Introduction

The primary aim of this research project is to more fully understand the effect of hard drug use (such as heroine and cocaine) on the general health and immune system of HIV+ homosexual and bisexual men from baseline to two years after initiating HAART. There is limited evidence that drug use has negative effects on HIV treatment response. The secondary aim of this research project is understand how certain demographics affect treatment response.

The data used is from the Multicenter AIDS Cohort Study. The cohort used in this data analysis involved 476 individuals that had all four treatment responses recorded at baseline and year two. Demographics and other comorbidities were also collected at baseline and year 2. Treatment response was measured using four different quantitative measures: two laboratory values (CD4+ T cell count and Viral load) and two quality of life measures from the SF-36 (aggregate physical score and aggregate mental score). The analysis was conducted in a Bayesian framework. It is hypothesized that the change in CD4+ and Viral Load from baseline to year 2 will be smaller in drug users compared to non-users. It is also hypothesized that there will be a difference in the QOL changes from baseline to year two in drug users and non-users.

Methods

RStudio version 3.4.0 was used for data cleaning and SAS version 9.4 was used for data analysis. Several patients were missing outcome data for one of the four health measurements. In order have the same cohort for all four outcome analyses, only individuals with all outcomes values at baseline and year 2 were included. Several individuals also had impossible BMI levels (about 400), which were coded as missing. The log of the Viral Load was used for all analysis purposes.

Several of the groupings in the demographic variables were collapsed due to small sample sizes. Race was grouped into White non-Hispanics and non-Whites. Income was classified into less than

$10,000, $10,000-40,000, or more than $40,000 a year. Alcohol consumption was grouped into three or fewer drinks per week and four or more drinks per week. Education was classified into 1 year of college or less or four years of college or more. Finally, HAART Adherence was grouped into 100% adherence since their last visit and less than 100%.

Categorical data was presented using percents and group sizes. Numerical variables were presented using means and standard deviations.

A hybrid linear regression model was used for the analysis of all four outcomes (the difference between baseline and year two was used as the outcome, with baseline controlled for as a covariate). Crude models were first run (controlling only for baseline and the hard drug covariate) and compared to full models, which were adjusted for smoking status, income level, marijuana use, drinks per week, race, education, ART Adherence, BMI, Age, and baseline (year 0) outcome measurement as well as the hard drug covariate.

Quality of Life Outcome Modelling-Physical and Mental

The coefficients for these models had vague priors, which were normally distributed with mean of zero and variance of 1000. The error was distributed as inverse gamma, which shape of 2.001 and scale of 1.001. PROC MCMC was used to simulate the posterior, which used a random walk Metropolis-Hastings. All coefficients were initialized to zero and the model error variance with one. Chains were run for 100,000 iterations with 30,000 iterations discarded as the burn-in. Convergence and mixing were assessed visually with the used of trace plots and autocorrelations. The models both had adequate mixing, as well as no evidence to the lack of convergence. Results were summarized using posterior mean and 95% HPD credible interval. Crude and Full models were compared using DIC.

Lab Values Outcome Modelling-Viral Load

The coefficients for these models had vague priors, which were normally distributed with mean of zero and variance of 1000. The error was distributed as inverse gamma, which shape of 2.001 and scale

of 1.001. PROC MCMC was used to simulate the posterior, which used a random walk Metropolis-Hastings. All coefficients were initialized to zero and the model error variance with one. Chains were run for 300,000 iterations with 30,000 iterations discarded as the burn-in. Convergence and mixing were assessed visually with the used of trace plots and autocorrelations. The models both had adequate mixing, as well as no evidence to the lack of convergence. Results were summarized using posterior mean and 95% HPD credible interval. Crude and Full models were compared using DIC.

Lab Values Outcome Modelling-CD4+ Count

The coefficients for these models had vague priors, which were normally distributed with mean of zero and variance of 1000, except for the intercept, which was normally distributed with a mean of zero and variance of 10,000. The error was distributed as inverse gamma, which shape of 2.001 and scale of 2.00001. PROC MCMC was used to simulate the posterior, which used a random walk Metropolis-Hastings. All coefficients were initialized to zero and the model error variance with one. Chains were run for 400,000 iterations with 40,000 iterations discarded as the burn-in and thinning set to 15. Convergence and mixing were assessed visually with the used of trace plots and autocorrelations. The models both had adequate mixing, as well as no evidence to the lack of convergence. Results were summarized using posterior mean and 95% HPD credible interval. Crude and Full models were compared using DIC.

