(0.1) [1.46–1.98]	1.65(0.1) [1.46–1.98]	1.63(0.1) [1.46–1.97]	0.2	1.58(0.1) [1.51–1.68]	0.2
Weight, kg	(*N*=782) 74.1(16.7) [34.2–166.2]	(*N*=666) 75.1(16.7) [34.2–166.2]	(*N*=103) 68.7(16.9) [43–107.6]	0.2	(*N*=10) 62.0(14.4) [42.3–78.5]	0.2
BMI, kg/m^2				0.536		
BMI distribution	27.5(4.1)	27.6(5.7)	26.0(4.9)		24.8(5.1)	
<25	36.8	34.4	53.4		40.0	
25–29	34.6	35.9	25.2		50.0	
>30	27.4	28.4	21.4		10.0	
						0.922
Smoking status	(*N* = 790)	(*N* = 674)	(*N* = 103)		(*N* = 10)	0.046
Neversmokers	17.6	18.7	12.6	0.912	70.0	
Former smokers	27.7	28.4	18.4	0.051	30.0	
Smokers14	47.4	46.2	58.3	0.037		
Heavy smokers	7.1	6.4	10.7	0.090		
Other smokers[a]	0.1	0.1				
Pack-year[b]	12.5(11.1)	6.5(3.4)	19.4(15.4)	0.001	7.1(2.1)	0.110
Male	14.4(12.1)	7.2(4.2)	2.0(17.5)		9.8(4.1)	
Female	10.2(9.1)	5.3(3.8)	16.0(11.3)		5.4(3.9)	
FEV_1 L	3.1(0.7) [0.9–5.6]	3.2(0.8) [1.1–5.5]	2.5(0.9) [0.9–5.6]	0.088	1.7(0.5) [0.9–2.7]	0.037
FVC L	4.0(1.1) [1.2–8.2]	4.1(1.0) [1.3–7.2]	3.8(1.3) [1.7–8.2]	0.067	2.2(0.5) [1.2–3.0]	0.010
FEV_1 (Pred %)[c]	104.5(17.2) [47.5–166.3]	107.3(14.9) [68.0–166.3]	90.5(19.9) [47.5–157.6]	0.399	69.1(9.2) [53.5–88.4]	0.183
FVC (Pred %)[c]	113.1(17.2) [55.1–190.2]	113.5(15.6) [66.5–175.4]	114.5(22.3) [55.1–190.2)	0.355	74.1(13.3) [55.4–107.8]	0.157
FEV_1/FVC, Ratio	77(7.1) [42.8–100.0]	80(4.7) [67.9–100.0]	64(5.8) [42.8–69.9]	0.016	78(8.8) [65.8–77.5]	0.524
FEV_1 *z*-score	0.3(1.0) [−3.4–3.5]	0.4(0.9) [−2.1–3.5]	−0.6(1.1) [−2.4–2.2]	0.266	−1.7(0.5) [−2.2-(−0.5)]	0.124
FVC *z*-score	0.8(1.1) [−2.8–4.9]	0.9(1.0) [−1.9–4.9]	0.9(1.3) [−2.8–4.5]	0.213	−1.6(0.8) [−2.6–0.4]	0.103
FEV1/FVC *z*-score	0.75(0.9) [−3.9–4.9]	0.82(1.4) [−3.9–4.9]	−0.28(3.9) [−3.3–4.6]	0.009	0.88(0.89) [−1.37–1.56]	0.409

IQR = interquartile ranges, [a]Smokers of other substances than tobacco; [b]Pack-years: 20 cigarettes/day in a year; [c]Pred % = present of predicted value acc to Global Lung Function Initiative Standard reference values.

Categorical variables are presented in percent (%), median (IQR) or continuous variables in mean (SD) where nothing else stated. And [ranges], in inuit from Greenland 2018. When *N* differs from the cohort it is stated in the table. Obstructive and restrictive subgroups are compared to the normal subpopulation. *P*-values in comparison with the normal subpopulation.

