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Cross Sectional Analysis of the Effect of Alcohol on Pulmonary Function in a Cohort of Men and Women Living with HIV

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Abstract

People living with HIV (PLWH) are living longer and are at increased risk for noncommunicable diseases such as lung disease in part due to opportunistic infections including pneumonia. HIV infection is associated with increased prevalence of impaired lung function and abnormal gas exchange. Alcohol use disorder (AUD) is exceedingly common in PLWH and is associated with even higher risk of pneumonia in PLWH. Alcohol use may lead lung damage through several mechanisms. Data on the long-term effect of AUD on pulmonary function in PLWH are sparse and conflicting. To evaluate this relationship, we conducted a cross-sectional analysis of adult PLWH in care in Louisiana. We hypothesized that chronic alcohol use would be associated with subsequent pulmonary dysfunction in a dose dependent fashion. All participants performed standardized spirometry on study entry. In total, 350 participants with acceptable spirometry were included in this analysis. Thirty-one percent of participants were female. Women reported less lifetime alcohol use and less smoking, however they reported more chronic respiratory symptoms. In adjusted models, total lifetime alcohol use was not associated with spirometry

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measures of pulmonary function. HIV related variables (CD4 cell count and viral load) were also not associated with measures of pulmonary function. We then conducted sex stratified analyses to eliminate residual confounding of sex and similarly found no association of total lifetime alcohol use and pulmonary function. We found no association of AUDIT score or early life alcohol use and pulmonary function. In latent class factor analysis, current heavy alcohol use was associated with lower measures of pulmonary function as compared to former heavy alcohol use. In summary, in this cohort of New Orleanian men and women living with HIV with robust measures of alcohol use, though total lifetime alcohol use and early life alcohol use were not associated with pulmonary function, current heavy alcohol use was associated with impaired pulmonary function.

Keywords

HIV; Alcohol; Pulmonary function; Spirometry

Introduction

As people living with HIV (PLWH) are living longer in the antiretroviral (ART) era, they are at increased risk for noncommunicable diseases (NCD) such as lung disease. NCDs occur more frequently and at younger ages in PLWH.(Crothers et al., 2011) PLWH are also at increased risk for opportunistic infections including pneumonia, which has been linked with subsequent lung disease.(Morris et al., 2000; Zifodya et al., 2021) HIV infection is also associated with increased prevalence of impaired pulmonary function including emphysema,(Attia et al., 2014) chronic obstructive pulmonary disease (COPD),(Bigna, Kenne, Asangbeh, & Sibetcheu, 2018) and abnormal gas exchange.(Kunisaki et al., 2020)

Alcohol use disorder (AUD) is exceedingly common in PLWH,(Bensley et al., 2019) with up to 27% of PLWH reporting current hazardous alcohol use.(Crane et al., 2017) AUD is associated with even higher risk of pneumonia in PLWH and also increased pneumonia severity.(Jolley, Alkhafaf, Hough, & Welsh, 2016) Alcohol use has been linked to increased risk for lung damage through several mechanisms including alterations in host defenses of upper and lower airways, disruption of alveolar epithelial barrier integrity, and alveolar macrophage immune dysfunction.(Mehta & Guidot, 2017) Much of the literature on alcohol use in both PLWH and HIV-negative individuals focuses on risk for subsequent pulmonary infections.(de Wit, Zilberberg, Boehmler, Bearman, & Edmond, 2011; Jolley et al., 2016; Simou, Britton, & Leonardi-Bee, 2018)

In spite of both HIV and AUD being linked with impaired pulmonary function, data on the effect of AUD on long term pulmonary function in PLWH, as measured by pulmonary function tests, are sparse and conflicting.(Frantz, Wollmer, Dencker, Engström, & Nihlén, 2014; Siu, Udaltsova, Iribarren, & Klatsky, 2010; Tabak et al., 2001; Vasquez et al., 2018) We hypothesized that chronic alcohol use would be associated with subsequent pulmonary dysfunction in a dose dependent fashion.

Material and Methods

This is a cross-sectional analysis of participants who are enrolled as part of the prospective New Orleans Alcohol Use in HIV (NOAH) study, details of which have previously been published.(Welsh et al., 2019) Briefly, NOAH is a prospective cohort study of PLWH in care in Louisiana designed to evaluate the effects of alcohol use on HIV-associated comorbidities. Participants included are aged ≥18 years and have documented HIV infection. The study oversampled for PLWH with alcohol use concerning for AUD (AUDIT ≥ 8). Exclusion criteria were acute illness within the last 6 weeks, non-prophylaxis prescription of antibiotics, and pregnancy. Those with acute illness were eligible for enrollment after resolution of the acute phase of identified illness.

All participants underwent anthropometric measurements and interviewer-administered questionnaires collecting data on alcohol use, tobacco use, medical history, and health behaviors. The questionnaires were supplemented by abstraction from electronic health records. Pulmonary function was measured in all participants using spirometry. Spirometry was performed using a KoKo Legend Spirometer (nSpire Health, Inc.) without bronchodilator pretreatment. Quality assessment was performed as follows: the spirometer software provided an overall numerical Quality Grade. All flow-volume and volume-time curves were visually inspected, and the session graded in a blinded fashion as acceptable, partially acceptable, or unacceptable by a board-certified pulmonologist (DW), in accordance with the 2005 ATS/ERS guidelines.(Pellegrino et al., 2005) All tests receiving a numerical Quality Grade other than the highest grade or judged other than ‘visually acceptable’ were independently visually inspected and blindly graded by a second board-certified pulmonologist (SK). Discrepancies in visual grades were resolved by group review.