Results

Table one shows the demographic for the entire population, as well as for the hard drug users and non-users. There were some notable difference between the drug user and non-user groups. A higher percent of non-users had 4 years or more of college education (80.55% vs. 58.97%). A higher percentage of the drug users also were smokers (76.92% vs 35.47%). There was also a higher percentage of Non-white individuals in the drug user group (51.28% vs. 36.16%). The two groups didn't differ very much in adherence, alcohol consumption, income, marijuana use, BMI, or age.

Table two shows the average scores for all four outcomes at baseline and year two, as well as the difference between year 2 and baseline, unadjusted for any covariates. Overall, both non drug users and drug users had on average lower Physical QOL scores at year two verses baseline (-1.34 and -3.85, respectively). However, drug users have on average a larger negative difference in Physical QOL scores between baseline and year two than non-users, which would provide evidence that hard drug use have a more negative affect on physical quality of life. Non-users have on average a higher CD4+ count difference between baseline and year two than the drug users (183.11 ± 175.67 vs. 13.43 ± 195.73). This provides evidence that drug use also has a negative effect on CD4+ counts. Mental QOL scores were on average similarly higher at year 2 verses baseline for both groups (3.58 for users and 2.23 for non-users). Viral Loads are also similarly higher at year two verses baseline for both groups (0.39 for users and 0.41 for non-users). Graphs 1 through 4 visually represent the differences between non drug users and drug users for all four outcomes. These graphs also show that CD4+ counts and Physical QOL scores differences from baseline and year two appear to change between the drug users and non-users.

Table Three shows the drug user coefficient estimates for the crude and full models for all four outcomes. Estimated values did not differ greatly between the crude and full models. Every full model also had a lower DIC. Therefore, the full model was used as a final model for each of the outcomes.

Hard drug users' Physical QOL score is on average 3.65 units smaller than non-hard drug users (95% HPD: -5.92 to -0.47). There was not enough evidence to demonstrate a difference in Mental QOL score between the hard drug and not hard drug users (95% HPD: -4.09 to 2.94). There was also not enough evidence to demonstrate a difference in log(Viral Load) values (95% HPD: -0.16 to 0.10). Hard drug users' CD4+ Count is on average 82 units smaller than non-hard drug users (95% HPD: -128.0 to -40.16).

Supplementary tables 1-4 show the coefficient estimates for the other covariates in each of the full models. Hard Drug use has the largest effect on predicting average Physical QOL score and CD4+ Count differences, when adjusting for all other covariates. Income level had the large influence on average log(Viral Load) differences. Those in the higher two income brackets had on average larger

negative differences (-0.1033 for those in the medium income bracket and -0.2050 for those in the highest income bracket), meaning they had lower Viral Load values at year two than baseline, which is a good health outcome. None of the covariates had a large effect on average change in Mental QOL score.

Conclusions

Overall, we found evidence was found that hard drug use does effect some health outcomes from baseline to year 2 for HIV+ homosexual and bisexual men. They had lower physical QOL scores as well as lower CD4+ Counts compared to non-users. Smaller values of both these variables are associated with poorer general health. There was however no evidence that hard drug use had an effect on log(Viral Load) or mental health scores. Those with higher incomes had lower Viral Load levels at year two compared to baseline. None of the variables had a large effect on Mental QOL scores. These relationships held after controlling for nearly a dozen covariates.

This study had several limitations. Overall, the drug-users sample size was rather small. It is hard to know if the results found in this study can be generalized to the whole population of HIV+ homosexual and bisexual male drug users. Around 40 people were dropped from the study due to missing outcome data. The data appeared to be missing completely at random data, but it is possible that this data could be missing not at random. Finally, only two years of data were used in this analysis. Several more years of data should be analyzed to see if the results found in this analysis hold as years since baseline increases.

