## **Supplemental Appendix Tables**

Table A1 –Raw Data Sources and Relevant Corresponding Data Elements

Database	Date Range of Data	Relevant Data Elements
Drug Program	Apr. 1/2000 –	Prescriptions for benzodiazepines (ATC codes
Information Network	Mar. 31/2016	N03AE, N05BA, N05CD), Z-Drugs (N05CF),
(DPIN)		Antidepressants, Antipsychotics, Mood stabilisers,
		Lithium and Opioids
		-Drug, dosage strength, dosage type, metric
		quantity dispensed, day supply, date of
		dispensation
Manitoba Health	Apr. 1/1996 –	Birth date/age of patient; sex; location of
Insurance Registry	Mar. 31/2016	residence, marital status, date of Manitoba Health
		coverage, date of coverage end, reason for
)	1/1006	coverage end (i.e death, emigration etc.)
Medical Claims	Apr. 1/1996 –	Services - type of physician (e.g., psychiatrist);
(Physician Billings)	Mar. 31/2016	dates of services, specific diagnoses (ICD-9 or
	1/1006	ICD-10 equivalent)
Hospital Separations	Apr. 1/1996 –	Diagnoses (ICD-9 or ICD-10 equivalent), length
Abstracts	Mar. 31/2016	of stay, admission dates, discharge dates,
Provider	Apr. 1/1996 –	Physician Age, Sex, Specialty
Registry/Physician	Mar. 31/2016	
Master File		
Social Allowances	Apr. 1/2001-	Receipt of income assistance
Management Information	Mar. 31/2013	
Network (SAMIN)		

Table A2 – International Classification for Disease Coding for Mood/Anxiety/Sleep Disorders (Cohort Inclusion)

	Source 1 - CPHA	Source 2 - MCHP	Study Algorithm

ICD Codes	All Mental Health Disorders: 9-CM: 290-319 10-CA: F00-F99	Mood Disorders: 296 and 311 (ICD-9-CM) or F30-F34, F39 (ICD 10-CA)	Mood disorders: 296 and 311 (ICD-9-CM) or F30-F34, F39 (ICD 10-CA)
		Anxiety Disorders: 300 (ICD-9-CM) or F40-F42	Anxiety disorders: 300 (ICD-9-CM) or F40-F43 (ICD-10- CA)
			Sleep disorders: 307, 780 or F51, G47 ICD-10-CA)
Case Definition	≥1 hospitalization or outpatient medical claim within 1 year	≥1 hospitalization or ≥1-3 outpatient medical claims within 3-5 years*	≥1 hospitalization or ≥3 outpatient medical claims within 5 years**

<sup>\*</sup>Range of similar definitions between studies from 2000 to 2016

Table A3 – International Classification for Disease Coding Algorithms for Seizure, Cancer and Palliation (Cohort Exclusion)

	Seizure	Cancer and other	Palliation
		Neoplasms	
ICD Codes	9-CM: 345	9-CM: 140-165, 170-	N/A*
	10-CA: G40	176,179-195, 200-208	
		10-CA: C00-C99	
Case Definition	≥1 hospitalization or	≥1 hospitalization or ≥3	Carrier code
	≥3 outpatient	outpatient medical	indicating palliative
	medical claim within	claims within 5 years	drug program
	5 years before index	before index date	enrollment in DPIN
	date		

<sup>\*</sup>While ICD codes do exist for palliation, the DPIN carrier code '04' is expected to be a reliable indicator of when patients become ill enough that community use of medication is required for symptom management.

<sup>\*\*</sup>The decision to use a 5-year pre-exposure window was based on the fact that all patients received a BZRA, which itself increases specificity for anxiety/sleep disorder diagnoses.