The primary outcomes were Forced Vital Capacity (FVC) in liters, Forced Expiratory Volume in 1-second (FEV1) in liters, and FEV1/FVC ratio. FEV1 and FVC were modeled using their actual values rather than percent predicted to avoid the potential bias of ethic adjustment.(Anderson, Malhotra, & Non, 2021) In multivariable models, we adjusted for sex, age, and height accordingly. The predictor variables were lifetime alcohol exposure (as estimated by a modified lifetime drinking history instrument, per Maffei et al (Maffei et al., 2020)), AUDIT score, early life alcohol use (using frequency of alcohol use from age 10 to 20 and from age 21 to 30 years), recent alcohol use (as measured by whole-blood spot phosphatidyl ethanol; PEth) level and alcohol use latent class (heavy drinkers, former heavy drinkers, heavy drinkers with problems, and low-risk drinkers/abstainers).(Madkour et al., 2019) Other predictors were selected *a priori*, these included weight, smoking, CD4 cell count, viral load, and prior pulmonary infections.

This study was approved by the Louisiana State University Health Sciences Center-New Orleans (LSUHSC-NO) Human Research Protection Program and Institutional Review Board. Written informed consent was obtained from all study participants.

Statistical analyses

Chi-square and Wilcoxon rank sum tests were used to compare differences in proportion and means/medians. Lifetime alcohol use was log2-transformed and phosphatidyl ethanol level

was log10-transformed to achieve normality. Unadjusted and multivariable linear regression were used to evaluate the association of alcohol use with pulmonary function (FEV1, FVC, and FEV1/FVC ratio). In multivariable models, we adjusted for factors that were selected a priori: female sex, height, weight, age, smoking status (never, former, current), years of smoking, CD4 cell count, and viral load (stratified into 3 categories: <400 copies/mL, 400–5000 copies/mL, and >5000 copies/mL). We also conducted sensitivity analyses limiting the cohort to non-smokers. All statistical analysis was performed using R (version 3.5.2; R Foundation for Statistical Computing, Vienna, Austria).

Results

Of 365 total participants, 356 completed spirometry of whom 350 (98%) had acceptable spirometry and were included in this analysis. In total, 109 participants (31%) were female. Baseline characteristics of the cohort, stratified by sex, are shown in Table 1. Most participants, 85% of women and 82% of men, self-reported black race. Female participants were more likely to have prior asthma (20%) than their male counterparts (5.8%, p<0.001), however prevalence of COPD and bronchitis were similar by sex. Notably, female participants reported more chronic respiratory symptoms with more cough, wheezing, dyspnea, and dyspnea on exertion than male participants. Fewer women were current smokers (54% vs. 66%, p=0.04) with fewer years of smoking (20 vs 25, respectively; p=0.007). Women also reported less lifetime alcohol use (61,000 grams vs. 223,000 grams, p<0.001) and a smaller proportion of women had an AUDIT score ≥ 8, (31% vs 44%, p=0.04). HIV characteristics and prior opportunistic infections were similar by sex.

We first evaluated the association of total estimated total lifetime alcohol use (log2-transformed) with pulmonary function. Lifetime alcohol use was not associated with FEV1 in either unadjusted or multivariable linear regression analyses (Beta-coefficient [β] (95% confidence interval [CI]) 0.01 (−0.009, 0.04), and 0.01 (−0.002, 0.03), respectively) (Table 2). Female sex, increasing age, years of smoking were associated with lower FEV1, whereas increasing height was positively associated with higher FEV1. Lifetime alcohol use was associated with higher FVC in unadjusted analyses (β (95% CI) 0.03 (0.001, 0.05)), however there was no association in multivariable models (β (95% CI) 0.02 (−0.002, 0.04)). In multivariable models of FVC, female sex and increasing age were associated with lower FVC, whereas increasing height was associated with higher FVC. Lifetime alcohol use was also not associated with FEV1/FVC ratio in unadjusted (β (95% CI) −0.002 (−0.004, 0.0003)) and multivariable analyses (β (95% CI) −0.0004 (−0.003, 0.002)). Increasing height, age, and number of years of smoking were associated with lower FEV1/FVC ratio, whereas increasing weight was associated with higher FEV1/FVC ratio. HIV related variables (CD4 cell count and viral load) were not associated with measures of pulmonary function. In separate models, we adjusted for race and found no association of self-reported race with FEV1, FVC, or their ratio. We also found no difference in the relationship of total alcohol use with pulmonary function in models adjusted for race.

As expected, women had lower FEV1 and FVC compared to men (both p<0.001) (Table 1). In contrast, women had a higher median FEV1/FVC ratio (0.79 vs 0.76, p=0.01). As we did not use predicted equations for FEV1, FVC and their ratio, we then conducted

sex stratified analyses to eliminate residual confounding of sex (Table 3). In multivariable analyses limited to women, lifetime alcohol use was not associated with FEV1 (β (95% CI) 0.009 (−0.01, 0.03)), FVC (β (95% CI) 0.02 (−0.04, 0.18), or FEV1/FVC ratio (β (95% CI) −0.003 (−0.007, 0.001)). We similarly found no associations with pulmonary function in multivariable analyses limited to male participants (β (95% CI) 0.02 (−0.007, 0.04) for FEV1, 0.01 (−0.01, 0.04) for FVC, and 0.001 (−0.002, 0.004) for FEV1/FVC ratio). Associations with other covariates in the multivariable model were similar by sex. We also evaluated whether there is an interaction between female sex the relationship of alcohol use with pulmonary function and found no significant interaction for FEV1 (p=0.77), FVC (p=0.92), or FEV1/FVC ratio (p=0.34).

