

Predictive Analytics in Child Welfare Using the Child and Adolescent Needs and Strengths (CANS)

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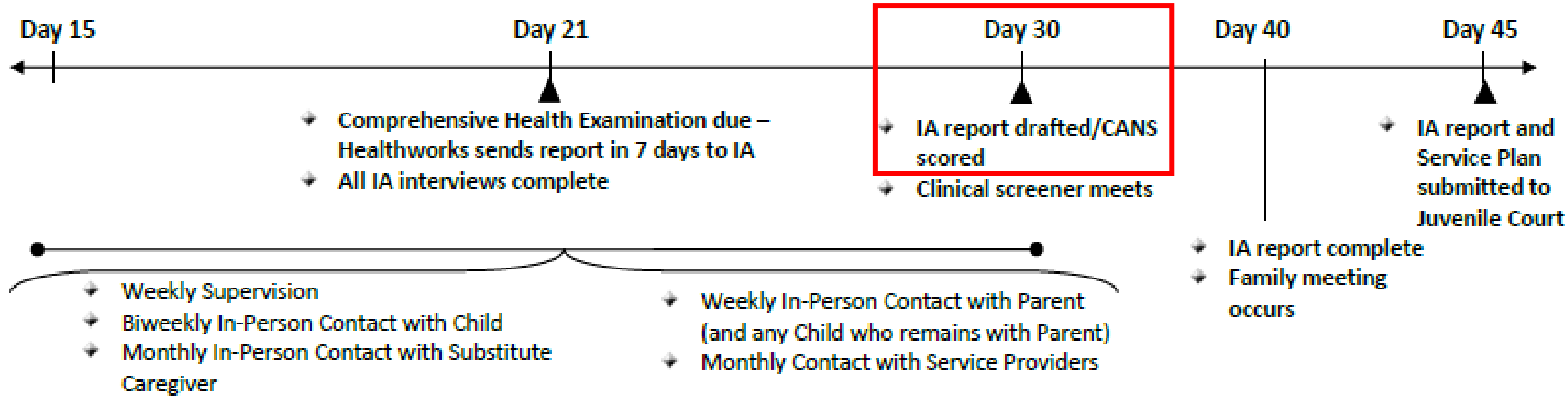
Overview

- **Background**
 - Illinois child welfare system
 - Use of the CANS
 - Predictive analytics
- **Predictive analytic studies**
 - Psychiatric hospitalization
 - Residential placement
- **Implications on implementation and practice**
- **Discussion**

Illinois Child Welfare System

- Lowest removal rate in the country (1.5 children per 1,000 children in the general population)¹
- >2 times the national median stay (>13.5 months vs. 6.5 months) in foster care until reunification²
- Integrated Assessment (IA): Assessment and service delivery for youth entering foster care:
 - Phase I: Initial Assessment – Begins during investigation by Child Protection
 - Phase II: Integrated Assessment (IA) – Begins once a youth is taken into Temporary Custody and ends with the completion of the **IA CANS**, development of the family service plan, and culmination of the initial Family Meeting, within 40 days after Temporary Custody
 - Phase III: Ongoing Assessment – Throughout the life of the family's involvement with DCFS

IA (Integrated Assessment) Timeline



Illinois CANS in the Illinois Child Welfare System

- Implementation since 2007
- Types
 - IA CANS (at entry)
 - Caseworker CANS (every 6 months)
 - CANS at residential treatment center (within 30 days of admission, every 90 days until discharge)
 - Child and Youth Investment Team CANS (triggered by placement disruption; no longer in use)
- Version evolution
 - Comprehensive CANS/CANS 1.0
 - CANS 2.0
 - IM-CANS