Tables and Figures

Table One: Demographics

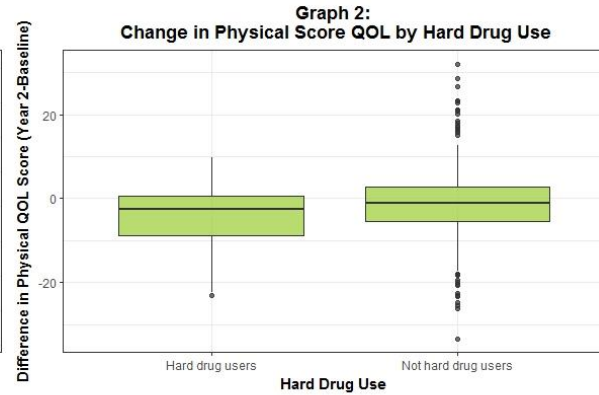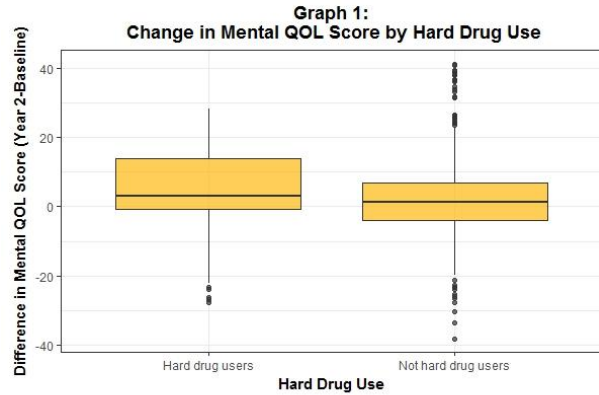| Variable	All Patients	Drug Users	Not Drug Users
N	476	39	437
Age (mean ± sd)	43.26 ± 8.72	44.62 ± 9.49	43.14 ± 8.65
BMI (mean ± sd)	25.21 ± 4.34	23.62 ± 3.45	25.34 ± 4.39
Race (% (n))			
White	62.61 (298)	48.72 (19)	63.84 (279)
Non-White	37.39 (178)	51.28 (20)	36.16 (158)
Marijuana Use (% (n))	40.76 (194)	30.77 (12)	41.65 (182)
Income (% (n))			
<10000	21.57 (99)	35.9 (14)	20.24 (85)
10000-39999	42.7 (196)	41.03 (16)	42.86 (180)
>40000	35.73 (164)	23.08 (9)	36.9 (155)
Smoker (% (n))	38.87 (185)	76.92 (30)	35.47 (155)
Alcohol consumption (% (n))			
3 or less/week	93.07 (443)	94.87 (37)	92.91 (406)
4 or more/week	6.93 (33)	5.13 (2)	7.09 (31)
Education (% (n))			
1 year college or less	21.22 (101)	41.03 (16)	19.45 (85)
4 year college or more	78.78 (375)	58.97 (23)	80.55 (352)
Adherence (% (n))			
100%	10.5 (50)	2.56 (1)	11.21 (49)
<100%	89.5 (426)	97.44 (38)	88.79 (388)

Table 2: Outcome Variables

Variable (mean ± sd)	All Patients	Drug Users	Not Drug Users
SF-36 Mental QOL Score (Baseline)	44.89 ± 13.5	42.31 ± 11.22	45.12 ± 13.68
SF-36 Physical QOL Score (Baseline)	51.04 ± 9.05	47.70 ± 8.5	51.34 ± 9.05
log(Viral Load) (Baseline)	10.40 ± 2.12	10.42 ± 1.97	10.40 ± 2.14
CD4+ T cell count (Baseline)	373.53 ± 200.46	352.18 ± 194.67	375.44 ± 201.07
SF-36 Mental QOL Score (2 year)	47.23 ± 11.98	45.89 ± 13.5	47.35 ± 11.85
SF-36 Physical QOL Score (2 year)	49.49 ± 10.14	43.84 ± 11.62	50.00 ± 9.86
log(Viral Load) (2 year)	4.14 ± 2.81	4.21 ± 3.22	4.13 ± 2.78
CD4+ T cell count (2 year)	542.74 ± 267.36	365.62 ± 239.7	558.54 ± 264.22
SF-36 Mental QOL Score (2 year - baseline)	2.34 ± 12.1	3.58 ± 15.07	2.23 ± 11.82
SF-36 Physical QOL Score (2 year - baseline)	-1.55 ± 8.37	-3.85 ± 8.71	-1.34 ± 8.32
log(Viral Load) (2 year - baseline)	0.41 ± 0.37	0.39 ± 0.25	0.41 ± 0.38
CD4+ T cell count (2 year - baseline)	169.21 ± 183.2	13.43 ± 195.73	183.11 ± 175.67