Next, we evaluated the association of AUDIT score with pulmonary function in analyses including all study participants. In multivariable models we found no association of AUDIT score with FEV1 (β (95% CI) −0.004 (−0.01, 0.003)), FVC (β (95% CI) −0.004 (−0.01, 0.004)), or FEV1/FVC ratio (β (95% CI) −0.0001 (−0.001, 0.001)) (Table 4). In separate analyses, we evaluated the effect of recent alcohol use (as measured by PEth) on pulmonary function and found no association with FEV1, FVC, or their ratio (Table 4). To evaluate the effect of early life alcohol use, we modeled early alcohol exposure using drinking frequency from 10 to 20 years of age. In multivariable linear regression models, we found no association of drinking frequency in this age range with FEV1, FVC, or FEV1/FVC ratio (Table 4). In similar analyses using drinking frequency from age 21 to age 30 years, we again found no association of drinking frequency with FEV1, FVC, or FEV1/FVC ratio (Table 4).

We then used a previously created latent class factor analysis of alcohol use.(Madkour et al., 2019) Participants were grouped into heavy drinkers (33%), former heavy drinkers (14%), heavy drinkers with problems (13%), and low-risk drinkers/abstainers (40%). In multivariable analyses, we found former heavy drinkers to have larger FEV1 and FVC compared to current heavy drinkers (β (95% CI) 0.19 (0.01, 0.36)) for FEV1 and 0.26 (0.05, 0.47) for FVC) (Table 4).

As tobacco and alcohol are commonly used together and may interact, in sensitivity analyses, we next evaluated the effect of alcohol use on pulmonary function in non-smokers. Lifetime alcohol use was not associated with pulmonary function as measured by FEV1 (β (95% CI) 0.02 (−0.005, 0.06)), FVC (β (95% CI) 0.03 (−0.006, 0.06)), or FEV1/FVC ratio (β (95% CI) 0.0001 (−0.004, 0.004)) in non-smokers (n=79), (Appendix Table A.1). We saw similar associations of lower FEV1 and FVC with female sex and increasing age, and higher FVC with increasing height in non-smokers as in the entire cohort. Additionally, in analyses including all participants, there was no correlation of years smoked with total lifetime alcohol (correlation co-efficient 0.09, p=0.11). We evaluated whether total lifetime alcohol use modifies the relationship of tobacco use and pulmonary function and found no significant interaction for FEV1 (p=0.55), FVC (p=0.94), or FEV1/FVC ratio (p=0.34).

Discussion

In this cohort of New Orleanian men and women living with HIV we did not find an association of total lifetime alcohol use, AUDIT score, or early life alcohol use with pulmonary function as measured by spirometry. Current heavy alcohol use was associated with lower FEV1 and FVC as compared to prior heavy alcohol use. In adjusted analyses increasing number of smoking years was associated with lower FEV1/FVC ratio consistent with the role of tobacco use in obstructive lung diseases. Alcohol use did not modify the effect of tobacco on pulmonary function.

Prior data on the effects of alcohol on pulmonary function are conflicting. Our study results differ from results by Sisson et al. (Sisson et al., 2005) who found an association of alcohol use with obstructive lung disease (which we have evaluated by FEV1/FVC in our study) only in former heavy drinkers. Additionally, they show alcohol use to be associated with a lower prevalence of restriction (low FVC). There are some differences between our studies. First, they used the Third National Health and Nutrition Examination Survey (NHANES) cohort of healthy adults.("Plan and operation of the Third National Health and Nutrition Examination Survey, 1988–94. Series 1: programs and collection procedures," 1994) They thus included younger adults and did not focus on PLWH. Second, the exposure to alcohol measured in NHANES is not as robust as the data we collected in this cohort, which includes estimated use per decade and thus is likely more indicative of effect of total alcohol use on pulmonary function. With these more robust alcohol exposure markers we are better able to define the effect of alcohol use on pulmonary function.

Frantz et al. in a cross-sectional study evaluated the effect of alcohol (measured both by self-report and a biomarker of recent heavy alcohol use - carbohydrate-deficient transferrin [CDT]) on pulmonary function.(Frantz et al., 2014) They measured spirometry, body plethysmography, and diffusing capacity for carbon monoxide (DLCO). In adjusted analyses they found that heavy alcohol use (higher CDT) had an independent negative effective on pulmonary function (FEV1 and DLCO) in smokers. Though strengthened by using a biomarker, as the authors acknowledge, CDT detects heavy alcohol use within the last 1 to 3 weeks. This limits inference on long-term heavy alcohol use. This limitation contrasts our study in which we were able to evaluate not only the effect of total lifetime alcohol use but were also able to assess the effect of early life alcohol use on pulmonary function. Additionally, we evaluated the effect of recent alcohol use, as measured by phosphatidyl ethanol level, and did not find any associations with pulmonary function. Phosphatidyl ethanol may be superior to CDT as it has been shown to correlate well with patterns of alcohol use (e.g., binge drinking).(Viel et al., 2012) However, similar to Frantz et al., we did find a relationship of current heavy use and lower FEV1 and FVC as compared to former heavy use. Continued heavy use may affect pulmonary function negatively.

Our study is unique in that we focused on PLWH. Vasquez et al. in a longitudinal population-based study of pulmonary function and alcohol use found a slower rate of decline of FVC over adult life with light-to-moderate alcohol use.(Vasquez et al., 2018) Tabak et al.(Tabak et al., 2001) and Siu et al.(Siu et al., 2010), also in population-based studies also showed improved pulmonary function with light to moderate use but potentially worsened

function with heavy alcohol use. Lange et al. also previously showed accelerated pulmonary function decline with heavy alcohol use in a population-based study.(Lange et al., 1988) Notably, all of these studies were in population-based studies that did not include PLWH. We provide evidence of the relationship of alcohol and pulmonary function in this important population.