Table 2 shows sex, age, and BMI, the latter two stratified for sex. In total, 13.3% (106/795) had obstructive spirometries. There were significantly more males than females with obstructive lung function. There were more, but not significantly more, males who were heavy smokers ($p = 0.035$).

In the obstructive subpopulation, the mean FEV_1 /FVC ratio was 64.0% (5.80). Female heavy smokers had higher, but not significantly higher fixed ratio levels than never smokers (FEV_1/FVC ratio 69.5% (0.45) vs 62.8% (8.37) respectively, $p = 0.07$). Male never smokers had the highest fixed ratio levels, and former smokers have the lowest however, not differences were not significantly different, (FEV_1/FVC ratio 66.6% (2.39) vs. 61.6% (5.94) respectively, $p = 0.07$). Details on lung function in relation to obstructive subpopulation and smoking status are described in Appendix 2.

Restrictive spirometry

The prevalence of restrictive lung function in Greenland was 1.4% (11/795). As shown in Table 1, there was an overrepresentation of women 63.6% with restrictive lung function (7/11).

In total, 50.0% (5/10) of the restrictive population had a normal BMI of 25–29. Altogether, 63.3% (7/11) had a smoking history.

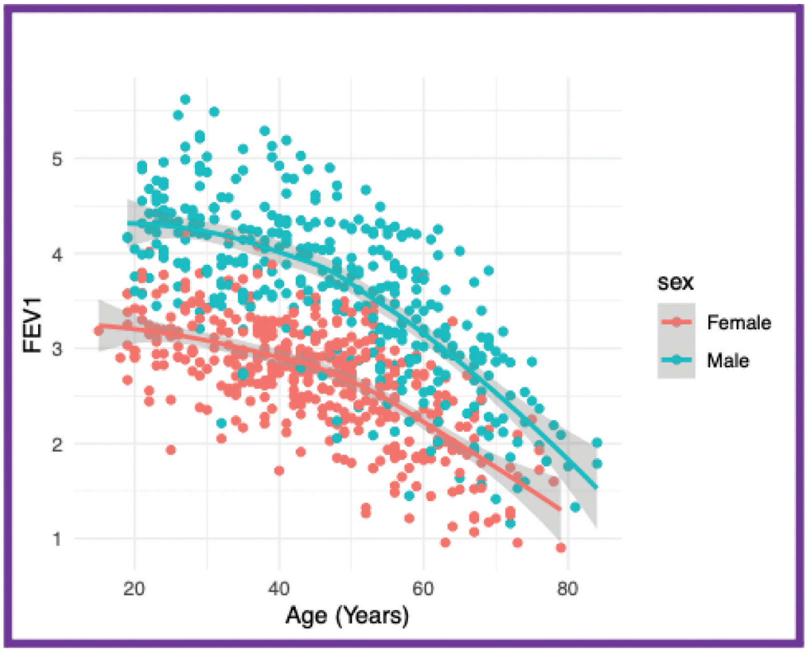

Figure 2. Local polynomial regression analysis of FEV_1 in liters and age (shaded areas 95% confidence intervals).

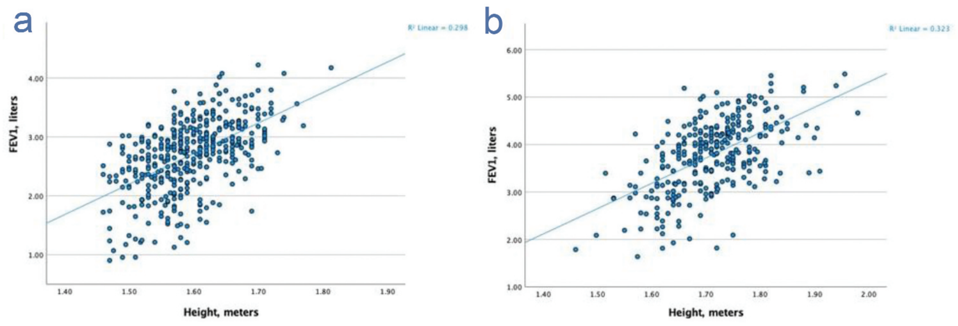

Figure 3. The linear correlation between FEV1 (liters) and height (meters) in inuit women (a) and men (b).