Table A4 – Independent 'Patient' Variables for Prediction of Long-Term BZRA Use

Baseline Patient Characteristics  Definition (Variable)		Measurement Period
Age	3 age groups; 18-44, 45-64, 65+ (Ordinal)	Index Date
Sex	Male or Female (Dichotomous Categorical)	Index Date
Region	Urban; Winnipeg or Brandon postal-codes Rural; Any other Manitoba postal-code (Dichotomous Categorical)	Census Period closest in time to the index date
Socioeconomic Status	Socio-Economic Factor Index – Version 2 (SEFI-2) score composite of four variables based on geography; i) unemployment rate ii) average household income iii) proportion of single-parent households iv) proportion of population without high school education. Scores <0 indicate more favourable socioeconomic conditions Scores >0 indicate less ideal socioeconomic conditions (Ordinal Scale)	Census Period closest in time to the index date
Income Assistance	Record of income assistance (Dichotomous Categorical)	Up to 1-year before the Index Date
Marriage Record	Record of Marriage (Dichotomous Categorical)	Entire available registry period up to the Index Date
Residential Mobility (i.e frequent mover)	Average of 1 move every 3 years from beginning of registry coverage to index date (Dichotomous)	Entire available registry period up to the Index Date
Comorbidity Burden	Charlson Comorbidity Index (CCI) Score; 0, 1, 2+ (Ordinal Scale)	Up to 1-year before the Index Date
Healthcare Resource Use	Johns Hopkins Adjusted Clinical Groups Resource Utilization Band (Ordinal	Up to 1-year before the Index Date

	Scale); placement into a band (0 to 5) based on grouping of ICD	
Prescription Psychotropic Use (non-BZRA)	Receipt of Prescription (Dichotomous Categorical)	Up to 1-year before the Index Date and 6 months after the Index Date
Prescription Opioid Use	Receipt of Prescription (Dichotomous Categorical)	Up to 1-year before the Index Date and 6 months after the Index Date

Table A5 - Independent 'First-Prescription' Variables for Prediction of Long-Term BZRA Use

Characteristics of First Consultation and Subsequent Prescription	Definition	Measurement Period
Fiscal Year Period	Fiscal year of first prescription Assigned to 3 five-year intervals; 2001-2005, 2006- 2010, 2011-2015 (Ordinal)	Index Date
Prescriber	10 Years or More (Dichotomous)	Index Date
Sex of Prescriber	Male or Female (Dichotomous)	Index Date
Prescriber Specialty	General Practitioner, Psychiatry or Other (Categorical)	Index Date

**Table A6 – Logistic Regression Methodology** 

Criteria	Approach
Variable Selection	-Informal selection via published literature -Simple logistic regression; β values (p < 0.25)
	-Dichotomous Categorical; 0 or 1
W. H. C. F.	-Ordinal; discrete number scale starting at 1
Variable Coding	-Polychotomous Categorical; 0 or 1 with auto-generated dummy variables
	-No continuous variables retained
Events-per-Variable	-Minimum 10 events per independent variable rule
Conformity of Linear Gradient	-Ordered categorical variables assessed for conformity of linear gradient; nonconformity handled by variable transformation or separation into additional (design) variables (i.e fiscal year was shown to be linear with respect to outcome so condensed variable into 5-year increments)
Interaction effects	-Assessed at p < 0.01. Suspected interactions included; age*sex, residential mobility*SEFI*income assistance, psychotropic use*opioid use, RUB*CCI
Collinearity	-Analysis of variance inflation factor, correlation coefficients, eigenvalues  -Significant collinearity; combine variables or removal of inferior explanatory variable
Statistical Significance	-Wald 95% CI for β and OR's
Goodness-of-Fit Measures	-C-statistic, Log-Likelihood Ratio, Hosmer- Lemeshow Statistic
Fitting Procedure	-Stepwise addition/subtraction of variables -Assessment of clinical significance

**Table A7 – Goodness of Fit for Final Logistic Regression Models Predicting Long-Term Use of BZRA** 

Model	Model Type	Independent Variables	Likelihood Ratio (higher is better)	C statistic	Hosmer- Lemeshow Chi-Square Statistic
1	Main-Effects	9 Variables;  Age-Sex Category, Period of First Rx, Psychotropic Use, Opioid Use, Income Assistance, Marriage, RUB CCI Score, Residential Mobility	6932 (p < 0.001)	0.738	$   \begin{array}{c}     10.78 \\     (p = 0.215)   \end{array} $
2	Main-Effects + Interaction Effects	10 Variables:  All from Model 1 + Residential Mobility*Income Assistance	6945 (p < 0.001)	0.739	11.02 (p = 0.20)

 $\begin{tabular}{ll} Table \ A8-Proportion \ of \ Long-Term \ BZRA \ Use \ by \ Differing \ Parameters \ and \ Duration \ Thresholds \end{tabular}$ 