Predictive Analytics



Predictive Analytics

- Extracts information from large-scale data to identify data patterns and predict the likelihood of future outcomes
- Potential applications in the child welfare system:
 - **Identify individuals “at risk”** of an adverse event to inform prevention of the adverse event (e.g., psychiatric hospitalization, residential placement)
 - Identify **risk factors** to inform services and treatments tailored to the needs of the “at risk” individuals
 - Help child welfare administrators **allocate limited resources** (e.g., evidence-based/informed practices) to target populations (e.g., youth at risk of psychiatric hospitalization, residential placement)
 - Assist **decision-making** by providing additional information to caseworkers, supervisors, and administrators

Predictive Analytics

Empirically predict/estimate the likelihood/probability of an event/outcome of interest



- Prediction \neq Causality
- Prediction \neq Crystal ball
- Prediction \neq Absolute truth
- Prediction \neq Error free



Predictive Analytics: Methodological Approaches (Some)

- **Regression** (e.g., linear, time-to-event, Poisson)
 - Estimates relationship among selected variables
 - Can describe the strength (“weight”) of a predictor’s relationship with an outcome
 - “Best fit” line formula minimizes differences between “predicted” and “observed” outcomes
- **Machine Learning**
 - Searches for patterns in mass data
 - Modeled on artificial intelligence (i.e., “learning”)
 - Decision tree learning (e.g. random forest)
 - Deep learning (e.g. neural network)
 - Formula yields a probability of prediction

Both approaches yield algorithms for prediction

Evaluating a Predictive Analytic Model

- **Error rate**

- True Positive
- True Negative
- False Negative
- False Positive

		Actual Outcome	
		Yes	No
Predicted Outcome	Yes	True Positive	False Positive
	No	False Negative	True Negative

- **Threshold**

- Turning continuous predicted “risk scores” into categorical prediction (e.g., yes/no)

Two Examples: Incorporating CANS into Predictive Analytic Models

Predicting **psychiatric hospitalization** in a child welfare system

- 3.1% of the U.S. child welfare population experiences psychiatric hospitalization,³ the 3rd most costly Medicaid-funded service⁴
- Association with decreased placement stability and decreased likelihood of permanency⁵

Predicting **residential placement** in a child welfare system

- 12.2% of the U.S. child welfare population are placed in group home or institution on the last day of the federal fiscal year⁶
- Family First Prevention Services Act (FFPSA) (P. L. 115-123) and its Qualified Residential Treatment Programs (QRTPs) provisions

Predicting First Psychiatric Hospitalization at Entry to the Illinois Child Welfare System

- **Goal:** Estimate the risk of first psychiatric hospitalization among youth upon entering custody of DCFS in order to provide preventive interventions
- **Cohort:** DCFS legal custody spells of youth who entered DCFS custody between 1/1/10 and 12/31/18 who had a CANS within 90 days of the legal custody spell (n=24,540)
- **Predictive Analytic Model:** Cox proportional-hazards regression predicting first psychiatric hospitalization

Predicting First Psychiatric Hospitalization at Entry to the Illinois Child Welfare System

- **Fixed Predictors:** Gender, ethnicity, developmental disability status, DCFS region, year of entry to DCFS custody, number of prior DCFS legal custody spells, baseline CANS (average domain scores)
- **Time-Varying Predictors:** Age at beginning of each placement, most recent allegation type, number of prior placements, placement type, number of siblings in the same placement, and the interaction of number of siblings in the same placement by placement type
- **Outcome:** Psychiatric hospitalization as defined by DCFS living arrangement codes
- **Model Validation:** Using 200 bootstrap samples, examine model prediction accuracy using bias-corrected indices

CANS Predictors (Average Domain Scores)

CANS Domain	CANS Items
Traumatic Stress Symptoms (5 Items)	Adjustment to Trauma
	Re-experiencing
	Avoidance
	Numbing
	Dissociation

