

Comparison between Individual and Ecological-Level Models: An HIV PrEP Prescription Example Using a National Pharmacy Database

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Abstract

Aggregate data may offer valuable clues about variable relationships, but the relationships do not necessarily hold at the individual-level. In this analysis, we include a policy level variable as a contextual predictor in both an individual and an ecological model of HIV pre-exposure prophylaxis (PrEP) prescription. Using a national pharmacy database, we assess the comparability of predictors of PrEP prescription by nurse practitioners (NPs) at the individual- and ecological-level using two statistical approaches: an ecological-level (state-level) Poisson regression with robust error variance and an individual-level hierarchical logistic regression model. The predictors are state NP scope of practice laws (both models: full practice, reduced practice and restricted practice), patient age (individual model: 5 age categories; ecological model: % 25 years of age or younger) and patient gender (individual model: male/female; ecological model % male). Scope of practice laws was significant in both models. Patient age and gender were significant in the individual model but only age was significant in the ecological model. The influence of policy level variable on individual and ecological outcomes are discussed.

Key Words: Aggregate, Ecological analyses, HIV PrEP, statistical models

1. Introduction

Oral antiretroviral pre-exposure prophylaxis (PrEP) is a safe and effective strategy for HIV prevention (Grant, Lama, and Anderson, 2010). The Centers for Disease Control and Prevention (CDC) has released several guidelines for healthcare providers regarding PrEP implementation (CDC, 2018). Providers play a crucial role in effective implementation of PrEP intervention strategies (Krakower and Mayer, 2016). Previous research has indicated low rates of PrEP prescription by health care providers. One barrier might be scope of practice restrictions on nurse practitioners (NPs) (Krakower, Ware, and Mitty, 2014). The objective of the current study is to develop statistical models to identify the variable relationships for individual and aggregate-level data and to compare approaches for determining significant predictors associated with PrEP prescription by NPs.

2. Data Sources

The PrEP prescription data are 2017 pharmacy data from the IQVIA Real World Data—Longitudinal Prescriptions database. The IQVIA database captured prescription transactions from all payers, representing approximately 92% of all prescriptions dispensed from retail pharmacies and 60%-86% of those dispensed from mail order outlets in the United States. In addition to antiretroviral drugs dispensed, the IQVIA database also included variables for patient demographics, residence state, date of service, prescriber type and specialty, and patients' medical claims, if available (n=79,023 eligible PrEP users). The state's scope of practice law data were obtained from the American Association of Nurse Practitioners (AANP)'s interactive State Practice Environment (<https://www.aanp.org/advocacy/state/state-practice-environment>).

3. Methods

We created a combined dataset by linking 2017 IQVIA pharmacy data including PrEP prescriptions from 50 states and the District of Columbia, with state scope of practice law data. The main individual-level outcome was whether PrEP was prescribed by NPs for new PrEP users during 1st time they were prescribed in 2017. The

aggregate-level outcome was the proportion of PrEP prescriptions by NPs, calculated by dividing the number of NP PrEP prescriptions by the number of total prescriptions during the year for each state.

Additional covariates included in the multivariate model were individual-level demographic variables such as patient age and patient gender, and aggregate-level demographic variables such as percentage of PrEP users <25 years old in each state and percentage of male PrEP users in each state. State-level laws were categorized into: (1) full practice, (2) reduced practice, and (3) restricted practice, according to NP's prescription authority as determined by each state law. (Figure 1)

To assess the comparability of predictors of PrEP prescription by Nurse Practitioners at the individual and aggregate-levels, we conducted two statistical analyses: a state- (ecological-) level Poisson regression with robust error variance and an individual-level hierarchical logistic regression model. For each level outcome, we computed prevalence ratios to determine the association between PrEP prescription by NPs and covariates.

4. Results

Both the individual-level and ecological-level models identified state licensure law as a significant predictor of PrEP prescription by NPs. (Tables 2 and 3). Younger age of patient (<25 years old) was associated with a higher likelihood of PrEP prescription by NPs in both models. (Tables 2 and 3). Patient being male was associated with a lower likelihood of PrEP prescription by NPs in the individual-level model but not in the ecological-level model. (Table 2 and 3)