Scenario*	Long-Term Use Parameter	Prescription Lapse Criteria	Patients (n)	Proportion of Cohort
A1**	First-Use Episode ≥ 180 days	30 days or 50% of previous Day Supply	9,327	4.51%
A2	First-Use Episode ≥ 90 days	30 days or 50% of previous Day Supply	13,745	6.64%
A3	First-Use Episode ≥ 60 days	30 days or 50% of previous Day Supply	19,948	9.64%
A4	First-Use Episode ≥ 180 days	60 Days or 50% of previous Day Supply	13,050	6.31%
A5	First-Use Episode ≥ 180 days	90 Days	16,831	8.13%
A6	First-Use Episode ≥ 270 days	90 Days	15,214	7.35%
A7	First-Use Episode ≥ 365 days	90 Days	14,219	6.87%
B1	Mean Episode Duration ≥ 180 days	30 days or 50% of previous Day Supply	38,853	18.78%
B2	Mean Episode Duration ≥ 90 days	30 days or 50% of previous Day Supply	58,442	28.24%
В3	Mean Episode Duration ≥ 60 days	30 days or 50% of previous Day Supply	72,639	35.10%
B4	Mean Episode Duration ≥ 180 days	60 Days or 50% of previous Day Supply	44,593	21.55%
В5	Mean Episode Duration ≥ 180 days	90 Days	50,142	24.23%
В6	User Mean Episode Duration ≥ 270 days	90 Days	39,395	19.04%
В7	User Mean Episode Duration ≥ 365 days	90 Days	32,200	15.56%

<sup>\*</sup>A=First Episode Scenario; B=Mean Episode Duration Scenario

<sup>\*\*</sup>Primary Scenario Used for Logistic Regression

 $\label{thm:condition} \textbf{Table A9 - Proportion of Long-Term Z-Drug Use by \ Differing \ Parameters \ and \ Duration \ Thresholds}$ 

Scenario	Long-Term Use	Prescription	Patients (n)	Proportion of
	Parameter	Lapse Criteria		Sub-Cohort
A1	First-Use Episode ≥ 180 days	30 days or 50% of previous Day Supply	8,206	7.41%
A2	First-Use Episode ≥ 90 days	30 days or 50% of previous Day Supply	12,155	11.0%
A3	First-Use Episode ≥ 60 days	30 days or 50% of previous Day Supply	17,126	15.5%
A4	First-Use Episode ≥ 180 days	60 Days or 50% of previous Day Supply	10,437	9.43%
A5	First-Use Episode ≥ 180 days	90 Days	12,719	11.49%
A6	First-Use Episode ≥ 270 days	90 Days	11,117	10.04%
A7	First-Use Episode ≥ 365 days	90 Days	10,045	9.07%
B1	User Mean Episode Duration ≥ 180 days	30 days or 50% of previous Day Supply	21,859	19.75%
B2	User Mean Episode Duration ≥ 90 days	30 days or 50% of previous Day Supply	32,020	28.92%
В3	User Mean Episode Duration ≥ 60 days	30 days or 50% of previous Day Supply	39,690	35.85%
B4	User Mean Episode Duration ≥ 180 days	60 Days or 50% of previous Day Supply	24,098	21.77%
В5	User Mean Episode Duration ≥ 180 days	90 Days	26,477	23.92%
В6	User Mean Episode Duration ≥ 270 days	90 Days	21,040	19.01%
В7	User Mean Episode Duration ≥ 365 days	90 Days	17,358	15.68%

Table A10 – Patient Characteristics of Z-Drug Users by First Use Episode Duration