The majority of the published literature relates alcohol use to impaired pulmonary immunity through various mechanisms.(de Wit et al., 2011; Jolley et al., 2016; Mehta & Guidot, 2017; Simou et al., 2018) Alcohol use has been associated with increased susceptibility to pneumonia and increased pneumonia severity.(Imtiaz et al., 2017; Jolley et al., 2016) We had planned to evaluate the effect of alcohol and opportunistic infections on pulmonary function. There were limited data for opportunistic infections (tuberculosis (n=6), pneumocystis pneumonia (n=7), and mycobacterium avium (n=2)), thus we were not powered to evaluate this effect. It is feasible that in a cohort of participants, in whom prior pneumonia is more common, there may be more impaired pulmonary function with increased alcohol use. We would expect this to be more evident in PLWH as they are at higher risk for opportunistic pneumonias.(Morris et al., 2000) But, our cohort is representative of modern HIV cohorts with the majority of participants being on therapy with well controlled HIV, thus opportunistic infections may be less common in the antiretroviral era.

Our study has several strengths. First, we have robust data on alcohol use including early life alcohol use, estimated lifetime use, and a large proportion of participants with alcohol use concerning for AUD. This allowed us to effectively model the effects of alcohol use on pulmonary function. Second, this is a large cohort of PLWH who are in care and have well controlled HIV which is representative of most PLWH. Finally, the spirometry data are robust with several quality control measures to ensure high quality data. Our study also has certain limitations. First, the use of alcohol and tobacco is by self-report thus is subject to recall bias. However, we do have phosphatidyl ethanol as a biomarker of alcohol use and had similar findings to the self-report of use. Second, we had a limited number of opportunistic infections thus potentially limiting our view of the association of alcohol with pneumonia and subsequent pulmonary function. Third, as our cohort is limited to PLWH we could not examine the interaction of HIV and alcohol use on pulmonary function without having HIV negative participants. Finally, our study was at a single center in Louisiana with demographics specific to New Orleans thus may not be generalizable to other cohorts of PLWH.

In conclusion, in this cohort of men and women with well controlled HIV, we found no association of total lifetime alcohol use and pulmonary function as measured by spirometry. Alcohol did not modify the effect of tobacco use on pulmonary function. In latent class analyses, current heavy alcohol use was associated with impaired pulmonary function. Future studies should evaluate methods to mitigate previously reported effects of alcohol in increasing susceptibility to opportunistic pneumonias in PLWH and further elucidate the mechanisms linking current heavy alcohol use with impaired pulmonary function.

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Appendix

Table A.1.

Multivariable analyses of factors associated with FEV1, FVC, and FEV1/FVC limited to non-smokers (n=79) using total lifetime alcohol use

	Multivariable[a] FEV1 (95% CI)	**Multivariable[a] FVC (95% CI)**	**Multivariable[a] FEV1/FVC (95% CI)**
Lifetime alcohol[b]	0.02 (−0.005, 0.06)	0.03 (−0.006, 0.06)	0.0001 (−0.004, 0.004)
Female Sex	−0.72 (−1.1, −0.35) ***	−0.73 (−1.1, −0.34) ***	−0.06 (−0.11, −0.002) *
Height (m)	1.6 (−0.08, 3.4)	3.7 (1.8, 5.5) ***	−0.40 (−0.65, −0.15) **
Weight[c]	−0.0007 (−0.05, 0.05)	−0.03 (−0.09, 0.02)	0.01 (0.002, 0.02) *
Age[d]	−0.28 (−0.40, −0.17) ***	−0.33 (−0.46, −0.21) ***	−0.005 (−0.02, 0.01)
CD4 count[e]	0.04 (−0.004, 0.09)	0.03 (−0.02, 0.08)	0.006 (−0.0008, 0.01)
Viral load[f]			
<400 copies/mL	Reference	Reference	Reference
400–5,000 copies/mL	0.28 (−0.34, 0.90)	0.16 (−0.50, 0.82)	0.03 (−0.06, 0.12)
>5,000 copies/mL	0.19 (−0.19, 0.58)	0.17 (−0.24, 0.58)	0.02 (−0.04, 0.07)

*P < .05;

**P < .01;

***P < .001.

[a]Adjusted for all listed variables

[b]Log 2 total lifetime alcohol use in grams

[c]Per 10kg change in weight

[d]Per 10-year change in age

[e]Per 100 cells/mm^3

[f]Stratified into 3 categories <400 copies/mL, 400–5000 copies/mL, and >5000 copies/mL

References

Anderson MA, Malhotra A, & Non AL (2021). Could routine race-adjustment of spirometers exacerbate racial disparities in COVID-19 recovery? Lancet Respir Med, 9(2), 124–125. doi:10.1016/s2213-2600(20)30571-3 [PubMed: 33308418]

Attia EF, Akgün KM, Wongtrakool C, Goetz MB, Rodriguez-Barradas MC, Rimland D, … Crothers K (2014). Increased risk of radiographic emphysema in HIV is associated with elevated soluble CD14 and nadir CD4. Chest, 146(6), 1543–1553. doi:10.1378/chest.14-0543 [PubMed: 25080158]