Fig 1. Distribution of Nurse Practitioner Licensure Law Type by State 2017

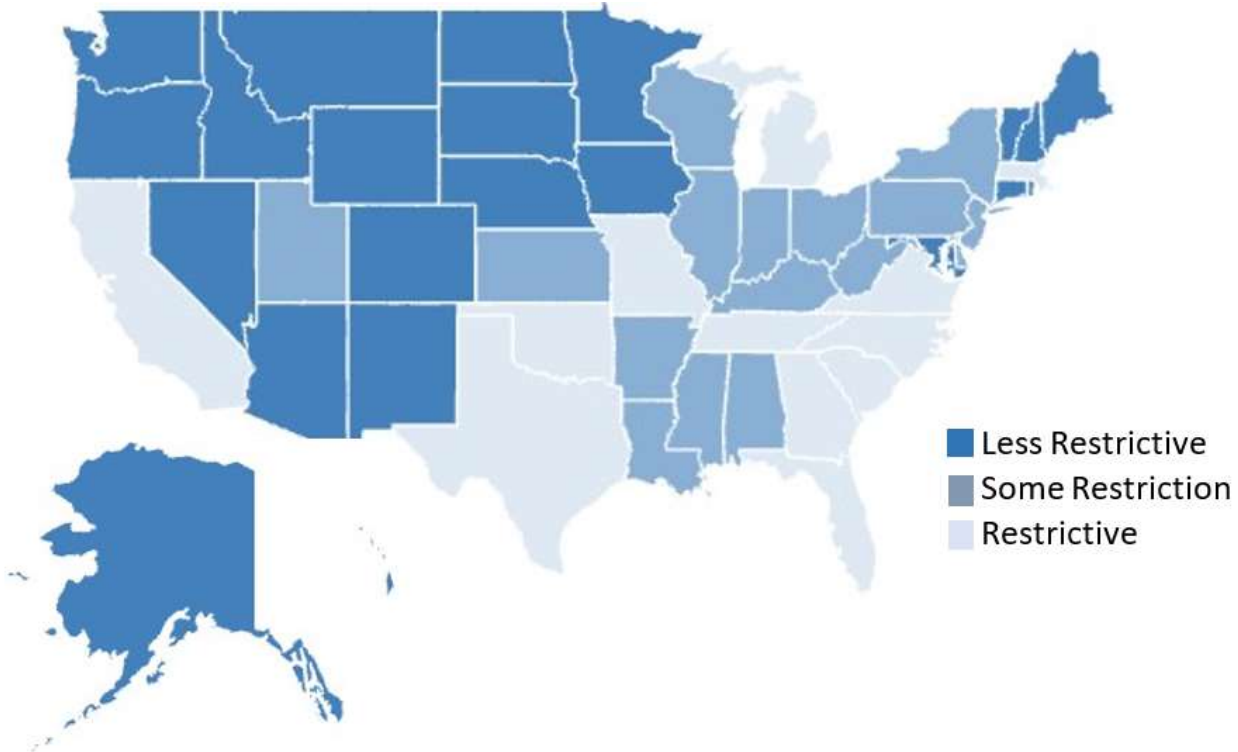


Table 1. Descriptive statistics of state-level factors and individual level factors by Nurse Practitioners (NP) Licensure Law, IQVIA Longitudinal Prescription Database, United States, 2017

	States with Restricted Licensure	States with Reduced Licensure	States with Full Licensure
State level percentage of PrEP user			
States (number)	12	16	23
Younger than 25 years (mean %, SD)	16.20 (2.42)	19.58 (4.41)	18.90 (6.31)
Male (mean %, SD)	91.15 (1.70)	89.51 (3.54)	91.13 (3.78)
Individual patient level			
PrEP users (number)	35,167	28,751	15,084
Younger than 25 years (%)	15.57	18.42	16.98
Male (%)	92.44	90.89	92.37

Table 2. Comparison of models with bivariate analysis for estimating association with PrEP prescription by NP, IQVIA 2017

Covariate	Individual-level model		Ecological-level model	
	Coefficient (SE)	RR	Coefficient (SE)	RR
NP Licensure law				
Restricted	Reference		Reference	
Reduced	0.31 (0.20)	1.27	0.35 (0.08) ***	1.42
Full	0.45 (0.19) *	1.40	0.32 (0.12) **	1.38
Percentage of PrEP user				
Younger than 25 years (%)	0.38 (0.02) ***	1.31	0.04 (0.02) **	1.04
Male (%)	-0.09 (0.03) **	0.94	-0.02 (0.02)	0.99

*p<.05, **p<.01, ***p<.001

Table 3. Comparison of models with multivariate analysis for estimating association with PrEP prescription by NP, IQVIA 2017

Covariate	Individual-level model		Ecological-level model	
	Coefficient (SE)	RR	Coefficient (SE)	RR
NP Licensure law				
Restricted	Reference		Reference	
Reduced	0.30 (0.20)	1.24	0.31 (0.09) ***	1.36
Full	0.45 (0.19) *	1.38	0.29 (0.12) **	1.33
Percentage of PrEP user				
Younger than 25 years (%)	0.38 (0.02) ***	1.31	0.03 (0.02) **	1.04
Male (%)	-0.09 (0.03) **	0.94	0.02 (0.02)	1.02

*p<.05, **p<.01, ***p<.001

5. Conclusions

For many policy-relevant research questions focused on understanding the relationship between state-level factors (e.g. state scope of practice law) and individual or aggregate-level outcomes, an ecological-level model is generally suitable (Jacob, Goddard and Kim, 2014). However, aggregate bias and confounding variables are major problems for ecological-level models. When individual-level characteristics were averaged by geographic area (i.e., state), aggregate bias occurred due to loss of individual variability. Thus, variable relationships for age and gender in ecological-level models should be interpreted with caution.

6. Limitations

IQVIA Prescription database is a convenience sample and may not be representative of all pharmacy data.

However, this sample represents approximately 92% of all prescriptions dispensed from retail pharmacies and 60% - 86% of prescriptions dispensed from mail order outlets in the United States. PrEP users were identified using an algorithm that might be subject to misclassification bias. Because we relied on an administrative database, missing data (e.g., provider type) was a common issue.

References

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