Table 2. Demographic data of inuit from Greenland (2018) with obstructive spirometry.

Obstructive subpopulation (*N* = 106)	Never smokers (*N* = 13)	Former smokers (*N* = 19)		Smokers14 (*N* = 60)		Heavy smokers (*N* = 11)	
			p-Values		*p*-Values		*p*-Values
Sex, %							
Male	61.5	52.6	0.618	60.0	0.918	81.8	0.386
Age, median, IQR	64 (48.0–75.5)	62 (58–73)	0.893	56.5(47–66.5)	0.130	51 [29-]57)	0.077
Male	61 (41.0–73.2)	64(61–74.5)	0.327	54(45.3–65.5)	0.563	51(42–62.5)	0.440
Female	69 (56.5–76)	59(48–63.5)	0.124	58(49.3–66.2)	0.083	51.5[49–54]*	0.118
BMI, kg/m^2 Mean (SD)	24.1(4.2)	29.6(4.4)	0.008	24.2(4.5)	0.022	26.3(6.8)	0.544
Male	23.7(6.1)	30.5(4.9)	0.581	24.5(5.1)	0.018	26.7(5.9)	0.369
Female	24.6(5.9)	28.7(5.3)	0.0001	24.1(4.7)	0.484	25.4(7.1)	0.670

IQR = Interquartile range, *[range]; *N* = 2.
Categorical variables are presented in percent (%), continuous variables in mean (SD) or median (IQR). When *N* differs from the cohort it is stated in the table. *p*-Values in comparison to never smokers.

Waste analysis

Waste-analysis showed that patients included and excluded were comparable, in terms of sex (52.6 vs 53.0% females ($p = 0.8$)), age (46.0 vs 48.0 ($p = 0.09$)) and BMI (26.5 vs 27.2 ($p = 0.12$)), never smokers (17.6 vs 15.1%. ($p = 0.1$)), former smokers (27.7 vs 26.9% ($p = 0.4$)), present smokers (54.6 vs 58.0% ($p = 0.09$)), and pack-years (12.5 vs 14.1 ($p = 0.12$)).

Table 3. Sensitivity analysis, comparing FEV1%, FVC%, FEV1/FVC, FEV1 *z*-ratio, FVC *z*-ratio and FEV1/FVC *z*-ratios of the excluded spirometries,[a] with the results of the included spirometries.

	Lack of forced expiration (*N* = 352)	Lack of repeatability (*N* = 488)	Cough (*N* = 288)	Short duration (*n* = 35)
FEV1 pred %	0.61	0.78	0.54	0.75
FVC pred%	0.59	0.61	0.61	0.37
FEV1/FVC	0.62	0.69	0.55	0.42
FEV1 *z*-score	0.69	0.79	0.55	0.79
FVC *z*-score	0.62	0.67	0.69	0.40
FEV1/FVC *z*-score	0.69	0.74	0.57	0.48

FEV1 = forced expiratory volume in the first second; FVC = forced vital capacity; Pred % = in percent of predicted value. [a]Excluded spirometries were spirometries with lack of forced expiration, lack of repeatability, cough, and duration of expiration.
Results are expressed in decimals with 1.0 expressing optimal agreement.

Table 3 shows the sensitivity analyses of the excluded spirometries, divided by category of exclusion, compared to the included measures. In general, sensitivity was slightly higher on *z*-scores than values in percent of predicted.