Bensley KM, McGinnis KA, Fortney J, Chan KCG, Dombrowski JC, Ornelas I, … Williams EC (2019). Patterns of Alcohol Use Among Patients Living With HIV in Urban, Large Rural, and Small Rural Areas. J Rural Health, 35(3), 330–340. doi:10.1111/jrh.12326 [PubMed: 30339740]

Bigna JJ, Kenne AM, Asangbeh SL, & Sibetcheu AT (2018). Prevalence of chronic obstructive pulmonary disease in the global population with HIV: a systematic review and meta-analysis. Lancet Glob Health, 6(2), e193–e202. doi:10.1016/s2214-109x(17)30451-5 [PubMed: 29254748]

Crane HM, McCaul ME, Chander G, Hutton H, Nance RM, Delaney JAC, … Kitahata MM (2017). Prevalence and Factors Associated with Hazardous Alcohol Use Among Persons Living with HIV Across the US in the Current Era of Antiretroviral Treatment. AIDS Behav, 21(7), 1914–1925. doi:10.1007/s10461-017-1740-7 [PubMed: 28285434]

Crothers K, Huang L, Goulet JL, Goetz MB, Brown ST, Rodriguez-Barradas MC, … Justice AC (2011). HIV infection and risk for incident pulmonary diseases in the combination antiretroviral therapy era. Am J Respir Crit Care Med, 183(3), 388–395. doi:10.1164/rccm.201006-0836OC [PubMed: 20851926]

de Wit M, Zilberberg MD, Boehmler JM, Bearman GM, & Edmond MB (2011). Outcomes of patients with alcohol use disorders experiencing healthcare-associated infections. Alcohol Clin Exp Res, 35(7), 1368–1373. doi:10.1111/j.1530-0277.2011.01475.x [PubMed: 21676005]

Frantz S, Wollmer P, Dencker M, Engström G, & Nihlén U (2014). Associations between lung function and alcohol consumption--assessed by both a questionnaire and a blood marker. Respir Med, 108(1), 114–121. doi:10.1016/j.rmed.2013.08.041 [PubMed: 24064346]

Imtiaz S, Shield KD, Roerecke M, Samokhvalov AV, Lönnroth K, & Rehm J (2017). Alcohol consumption as a risk factor for tuberculosis: meta-analyses and burden of disease. European Respiratory Journal, 50(1), 1700216. doi:10.1183/13993003.00216-2017 [PubMed: 28705945]

Jolley SE, Alkhafaf Q, Hough C, & Welsh DA (2016). Presence of an Alcohol Use Disorder is Associated with Greater Pneumonia Severity in Hospitalized HIV-Infected Patients. Lung, 194(5), 755–762. doi:10.1007/s00408-016-9920-1 [PubMed: 27405853]

Kunisaki KM, Nouraie M, Jensen RL, Chang D, D'Souza G, Fitzpatrick ME, … Morris A (2020). Lung function in men with and without HIV. AIDS (London, England), 34(8), 1227–1235. doi:10.1097/qad.0000000000002526

Lange P, Groth S, Mortensen J, Appleyard M, Nyboe J, Jensen G, & Schnohr P (1988). Pulmonary function is influenced by heavy alcohol consumption. Am Rev Respir Dis, 137(5), 1119–1123. doi:10.1164/ajrccm/137.5.1119 [PubMed: 3195811]

Madkour AS, Felker-Kantor E, Wallace M, Ferguson T, Welsh DA, Molina PE, & Theall KP (2019). Latent Alcohol Use Typologies and Health Status Among a Cohort of Adults Living with HIV. Alcohol Alcohol, 54(6), 584–592. doi:10.1093/alcalc/agz071 [PubMed: 31580404]

Maffei VJ, Ferguson TF, Brashear MM, Mercante DE, Theall KP, Siggins RW, … Welsh DA (2020). Lifetime alcohol use among persons living with HIV is associated with frailty. AIDS (London, England), 34(2), 245–254. doi:10.1097/QAD.0000000000002426

Mehta AJ, & Guidot DM (2017). Alcohol and the Lung. Alcohol research : current reviews, 38(2), 243–254. Retrieved from https://pubmed.ncbi.nlm.nih.gov/28988576 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5513688/ [PubMed: 28988576]

Morris AM, Huang L, Bacchetti P, Turner J, Hopewell PC, Wallace JM, … Stansell JD (2000). Permanent declines in pulmonary function following pneumonia in human immunodeficiency virus-infected persons. The Pulmonary Complications of HIV Infection Study Group. Am J Respir Crit Care Med, 162(2 Pt 1), 612–616. doi:10.1164/ajrccm.162.2.9912058 [PubMed: 10934095]

Pellegrino R, Viegi G, Brusasco V, Crapo RO, Burgos F, Casaburi R, … Wanger J (2005). Interpretative strategies for lung function tests. Eur Respir J, 26(5), 948–968. doi:10.1183/09031936.05.00035205 [PubMed: 16264058]

Plan and operation of the Third National Health and Nutrition Examination Survey, 1988–94. Series 1: programs and collection procedures. (1994). Vital Health Stat 1(32), 1–407.

Simou E, Britton J, & Leonardi-Bee J (2018). Alcohol and the risk of pneumonia: a systematic review and meta-analysis. BMJ Open, 8(8), e022344. doi:10.1136/bmjopen-2018-022344

Sisson JH, Stoner JA, Romberger DJ, Spurzem JR, Wyatt TA, Owens-Ream J, & Mannino DM (2005). Alcohol intake is associated with altered pulmonary function. Alcohol, 36(1), 19–30. doi:10.1016/j.alcohol.2005.05.002

Siu ST, Udaltsova N, Iribarren C, & Klatsky AL (2010). Alcohol and lung airways function. Perm J, 14(1), 11–18.