		Short-term	Long-term	Total
Number of (	Number of Users		8,204 (100%)	110,663 (100%)
Care Distribution	Male	40,516 (39.5%)	3,473 (42.3%)	43,989 (39.8%)
Sex Distribution	Female	61,943 (60.5%)	4,731 (57.7%)	66,674 (60.2%)
	18-44	42,663 (41.6%)	1,795 (21.9%)	44,458 (40.2%)
Age Category	45-64	39,817 (38.9%)	3,184 (38.8%)	43,001 (38.9%)
	65+	20,011 (19.5%)	3,227 (39.3%)	23,238 (21.0%)
	<-1	13,678 (13.3%)	981 (12.0%)	14,659 (13.2%)
6551.3.6	-1 to 0	45,136 (44.1%)	3,674 (44.8%)	48,810 (44.1%)
SEFI-2 Score	0 to 1	33,719 (32.9%)	2,885 (35.2%)	36,604 (33.1%)
	>1	9,958 (9.7%)	666 (8.1%)	10,624 (9.6%)
Residence	Urban	63,207 (61.7%)	3,313 (40.4%)	66,520 (60.1%)
Distribution	Rural	39,284 (38.3%)	4,893 (59.6%)	44,177 (39.9%)
High Residentia	Mobility	22,408 (21.9%)	2,523 (30.8%)	24,931 (22.5%)
Receipt of Income	Assistance	8,351 (8.2%)	758 (9.2%)	9,109 (8.2%)
Marriage Re	ecord	57,308 (55.9%)	4,595 (56.0%)	61,903 (55.9%)
	0 (no utilization)	1,771 (1.7%)	234 (2.9%)	2,005 (1.8%)
	1	3,205 (3.1%)	175 (2.1%)	3,380 (3.1%)
Johns Hopkins Healthcare	2	17,523 (17.1%)	1,012 (12.3%)	18,535 (16.7%)
Resource	3	65,067 (63.5%)	4,699 (57.3%)	69,766 (63.0%)
Utilization Band	4	10,810 (10.6%)	1,259 (15.3%)	12,069 (10.9%)
	5 (high- utilization)	4,083 (4.0%)	825 (10.1%)	4,908 (4.4%)

		Short-term	Long-term	Total
		400 470 (4000)	0.004 (4.004)	440 550 (4000)
Number of Users		102,459 (100%)	8,204 (100%)	110,663 (100%)
Charlson	0	72,490 (70.8%)	4,528 (55.2%)	77,018 (69.6%)
Comorbidity index	1	19,495 (19.0%)	1,905 (23.2%)	21,400 (19.3%)
Score	2+	10,506 (10.3%)	1,773 (21.6%)	12,279 (11.1%)
Non-BZRA	0	27,797 (27.1%)	1,784 (21.7%)	29,581 (26.7%)
Psychotropic Prescription	1	36,939 (36.1%)	2,156 (26.3%)	39,095 (35.3%)
Dispensations	2+	37,755 (36.8%)	4,266 (52.0%)	42,021 (38.0%)
	0	47,427 (46.3%)	3,298 (40.2%)	50,725 (45.8%)
Opioid Prescription Dispensations	1	34,505 (33.7%)	2,772 (33.8%)	37,277 (33.7%)
	2+	20,559 (20.1%)	2,136 (26.0%)	22,695 (20.5%)
Sex of Prescriber Issuing First Prescription	Male	71,485 (69.8%)	5,627 (68.6%)	77,112 (69.7%)
	Female	28,485 (27.8%)	2,273 (27.7%)	30,758 (27.8%)
Age of Prescriber Issuing First	50+ Years	47,871 (46.7%)	4,014 (48.9%)	51,885 (46.9%)
Prescription	<50 Years	49,257 (48.1%)	3,758 (45.8%)	53,015 (47.9%)
Type of Prescriber Issuing First	General Practitioner	78,610 (76.7%)	6,366 (77.6%)	84,976 (76.8%)
Prescription	Psychiatry	3,912 (3.8%)	475 (5.8%)	4,387 (4.0%)
,	Other	3,881 (3.8%)	381 (4.6%)	4,262 (3.9%)
Period of First	2001-2006	34,360 (33.5%)	1,526 (18.6%)	35,886 (32.4%)
Prescription	2006-2011	37,752 (36.8%)	2,808 (34.2%)	40,560 (36.7%)
'	2011-2016	30,379 (29.6%)	3,872 (47.2%)	34,251 (31.0%)

 $\begin{tabular}{ll} Table A11-Frequency of Charlson Comorbidity Group Diagnoses by First Use Episode \\ Duration for Z-Drug Cohort \\ \end{tabular}$ 