Table Three: Hard Drug Use Estimates

Outcome/Model	Estimate	SD	HPD Interval	DIC
Crude- CD4+ Count	-89.2782	21.7383	(-131.4, -45.8162)	6292.001
Full*-CD4+ Count	-82.7244	22.4302	(-128.0, -40.1647)	5880.173
Crude-log(Viral Load)	-0.0172	0.0615	(-0.1349, 0.1045)	390.493
Full*- log(Viral Load)	-0.0265	0.0664	(-0.1598, 0.1020)	370.170
Crude-Mental QOL Score	-0.0452	1.6673	(-3.2998, 3.2055)	3547.074
Full*- Mental QOL Score	-0.4596	1.7955	(-4.0932, 2.9386)	3328.946
Crude-Physical QOL Score	-3.6467	1.3329	(-6.2632, -1.0364)	3320.320
Full*- Physical QOL Score	-3.0955	1.3900	(-4.0932, 2.9386)	3093.463

*Full models are adjusted for smoking status, income level, marijuana use, drinks per week, race, education, ART Adherence, BMI, Age, and baseline (year 0) outcome measurement.

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Graph 1:
Change in Mental QOL Score by Hard Drug Use

Graph 2:
Change in Physical Score QOL by Hard Drug Use

Graph 3:
Change in log(Viral Load) by Hard Drug Use

Graph 4:
Change in CD4+ Count by Hard Drug Use
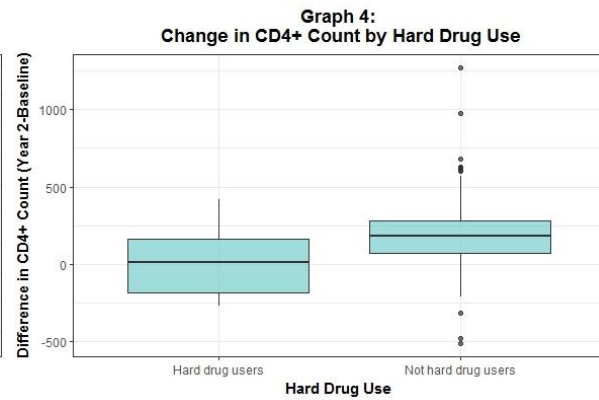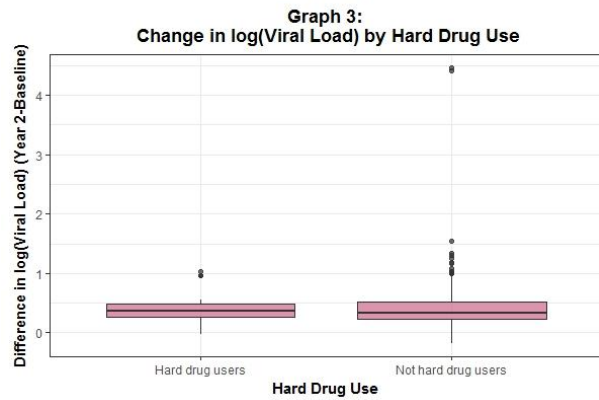
Supplementary Table 1: Physical QOL full model