Tabak C, Smit HA, Räsänen L, Fidanza F, Menotti A, Nissinen A, … Kromhout D (2001). Alcohol Consumption in Relation to 20-Year COPD Mortality and Pulmonary Function in Middle-Aged Men from Three European Countries. Epidemiology, 12(2). Retrieved from https://journals.lww.com/epidem/Fulltext/2001/03000/Alcohol_Consumption_in_Relation_to_20_Year_COPD.18.aspx

Vasquez MM, Sherrill DL, LeVan TD, Morgan WJ, Sisson JH, & Guerra S (2018). Persistent light to moderate alcohol intake and lung function: A longitudinal study. Alcohol, 67, 65–71. doi:10.1016/j.alcohol.2017.08.013 [PubMed: 29396309]

Viel G, Boscolo-Berto R, Cecchetto G, Fais P, Nalesso A, & Ferrara SD (2012). Phosphatidylethanol in blood as a marker of chronic alcohol use: a systematic review and meta-analysis. Int J Mol Sci, 13(11), 14788–14812. doi:10.3390/ijms131114788 [PubMed: 23203094]

Welsh DA, Ferguson T, Theall KP, Simon L, Amedee A, Siggins RW, … Molina PE (2019). The New Orleans Alcohol Use in HIV Study: Launching a Translational Investigation of the Interaction of Alcohol Use with Biological and Socioenvironmental Risk Factors for Multimorbidity in People Living with HIV. Alcohol Clin Exp Res, 43(4), 704–709. doi:10.1111/acer.13980 [PubMed: 30748025]

Zifodya JS, Temu TM, Masyuko SJ, Nyale G, Kinuthia J, Page ST, … Crothers K (2021). HIV, Pulmonary Infections, and Risk of Chronic Lung Disease among Kenyan Adults. Ann Am Thorac Soc. doi:10.1513/AnnalsATS.202103-251RL

Highlights

- Compared to former heavy use, current heavy alcohol use was associated with impaired lung function.
- Total lifetime alcohol use and early life alcohol use were not associated with pulmonary function.
- Effect of chronic alcohol use on pulmonary function was similar by sex.
- Tobacco use was associated with lower pulmonary function and this was not modified by alcohol use.

Table 1.

Baseline characteristics of participants of the New Orleans Alcohol Use and HIV Study cohort with acceptable spirometry (N=350) stratified by sex

	Female (n=109)	Male (n=241)	p-value
	Number (%) or Median (IQR)		
Age	49 (42, 55)	51 (41, 56)	0.39
Black race	93 (85)	197 (82)	0.50
BMI (kg/m^2)	28 (24, 35)	25 (22, 29)	<0.001
Prior asthma	22 (20)	14 (5.8)	<0.001
Prior COPD or emphysema	8 (7.3)	11 (4.6)	0.42
Chronic Bronchitis[a]	0 (0.0)	2 (0.8)	0.85
Chronic respiratory symptoms			
Cough	43 (39)	61 (25)	0.01
Wheezing	51 (47)	62 (26)	<0.001
Dyspnea	67 (61)	102 (42)	0.001
Dyspnea on exertion	70 (64)	111 (46)	0.002
Tobacco use			
Current smoker	59 (54)	160 (66)	0.04
Former smoker	16 (15)	36 (15)	1.0
Pack years	6.0 (0.0, 18)	8.9 (2.1, 22)	0.03
Years smoking	20 (0, 34)	25 (10, 37)	0.007
Alcohol use			
Total lifetime use (grams)	61, 000 (8,300, 305,000)	223,000 (50,000, 527,000)	<0.001
Lifetime use per kg (grams/kg)	730 (110, 4,100)	2,900 (660, 6,400)	<0.001
Total in last 30-days (grams)	70 (0, 400)	224 (21, 896)	0.002
AUDIT score	3 (1, 12)	6 (2, 13)	0.003
AUDIT score ≥ 8	34 (31)	105 (44)	0.04
PEth (ng/μL)[b]	10 (0, 89)	48 (0, 235)	<0.001
HIV			
Years with HIV	14 (5, 21)	16 (6, 23)	0.20

	Female (n=109)	Male (n=241)	p-value
	Number (%) or Median (IQR)		
CD4 count (cells/mm^3)[c]	528 (357, 715)	476 (323, 696)	0.40
Viral load <20 copies/mL[c]	70 (68)	166 (69)	0.10
Prior *M. tuberculosis*	2 (1.8)	3 (1.2)	1.0
Prior pneumocystis pneumonia	5 (4.6)	2 (0.82)	0.06
Prior *M. avium*	0 (0.0)	2 (0.82)	0.85
Pulmonary function tests			
FEV1 (liters)	2.1 (1.7, 2.4)	3.1 (2.6, 3.5)	<0.001
FVC (liters)	2.7 (2.3, 3.1)	4.0 (3.6, 4.6)	<0.001
FEV1/FVC ratio	0.79 (0.74, 0.83)	0.76 (0.70, 0.81)	0.01

Compared medians using Wilcoxon rank sum test and Chi-square for proportions

Abbreviations: BMI body mass index, COPD chronic obstructive pulmonary disease, FEV1 forced expiratory volume in 1-second, FVC forced vital capacity, IQR interquartile range

[a]Sputum for >=3 months for >= 2 years

[b]PEth: whole-blood spot phosphatidyl ethanol, data available for 340 participants

[c]CD4 cell count and viral load data available for 103 women and 239 men

Table 2.