<b>Charlson Diagnosis</b>	Short-Term	Long-Term 'First-		
	'First-Episode'	Episode' Users	<b>Z-Test of Two</b>	
	Users	(n=8,204)	<b>Proportions</b>	
	(n=102,459)			
Myocardial Infarction	1,836 (1.8%)	306 (3.7%)	p < 0.01	
Congestive Heart Failure	3,174 (3.1%)	700 (8.5%)	p < 0.01	
Peripheral Vascular Disease	1,772 (1.7%)	284 (3.5%)	p < 0.01	
Cerebrovascular Disease	2,321 (2.3%)	550 (6.7%)	p < 0.01	
Dementia	1,925 (1.9%)	865 (10.5%)	p < 0.01	
COPD	12,357 (12.1%)	1,171 (14.3%)	p < 0.01	
Connective	1 006 (1 00/)	242 (2.00/)	n < 0.01	
Tissue/Rheumatic Disease	1,906 (1.9%)	243 (3.0%)	p < 0.01	
Peptic Ulcer Disease	1,111 (1.1%)	123 (1.5%)	p < 0.01	
Mild Liver Disease	1,672 (1.6%)	139 (1.7%)	p = 0.33	
Moderate/Severe Liver	275 (0.2%)	38 (0.4%)	p < 0.01	
Disease Unacconficated Dishetes	0.217 (0.10/)	1 150 (14 00/)	- c 0 01	
Uncomplicated Diabetes	9,317 (9.1%)	1,150 (14.0%)	p < 0.01	
Complicated Diabetes	1,639 (1.6%)	328 (4.0%)	p < 0.01	
Paraplegia and Hemiplegia	508 (0.5%)	136 (1.7%)	p < 0.01	
Renal Disease	1,543 (1.5%)	293 (3.6%)	p < 0.01	
Cancer	2,109 (2.1%)	247 (3.0%)	p < 0.01	
Metastatic Carcinoma	429 (0.4%)	45 (0.5%)	p = 0.04	
HIV/AIDS	118 (0.1%)	16 (0.2%)	p = 0.02	

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Table A12 – Statistical Associations between Predictor Variables and Long-term Use of Z-Drugs

		Use Duration					
<u>Independent Variable</u>		≥ <b>180</b> days		≥90 days		≥60 days	
		Crude OR (95% CI)	Adjusted OR (95% CI)	Crude OR (95% CI)	Adjusted OR (95% CI)	Crude OR (95% CI)	Adjusted OR (95% CI)
Мс	ıle	1.12 (1.07-1.18)	1.04 (0.99-1.09)	1.13 (1.08-1.17)	1.05 (1.01-1.10)	1.08 (1.05-1.12)	1.04 (1.00-1.08)
	18-44	1 (ref)	1 (ref)	1 (ref)	1 (ref)	1 (ref)	1 (ref)
Age	45-64	1.90 (1.79-2.02)	2.02 (1.89-2.17)	1.74 (1.66-1.82)	1.78 (1.68-1.88)	1.71 (1.64-1.78)	1.68 (1.60-1.76)
	65+	3.83 (3.61-4.07)	3.71 (3.44-4.00)	3.24 (3.08-3.40)	3.08 (2.90-3.28)	2.99 (2.87-3.12)	2.78 (2.64-2.93)
Rural Re	esidence	0.92 (0.88-0.96)	1.13 (1.07-1.19)	0.99 (0.96-1.03)	1.02 (0.98-1.07)	1.08 (1.04-1.11)	0.95 (0.91-0.99)
High Residential Mobility		1.59 (1.51-1.67)	1.26 (1.19-1.33)	1.53 (1.46-1.59)	1.21 (1.15-1.27)	1.30 (1.26-1.35)	1.12 (1.07-1.17)
Income A	ssistance	1.15 (1.06-1.24)	1.47 (1.34-1.61)	1.02 (0.95-1.09)	1.29 (1.19-1.40)	0.82 (0.77-0.87)	1.08 (1.00-1.17)
	<-1	1 (ref)	1 (ref)	1 (ref)	1 (ref)	1 (ref)	1 (ref)
SEFI-2 Score	-1 to 0	1.14 (1.06-1.22)	1.07 (0.99-1.16)	1.03 (0.97-1.09)	0.98 (0.92-1.04)	0.95 (0.91-1.00)	0.94 (0.89-0.99)
SEF1-2 Score	0 to 1	1.19 (1.11-1.29)	1.08 (0.99-1.17)	1.04 (0.98-1.11)	0.99 (0.93-1.06)	0.92 (0.87-0.97)	0.93 (0.88-0.99)
	>1	0.93 (0.84-1.03)	0.84 (0.75-0.94)	0.80 (0.73-0.87)	0.77 (0.70-0.85)	0.68 (0.63-0.73)	0.72 (0.66-0.78)
Mar	ried	1.00 (0.96-1.05)	0.86 (0.82-0.91)	1.07 (1.03-1.10)	0.93 (0.89-0.98)	1.13 (1.10-1.17)	0.98 (0.94-1.01)
Opioi	d Use	1.28 (1.22-1.34)	1.15 (1.09-1.21)	1.26 (1.21-1.31)	1.15 (1.11-1.20)	1.18 (1.14-1.21)	1.11 (1.07-1.15)

