care delivered. Our study does have limitations because our findings arise from a single center. Also, we did not evaluate the equivalent ICD-10 code (Z66 "Do-not-resuscitate") that is now largely used, though prior studies have demonstrated a similar performance between equivalent ICD-9 and ICD-10 codes (11–13). Given the observed performance characteristics, we recommend that the V49.86 code be used for studies designed to capture the general epidemiology of patients with DNR status (e.g., evaluating secular trends and variation in DNR orders). However, given that administrative data cannot reliably determine timing of DNR status within a hospitalization, this code should not be used for risk adjustment within a hospitalization, though prior DNR may be used for risk adjustment in longitudinal studies.

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Interpretation of Spirometry in Saskatchewan First Nations Adults

To the Editor:

The Canadian First Nations and Inuit communities bear a large burden of respiratory disease, with increased rates of smoking, respiratory infections, asthma, chronic obstructive lung disease, and hospitalizations (1). Identification of respiratory disease and classification has relied on spirometric reference values from white individuals, or in the case of the Global Lung Initiative (GLI) dataset, "other" (2), because there are no published reference values for Canadian First Nations individuals. Several studies have suggested that spirometric values for Canadian Inuit populations may be different from those for white populations (3–7), but these observations are not consistent (7–10). This study investigated whether lung function measured in Plains Cree adults differed from that expected in white adults. Part of the data reported in this letter was presented at the 2014 American Thoracic Society International Conference in abstract form (11).

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Methods

We conducted a voluntary survey of Saskatchewan Plains Cree adults aged 18 years and older. Exclusion criteria were physician diagnosis of lung disease, current respiratory infection, dialysis, congestive heart failure, and inability to perform spirometry. Those reporting respiratory diseases were included if there was no spirometric evidence of obstruction or restriction and no current symptoms.

Spirometry was performed using an Easy on-PC spirometer (ndd Medical Technologies, Inc.) following American Thoracic Society/European Respiratory Society guidelines (12). Forced expiratory volume in 1 second (FEV_1), forced vital capacity (FVC), and flow–volume graphs were reviewed and graded separately (13) by two readers (M.E.F. and B.L.G.) to exclude unusable results. *z*-Scores were calculated using the 2012 GLI spirometric reference equations for white individuals (2).

Statistical analysis. Descriptive statistics were used to compare GLI *z*-scores with the expected distribution (mean, 0; standard deviation [SD], 1). The relationship of *z*-scores for each spirometry outcome to age and body mass index (BMI) was assessed using a simple linear regression. Two subgroup analyses were conducted.

Ethics approval process. A research agreement was developed with Battle River Treaty 6 Health Centre using accepted principles (14) and signed after approval by the Battlefords Tribal Council, leadership representing Poundmaker Cree Nation, Little Pine First Nation, Red Pheasant First Nation, Mosquito Grizzly Bear's Head First Nation, Sweetgrass First Nation, Mossomin First Nation, and Lucky Man First Nation.

Results

Demographics. A total of 412 participants (266 female) were enrolled, representing approximately 13% of adults. Spirometry was performed in 392 (95%) participants, 324 (82.6%) of whom had usable FEV_1 and FVC data and met inclusion criteria. Of these, 88% were current or former smokers, and 81% were overweight (BMI, >25 kg/m^2).

Mean *z*-scores for FEV_1, FVC, and FEV_1/FVC were all within the 0.5 *z*-score limits for white individuals, indicating good overall fit (15) (Table 1), with 5.6%, 4.6%, and 4.0% of observations below the lower limit of normal for FEV_1, FVC, and FEV_1/FVC, respectively (Figure 1). *z*-Scores significantly decreased with increasing age for $zFEV_1$ (fitted line slope, −0.02; 95% confidence interval, −0.02, −0.01) and *z*FVC (−0.02; −0.03, −0.01), whereas they increased with increasing age for $zFEV_1$/FVC (0.004; −0.001, 0.01). *z*-Scores significantly decreased with increasing BMI for $zFEV_1$ (−0.03; −0.04, 0.01) and *z*FVC (−0.04; −0.05, −0.02), whereas they increased with increasing BMI for $zFEV_1$/FVC (0.02; 0.006, 0.03).

Subgroup analyses. In a subgroup of nonsmokers without a history of respiratory disease ($n = 38$), the average *z*-scores were lower for our First Nations population than for white individuals (mean [SD] values of $zFEV_1$, −0.35 [1.3]; *z*FVC, −0.25 [1.1]; $zFEV_1$/FVC, −0.28 [0.9]). Sixty-one percent had a BMI greater than or equal to 30 kg/m^2. In a second subgroup analysis, adults younger than 55 years of age with a BMI greater than 18 kg/m^2 and less than 30 kg/m^2 ($n = 138$) had $zFEV_1$ and *z*FVC values above zero (0.21 [1.0] and 0.32 [0.9], respectively) and FEV_1/FVC values below zero (−0.24 [0.8]). Furthermore, *z*-sores for FVC and FEV_1 in this subgroup were independent of age and BMI.