Unadjusted and multivariable linear regression analyses of factors associated with FEV1, FVC, and FEV1/FVC in all participants (n=350) using total lifetime alcohol use

	Unadjusted FEV1 (95% CI)	**Multivariable[a] FEV1 (95% CI)**	**Unadjusted FVC (95% CI)**	**Multivariable[a] FVC (95% CI)**	**Unadjusted FEV1/FVC (95% CI)**	**Multivariable[a] FEV1/FVC (95% CI)**
Lifetime alcohol[b]	0.01 (−0.009, 0.04)	0.01 (−0.002, 0.03)	0.03 (0.001, 0.05) *	0.02 (−0.002, 0.04)	−0.002 (−0.004, 0.0003)	−0.0004 (−0.003, 0.002)
Female Sex	−0.97 (−1.1, −0.82) ***	−0.64 (−0.82, −0.46) ***	−1.3 (−1.5, −1.2) ***	−0.78 (−0.99, −0.57)***	0.02 (−0.001, 0.04)	−0.02 (−0.04, 0.009)
Height (m)	4.6 (3.8, 5.3) ***	2.3 (1.5, 3.2) ***	6.4 (5.6, 7.2) ***	3.9 (2.8, 4.9) ***	−0.11 (−0.20, −0.01) *	−0.22 (−0.35, −0.09)**
Weight[c]	0.07 (0.03, 0.11) **	0.008 (−0.02, 0.04)	0.05 (0.001, 0.10) *	−0.03 (−0.07, 0.006)	0.009 (0.005, 0.01) ***	0.01 (0.006, 0.02) ***
Age[d]	−0.34 (−0.42, −0.27) ***	−0.33 (−0.39, −0.26) ***	−0.33 (−0.43, −0.24) ***	−0.34 (−0.41, −0.27) ***	−0.02 (−0.03, −0.02) ***	−0.02 (−0.03, −0.008) ***
Tobacco use[e]						
Never	Reference	--	Reference	--	Reference	--
Former	0.12 (−0.16, 0.40)	--	0.25 (−0.09, 0.59)	--	−0.02 (−0.05, 0.009)	--
Current	0.10 (−0.10, 0.31)	--	0.26 (0.008, 0.51) *	--	−0.03 (−0.05, −0.008) **	--
Years smoked[f]	−0.09 (−0.14, −0.04) ***	−0.04 (−0.08, −0.0001) *	−0.05 (−0.11, 0.02)	−0.02 (−0.07, 0.03)	−0.02 (−0.02, −0.01) ***	−0.007 (−0.01, −0.0006) *
CD4 count[g]	0.007 (−0.02, 0.03)	0.009 (−0.01, 0.03)	0.01 (−0.02, 0.05)	0.02 (−0.006, 0.04)	−0.0005 (−0.004, 0.002)	−0.001 (−0.004, 0.002)
Viral load[h]						
<400 copies/mL	Reference	Reference	Reference	Reference	Reference	Reference
400–5,000 copies/mL	−0.06 (−0.50, 0.39)	−0.10 (−0.40, 0.20)	−0.18 (−0.73, 0.36)	−0.28 (−0.63, 0.07)	0.02 (−0.03, 0.06)	0.02 (−0.02, 0.07)
>5,000 copies/mL	0.14 (−0.17, 0.46)	−0.04 (−0.18, 0.26)	0.003 (−0.38, 0.39)	−0.02 (−0.28, 0.24)	0.03 (−0.007, 0.07)	0.009 (−0.02, 0.04)

*P < .05;

**P < .01;

***P < .001.

[a]Adjusted for all listed variables

[b]Log 2 total lifetime alcohol use in grams

[c]Per 10kg change in weight

[d]Per 10-year change in age

[e] Smoker defined as never, former, or current

[f] Per 10 years of smoking; as tobacco smoking status (never, former, or current) is colinear with years smoked, we adjusted only for years smoked in the multivariable analyses

[g] Per 100 cells/mm^3

[h] Stratified into 3 categories <400 copies/mL, 400–5000 copies/mL, and >5000 copies/mL

Table 3.

Multivariable linear regression analyses of factors associated with FEV1, FVC, and FEV1/FVC stratified by sex in women (n=109) using total lifetime alcohol use

Factors associated with pulmonary function in women (n=109)			
	Multivariable[a] FEV1 (95% CI)	***Multivariable[a] FVC (95% CI)***	***Multivariable[a] FEV1/FVC (95% CI)***
Lifetime alcohol[b]	0.009 (−0.01, 0.03)	0.02 (−0.04, 0.18)	−0.003 (−0.007, 0.001)
Height (m)	2.0 (0.65, 3.3) **	3.3 (1.8, 4.8) ***	−0.26 (−0.50, −0.02) *
Weight[c]	0.004 (−0.03, 0.04)	−0.03 (−0.07, 0.01)	0.01 (0.003, 0.02) **
Age[d]	−0.29 (−0.38, −0.20) ***	−0.32 (−0.41, −0.21) ***	−0.01 (−0.03, 0.004)
Years smoked[e]	−0.04 (−0.10, 0.02)	−0.05 (−0.11, 0.03)	−0.0001 (−0.01, 0.01)
CD4 count[f]	0.02 (−0.008, 0.05)	0.04 (0.009, 0.08) *	−0.003 (−0.009, 0.003)
Viral load[g]			
<400 copies/mL	Reference	Reference	Reference
400–5,000 copies/mL	−0.12 (−0.62, 0.39)	−0.22 (−0.80, 0.37)	0.02 (−0.08, 0.11)
>5,000 copies/mL	−0.09 (−0.21, 0.39)	0.14 (−0.20, 0.48)	−0.006 (−0.06, 0.05)
Factors associated with pulmonary function in men (n=241)			
Lifetime alcohol[b]	0.02 (−0.007, 0.04)	0.01 (−0.01, 0.04)	0.001 (−0.002, 0.004)
Height (m)	2.5 (1.3, 3.6) ***	4.2 (2.9, 5.6) ***	−0.22 (−0.39, −0.06) **
Weight[c]	0.01 (−0.04, 0.06)	−0.04 (−0.09, 0.02)	0.01 (0.005, 0.02) ***
Age[d]	−0.34 (−0.42, −0.26) ***	−0.36 (−0.45, −0.26) ***	−0.02 (−0.03, −0.006) **
Years smoked[e]	−0.03 (−0.09, 0.02)	−0.0002 (−0.07, 0.07)	−0.01 (−0.02, −0.002) *
CD4 count[f]	0.004 (−0.02, 0.03)	0.006 (−0.02, 0.04)	0.0001 (−0.003, 0.004)
Viral load[g]			
<400 copies/mL	Reference	Reference	Reference
400–5,000 copies/mL	−0.13 (−0.50, 0.24)	−0.36 (−0.80, 0.08)	0.03 (−0.02, 0.08)
>5,000 copies/mL	−0.02 (−0.29, 0.32)	−0.12 (−0.48, 0.24)	−0.02 (−0.02, 0.06)