Parameter	Mean	SD	95% HPD Interval	
betaint	15.5571	3.8337	7.8492	22.8782
betaSmokerInd	-0.8142	0.8160	-2.4438	0.7693
betaDrinksInd	-0.9509	1.3934	-3.7489	1.6555
betaRaceInd	-0.00104	31.5169	-63.1839	60.3756
betaEducationInd	1.0765	1.0254	-1.0104	3.0365
betaAdherenceInd	1.2473	1.2177	-1.1756	3.6359
betaIncomeMedInd	1.9025	1.0796	-0.2593	3.9646
betaIncomeHighInd	2.2565	1.2294	-0.0857	4.7270
betaHashVInd	0.6645	0.7363	-0.7715	2.0836
betaBMI	0.0674	0.0874	-0.1063	0.2335
betaAge	-0.1206	0.0436	-0.2044	-0.0331
betaHardDrugs	-3.0955	1.3900	-5.9218	-0.4560
betaQOLBase	-0.3301	0.0449	-0.4217	-0.2467
sigma2	58.1203	3.9406	50.5557	65.9492

Supplementary Table 2: Mental QOL full model

Parameter	Mean	SD	95% HPD Interval	
betaint	16.4836	4.0514	8.3123	24.1994
betaSmokerInd	1.7094	1.0780	-0.3658	3.8490
betaDrinksInd	-0.3037	1.8255	-3.9225	3.2268
betaRaceInd	-0.0148	31.6561	-61.0629	62.7091
betaEducationInd	1.0082	1.3450	-1.5492	3.7267
betaAdherenceInd	2.2911	1.6088	-0.9304	5.4409
betaIncomeMedInd	1.0091	1.3554	-1.6265	3.6806
betaIncomeHighInd	2.4132	1.5294	-0.7007	5.2883
betaHashVInd	1.3467	0.9828	-0.6841	3.1706
betaBMI	0.0467	0.1132	-0.1786	0.2639
betaAge	0.0820	0.0562	-0.0267	0.1934
betaHardDrugs	-0.4596	1.7955	-4.0932	2.9386
betaQOLBase	-0.5325	0.0357	-0.5997	-0.4605
sigma2	98.5281	6.6923	85.5501	111.8

Supplementary Table 3: log(Viral Load) full model

Parameter	Mean	SD	95% HPD Interval	
betaint	1.2957	0.1793	0.9446	1.6489
betaSmokerInd	-0.0445	0.0394	-0.1206	0.0326
betaDrinksInd	-0.0146	0.0672	-0.1459	0.1163
betaRaceInd	0.0948	31.5773	-60.9702	62.9607
betaEducationInd	0.0401	0.0496	-0.0557	0.1391
betaAdherenceInd	-0.1476	0.0596	-0.2601	-0.0262
betaIncomeMedInd	-0.1033	0.0510	-0.2036	-0.00348
betaIncomeHighInd	-0.2050	0.0580	-0.3182	-0.0910
betaHashVInd	-0.0474	0.0361	-0.1181	0.0233
betaBMI	-0.00851	0.00415	-0.0166	-0.00031
betaAge	-0.00009	0.00204	-0.00412	0.00389
betaHardDrugs	-0.0265	0.0664	-0.1598	0.1020
betaQOLBase	-0.0392	0.00872	-0.0570	-0.0228
sigma2	0.1340	0.00910	0.1165	0.1519

Supplementary Table 4: CD4+ Count full model

Parameter	Mean	SD	95% HPD Interval	
betaint	49.3244	56.2513	-63.3750	156.9
betaSmokerInd	-10.6357	15.8172	-41.2600	20.5217
betaDrinksInd	-3.5441	22.5173	-46.3216	41.3411
betaRaceInd	-0.4483	31.3761	-61.3312	61.3356
betaEducationInd	18.5881	18.0337	-17.3557	53.5656
betaAdherenceInd	31.2939	20.7659	-9.9594	71.0130
betaIncomeMedInd	17.6851	17.1761	-15.6573	51.5377
betaIncomeHighInd	-25.8987	18.8165	-62.5089	10.6131
betaHashVInd	30.0291	14.8598	0.7312	58.6988
betaBMI	4.8718	1.8004	1.3214	8.3564
betaAge	-0.5504	0.9183	-2.3870	1.2311
betaHardDrugs	-82.7244	22.4302	-128.0	-40.1647
betaQOLBase	-0.0584	0.0403	-0.1355	0.0221
sigma2	30235.4	2063.7	26313.3	34327.1

Reproducible Research Information

Code to generate the results in this report can be found at:
https://github.com/BIOS6623-UCD/bios6623-elcotton/tree/master/Project1