Discussion

This study shows that in the Inuit population without obstructive and restrictive lung function patterns, the average lung function was higher than GLI Caucasian reference values. However, importantly, the prevalence of obstructive lung function was high in the Inuit population. Furthermore, an accelerated decline in lung function was seen after the age of 50 y.o, compared to that of younger age.

In this study, we found that the Inuit population had an average lung function above 100%. This is in concordance with previous findings. A study on lung function of Canadian Inuit by Rode et al. found that both FEV_1 and FVC were higher than predicted from age and height using the formula of Cotes and Anderson [3,30,31]. In participants with no prior lung diseases, male FVC was 109–113 pred% and female 119–122 pred%, whereas FEV_1 was 101 pred% in males and 115 pred% in females [6]. Krause et al. compared FEV_1 and FVC between Greenlandic Inuit and Danish children and adolescents at the age of 6–18 years. They found that Greenlandic Inuit, who were less than 130 cm tall, had the same or lower FEV_1 than Danish children, while Inuit, who were taller than 130 cm, had FEV_1 and FVC 300–400 ml higher [4]. Laustsen et al. examined lung function values according to standard GLI guidelines in Inuit seafood workers and found FVC and FEV_1 in liters and *z*-scores to be significantly higher than predicted, in contrast to other participants [32]. The *z*-scores in our study were in general above 0, which also support the theory of a higher lung function. Interestingly, in a study by Laustsen et al., when using sitting height ratio for Inuit, FVC and FEV_1 were no longer significantly different from GLI [32]. This indicates that physiognomy in Inuit is an important factor for lung function reference. Taken together, both the above mentioned and our results underline the importance of validated ethnic reference values for the correct interpretation of spirometric results, in order to obtain correct diagnosis and to evaluate the severity of lung diseases. An adult Greenlandic Inuit reference for lung function is therefore needed.

In this study, we found that lung function declined rapidly after the age of 50 for both men and women. A review by Thomas et al. on longitudinal lung function decline in adults above the age of 65 y.o. found a mean FEV_1 decline of 22 ml/year, and that men had more rapid decline than women [28]. Barroso et al. made a systematic review of lung function decline and found that FEV_1 decline gradually increases to 35 ml/year after the age of 65, due to decreased compliance of chest wall, loss of expiratory muscle strength, and the growing of smaller airways [5]. Yet, we found FEV_1 declines of more than 60 mL/year above the age of 50 y.o. which leads to speculation that decline in lung function may differ in different ethnicities of all ages. There may be several explanations to this. The main cause of lung function decline in previously healthy people is smoking, shown by several authors [33–37]. In this study, almost half of the population were current smokers, whereas Thomas et al. excluded smokers in their study. Another predictor for lung function decline is high BMI [38], and in this study more than one-fourth of the Inuit population had a BMI >30 kg/m^2. According to Triebna et al., greater reductions in FEV1 were seen in obese individuals compared to individuals with normal BMI [39]. In addition, the body composition of Inuit has previously been proven different to Caucasian, and Inuit are as such of limited height [29]. There is a slight tendency towards a skewed correlation between FEV1 and height in this material. It has previously been suggested that sitting height is better correlated to lung function than standing height [5] This could be relevant for a future Inuit reference material. Lastly, an Inuit population with a mean age around 60 will have experienced a lot of childhood infections, and nutrition and their childhood living conditions very different to present time, which has been shown to affect lung function in adulthood [17,40]. The findings may therefore not be a sign of accelerated loss of lung function, but of population, that had low lung function when entering adulthood. Longitudinal studies of the younger Inuit population are needed to test this hypothesis. It is important to underline that two of three possible explanation of an accelerated loss of lung function in this Inuit population are treatable traits. This should be taken into account in future health care planning, although a clear association cannot be established from the data available in this study.