Table 1. Summary of the study participants with acceptable spirometry results who met inclusion criteria

	n	All	Female	Male
Sex	324		63%	37%
Age, yr	324	41.1 ± 14.7	41.7 ± 13.4	40.2 ± 16.8
Height, cm	324	169 ± 8.9	164 ± 6.3	177 ± 6.3
Weight, kg	324	87.8 ± 20.6	84.6 ± 18.8	93.2 ± 22.5
BMI, kg/m^2	324	30.7 ± 7.1	31.3 ± 7.2	29.6 ± 6.7
<25		19%	17%	22%
⩾25 to <30		30%	26%	38%
⩾30 to <35		27%	30%	20%
⩾35		25%	27%	21%
Questionnaire				
Smoking	313	87.9%	87.8%	88.0%
Disease*	322	29.5%	27.7%	32.5%
mMRC ⩾3	319	17.6%	19.5%	14.3%
Spirometry				
$zFEV_1$	324	−0.06 (1.1)	−0.02 (1.0)	−0.13 (1.2)
*z*FVC	324	0.00 (1.0)	0.03 (0.9)	−0.03 (1.1)
$zFEV_1$/FVC	324	−0.18 (0.8)	−0.15 (0.7)	−0.23 (0.9)

Definition of abbreviations: BMI = body mass index; mMRC = modified Medical Research Council dyspnea scale; $zFEV_1$ = *z*-score for forced expiratory volume in 1 second; $zFEV_1$/FVC = *z*-score for ratio of forced expiratory volume in 1 second to forced vital capacity; *z*FVC = *z*-score for forced vital capacity.
Note: Not all questionnaire data were completed by all participants.
*Self-reported history of a respiratory disease.

Discussion

When using the GLI reference equations, the predicted values for white individuals are currently the most appropriate for our First Nations study population. Our results suggest that lung volumes may be underestimated in this population; however, the high rates of smoking and obesity in the general population make it challenging to identify a cohort of "healthy" individuals. The lower *z*-scores in asymptomatic nonsmokers are likely due to the "healthy smoker effect" because smoking is endemic (16). The next best approximation of a healthy population was

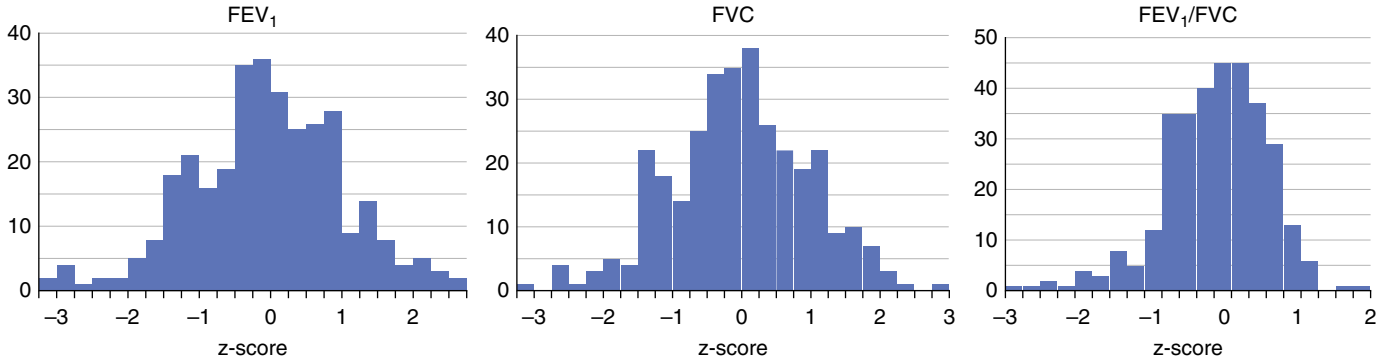

Figure 1. *z*-Score histograms for forced expiratory volume in 1 second (FEV_1; left panel), forced vital capacity (FVC; center panel), and FEV_1/FVC ratio (right panel) for all 334 participants who had usable FEV_1 and FVC data and met inclusion criteria. The mean (standard deviation) values were as follows: FEV_1, −0.06 (1.08); FVC, 0.00 (1.00); and FEV_1/FVC, −0.18 (0.78).

the second subgroup analysis of younger, nonobese adults, who showed a trend toward lung volumes larger than in white individuals, even though 90% were current or former smokers.

The observed results have clinical implications for the diagnosis of restrictive lung disease. The use of GLI predicted values for white individuals in First Nations populations may underestimate the early phases of lung volume decline in restrictive lung diseases, potentially delaying diagnosis/intervention. Resolving this question definitively remains a vital issue in the clinical assessment of First Nations patients to avoid misclassification of disease.

In addition, we observed a likely cohort effect and accelerated lung function decline with aging. A previous study observed similar associations in Inuit populations (17). We speculate that there is a "multiple-hit" causality whereby an integration of exposures and illness, such as environmental exposures (smoke, poor housing), high prevalence of smoking, and high rates of childhood and adult respiratory tract infections, may explain this accelerated loss. In particular, 5.3% of the population reported a history of tuberculosis, which has been associated with long-term lung function impairment (18) and has been proposed as a cause of age-related accelerated decline in lung function (17). Furthermore, other infections (e.g., childhood respiratory syncytial virus [19]) may also play a role.

Limitations. Recruitment for the present study was nonrandom, occurring during working hours, introducing potential selection bias. The demographic and sociodemographic characteristics of this population (88% current/former smokers, 52% obese, and 64% with a history of respiratory diseases or symptoms) make it challenging to select a representative sample of healthy individuals. Nonsmokers may not have normal lung function and may choose to avoid smoking for health reasons—the "healthy smoker effect" (16). Typically, random samples of healthy nonsmokers larger than 150 males and 150 females are required to validate reference equations for a population (15), which was not feasible in this study. Our results are applicable among Plains Cree First Nations populations and may have limited applicability to other Aboriginal groups (20).

Conclusions. Until more data are available, we recommend using the "Caucasian" ethnicity for GLI reference values, rather than "Other," for interpretation of spirometry in Plains Cree adults. This study suggests that lung volumes in First Nations people may be higher than in white individuals, and more studies are required to establish this difference and derive appropriate prediction equations if necessary.

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