*P < .05;

**P < .01;

*** P < .001.

[a] Adjusted for all listed variables

[b] Log 2 total lifetime alcohol use in grams

[c] Per 10kg change in weight

[d] Per 10-year change in age

[e] Per 10 years of smoking

[f] Per 100 cells/mm^3

[g] Stratified into 3 categories <400 copies/mL, 400–5000 copies/mL, and >5000 copies/mL

Table 4.

Multivariable linear regression analyses of factors associated with FEV1, FVC, and FEV1/FVC all participants (n=350) using various measures of alcohol exposure

	Multivariable[a] FEV1 (95% CI)	**Multivariable[a] FVC (95% CI)**	**Multivariable[a] FEV1/FVC (95% CI)**
Multivariable analysis of effect of **AUDIT score** on pulmonary function			
AUDIT score	−0.004 (−0.01, 0.003)	−0.004 (−0.01, 0.004)	−0.0001 (−0.001, 0.001)
Multivariable analysis of effect of PEth on pulmonary function			
Peth[b]	−0.03 (−0.09, 0.02)	−0.05 (−0.11, 0.01)	0.001 (−0.007, 0.009)
Multivariable analysis of effect of **early lifetime alcohol use (age 10 to 20)** on pulmonary function			
Drink frequency age 10–20[c]			
Never	Reference	Reference	Reference
Monthly or less	0.07 (−0.11, 0.25)	0.07 (−0.14, 0.28)	0.001 (−0.03, 0.03)
2–4 times/month	0.05 (−0.11, 0.21)	0.08 (−0.11, 0.27)	−0.003 (−0.03, 0.02)
2–3 times/week	0.09 (−0.09, 0.28)	0.10 (−0.12, 0.31)	0.003 (−0.03, 0.03)
Daily	0.12 (−0.08, 0.31)	0.16 (−0.06, 0.39)	0.003 (−0.03, 0.03)
Multivariable analysis of effect of **early lifetime alcohol use (age 21 to 30)** on pulmonary function			
Drink frequency age 21–30[c]			
Never	Reference	Reference	Reference
Monthly or less	0.06 (−0.19, 0.31)	0.14 (−0.15, 0.43)	−0.02 (−0.06, 0.01)
2–4 times/month	0.14 (−0.10, 0.38)	0.19 (−0.09, 0.48)	−0.01 (−0.05, 0.02)
2–3 times/week	0.21 (−0.03, 0.45)	0.24 (−0.05, 0.52)	−0.0007 (−0.04, 0.04)
Daily	0.06 (−0.18, 0.31)	0.10 (−0.19, 0.39)	0.01 (−0.05, 0.02)
Multivariable analysis of effect **latent class factor analysis** on pulmonary function			
Latent class[d]			
Class 1: heavy drinkers	Reference	Reference	Reference
Class 2: former heavy drinkers	0.19 (0.01, 0.36) *	0.26 (0.05, 0.47) *	−0.004 (−0.03, 0.02)
Class 3: heavy drinkers with problems	−0.02 (−0.20, 0.16)	0.06 (−0.15, 0.27)	−0.02 (−0.04, 0.01)

	Multivariable[a] FEV1 (95% CI)	**Multivariable[a] FVC (95% CI)**	**Multivariable[a] FEV1/FVC (95% CI)**
Class 4: low-risk drinkers/abstainers	−0.08 (−0.21, 0.05)	−0.03 (−0.18, 0.13)	−0.02 (−0.04, 0.01)

*P < .05;

**P < .01;

***P < .001.

[a]All analyses are adjusted for sex, height, weight, age, years smoked, CD4 cell count, and viral load category (3 categories: <400 copies/mL, 400–5000 copies/mL, and >5000 copies/mL)

[b]Log 10 PEth (whole blood spot phosphatidyl ethanol level in ng/μL)

[c]Categorized as never, monthly or less, 2–4 times/month, 2–3 times/week, everyday

[d]Latent class analysis dividing participants into four groups: a high-risk class of drinkers with more extreme alcohol use patterns as well as alcohol-related consequences (class 3); an intermediate-risk class who exhibit hazardous drinking levels, but without the consequences suffered by the riskiest class (class 1); and two typologies of current low-risk drinkers/abstainers, differentiated by their past history of heavy drinking (class 2 and 4)