Independent Variable		Use Duration					
		≥180 days		≥90 days		≥60 days	
		Crude OR (95% CI)	Adjusted OR (95% CI)	Crude OR (95% CI)	Adjusted OR (95% CI)	Crude OR (95% CI)	Adjusted OR (95% CI)
Psychotropic Rx Use (Non-BZRA)		1.34 (1.27-1.41)	1.24 (1.17-1.32)	1.35 (1.29-1.41)	1.27 (1.20-1.33)	1.22 (1.17-1.27)	1.19 (1.14-1.24)
	0	1 (ref)	1 (ref)	1 (ref)	1 (ref)	1 (ref)	1 (ref)
Charlson Comorbidity	1	1.56 (1.48-1.65)	1.25 (1.18-1.33)	1.45 (1.39-1.52)	1.21 (1.15-1.27)	1.33 (1.28-1.38)	1.13 (1.08-1.19)
Index Score	2+	2.70 (2.55-2.87)	1.46 (1.36-1.58)	2.34 (2.22-2.46)	1.38 (1.29-1.47)	2.02 (1.93-2.12)	1.30 (1.22-1.37)
	0-3 (≤Moderate)	1 (ref)	1 (ref)	1 (ref)	1 (ref)	1 (ref)	1 (ref)
Resource Utilization Band	4 (High)	1.67 (1.56-1.78)	1.16 (1.08-1.25)	1.47 (1.39-1.56)	1.09 (1.01-1.16)	1.30 (1.24-1.37)	1.00 (0.95-1.07)
Ollitzation Bana	5 (Very High)	2.89 (2.67-3.13)	1.55 (1.41-1.70)	2.43 (2.26-2.61)	1.42 (1.30-1.55)	1.97 (1.85-2.11)	1.22 (1.12-1.32)
Male Prescriber of First Prescription		0.99 (0.94-1.04)	0.97 (0.92-1.03)	0.98 (0.94-1.02)	0.98 (0.93-1.02)	0.94 (0.90-0.97)	0.93 (0.90-0.97)
Prescriber Age ≥50 Years		1.10 (1.05-1.15)	0.98 (0.93-1.03)	1.10 (1.06-1.15)	0.98 (0.94-1.02)	1.15 (1.11-1.19)	1.05 (1.01-1.09)
	GP	1 (ref)	1 (ref)	1 (ref)	1 (ref)	1 (ref)	1 (ref)
Prescriber of First Prescription	Psychiatrist	1.50 (1.36-1.66)	1.96 (1.76-2.17)	1.36 (1.25-1.49)	1.72 (1.57-1.89)	1.11 (1.02-1.20)	1.38 (1.27-1.51)
	Other	1.21 (1.09-1.35)	0.92 (0.82-1.03)	1.18 (1.07-1.29)	0.91 (0.83-1.00)	1.19 (1.10-1.29)	0.98 (0.91-1.07)
	2001-2006	1 (ref)	1 (ref)	1 (ref)	1 (ref)	1 (ref)	1 (ref)
Period of First Prescription	2006-2011	1.68 (1.57-1.79)	1.57 (1.46-1.68)	1.67 (1.59-1.76)	1.56 (1.47-1.66)	1.53 (1.46-1.60)	1.46 (1.39-1.54)
	2011-2015	2.87 (2.70-3.05)	2.45 (2.28-2.65)	2.83 (2.69-2.97)	2.44 (2.30-2.59)	2.20 (2.10-2.29)	1.96 (1.86-2.07)