More than 13% of the study population had obstructive lung function measurements. This is considerably higher than in a Danish population [41], however, consistent with findings among Canadian Inuit [3]. In a study by Ospina et al., the prevalence and incidence of COPD among Indigenous and non-indigenous people in Canada found that Inuit had twofold higher prevalence and incidence of COPD compared to non-indigenous counterparts in Canada [27]. Olsen et al. investigated redeemed medication among adults above the age of 50 in Greenland and found that 6% used medication for obstructive lung disease, more than one-third of those had an actual diagnosis of COPD [42]. This indicates the possibility of a large number of undiagnosed or untreated patients with obstructive lung disease in Greenland.

From lung function measures alone, we do not know precisely which diagnosis the patients have. Given that more than 80% of the population with obstructive lung function had a smoking history, it is pertinent to anticipate that COPD is highly prevalent among Greenlandic Inuit. However, the prevalence of COPD in the sub-population with a smoking history in this cohort is lower than what has been shown in previous studies, which have found the prevalence of COPD among patients with a smoking history to be 15–20% [43–45]. The average tobacco consumption in this study is lower than the 20 pack-years that is considered a risk factor for developing COPD [46]. Environmental factors may be an explanation of this finding, as it has been hypothesized that Inuit had lower risk of developing COPD due to a protective effect of artic traditional food [17]. This has been supported by Rode et al. who indicated a negative effect on lung function when living habits approach a Western lifestyle [47]. Furthermore, a smoking history does not rule out an asthma diagnosis. Laustsen et al. reported physician-diagnosed asthma in 9% of their Inuit cohort [32], which is higher than in the Danish population in general [48]. Lastly, obstructive lung function decline is also seen in patients with heart failure and overweight [49]. Although this study cannot establish causality, an obstructive lung function warrants disease, and is therefore an alarming signal for lung health in a population.

This study does have limitations. First, the number of lung functions which were excluded from the study due to quality of the measurement. However, the waste analysis did not show any significant differences in those included, and those excluded on parameters significant for interpretation on lung function. To support a waste analysis sensitivity analyses were carried out on the central lung function parameters on a subgroup level of the excluded spirometries. None of the included parameters showed acceptable sensitivity to consider inclusion in the dataset. It is therefore a major limitation to this dataset that almost two-thirds of the data material was excluded and only about one-third included in the analyses. This may leave residual bias, as those who found difficulties performing the spirometry may be those with poorer lung health. This also applies to the patients who were included in the overall survey, but where a spirometry was not carried out. A number of factors may have influenced outcome, e.g. language barriers, if instructions were given in Danish, and the routine in performing lung function testing by the instructor. As for study design, no re-training, nor evaluation of spirometries during study was performed, which should be considered in the design of future studies. Taken together, differences in descriptive analyses should be read with caution, due to multiple comparisons and the high number of excluded individuals, which is underlined by the correction of the significance level of 0.003. Nonetheless, this study is the largest study of lung function in a Greenlandic Inuit population to date and therefore a sound indicator of the present state of Greenlandic Inuit lung function.

Secondly, the study does not allow disease-specific interpretation. However, the material is solid for generating hypotheses for future studies on more detailed knowledge on chronic lung disease in the Inuit population.

Lastly, the mean age is high in this population, which may influence outcome. The cohort contains a relatively low number of younger individuals. We have therefore kept data descriptive, in order not to present skewed results. In future, we need studies on Inuit lung function with a broader age range.

In conclusion, this study indicates that Inuit lung function in absolute measures is higher than in standard GLI references, despite a large proportion of citizens with a smoking history. This calls for a Greenlandic Inuit normal material. The study also shows a high prevalence of obstructive lung function reduction, a rapid decline in lung function in people above the age of 50 y.o. and a high prevalence of active- and heavy smokers. It therefore also warrants a focus on lung health in the Inuit population.

Disclosure statement

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Ethics

The main study was approved by the ethical review committee for Greenland (KVUG 2017–05). Participants were informed about the study objectives and procedures verbally and in writing and signed a written consent form including consent to pass results on to the local health center.

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