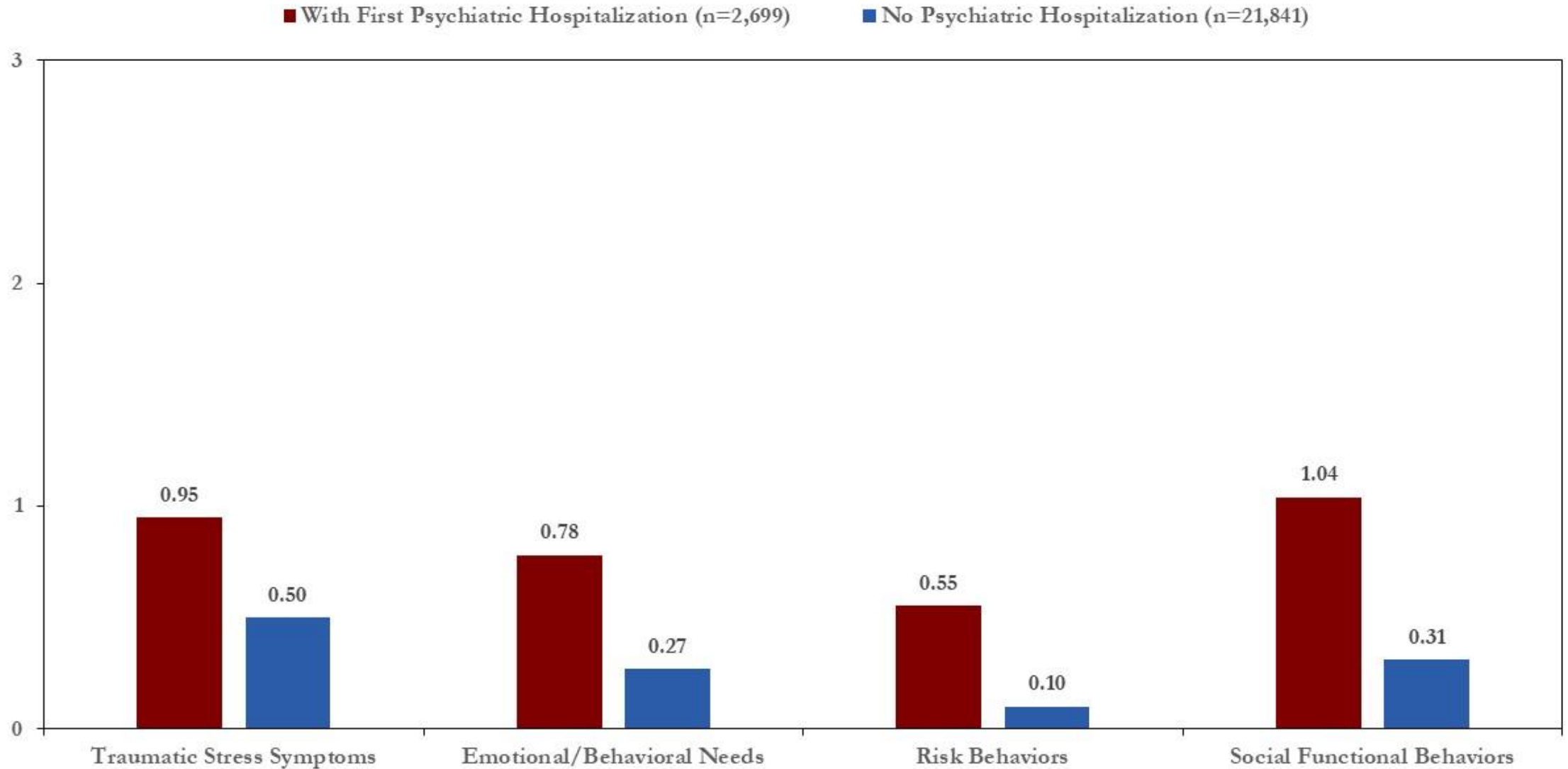
CANS Domain	CANS Items
Emotional/Behavioral Needs (13 Items)	Psychosis
	Attention Deficit/Impulse Control
	Depression
	Anxiety
	Oppositional Behavior
	Conduct
	Substance Abuse
	Attachment Difficulties
	Eating Disturbances
	Affect Dysregulation
	Behavioral Regression
	Somatization
	Anger Control

CANS Predictors (Average Domain Scores)

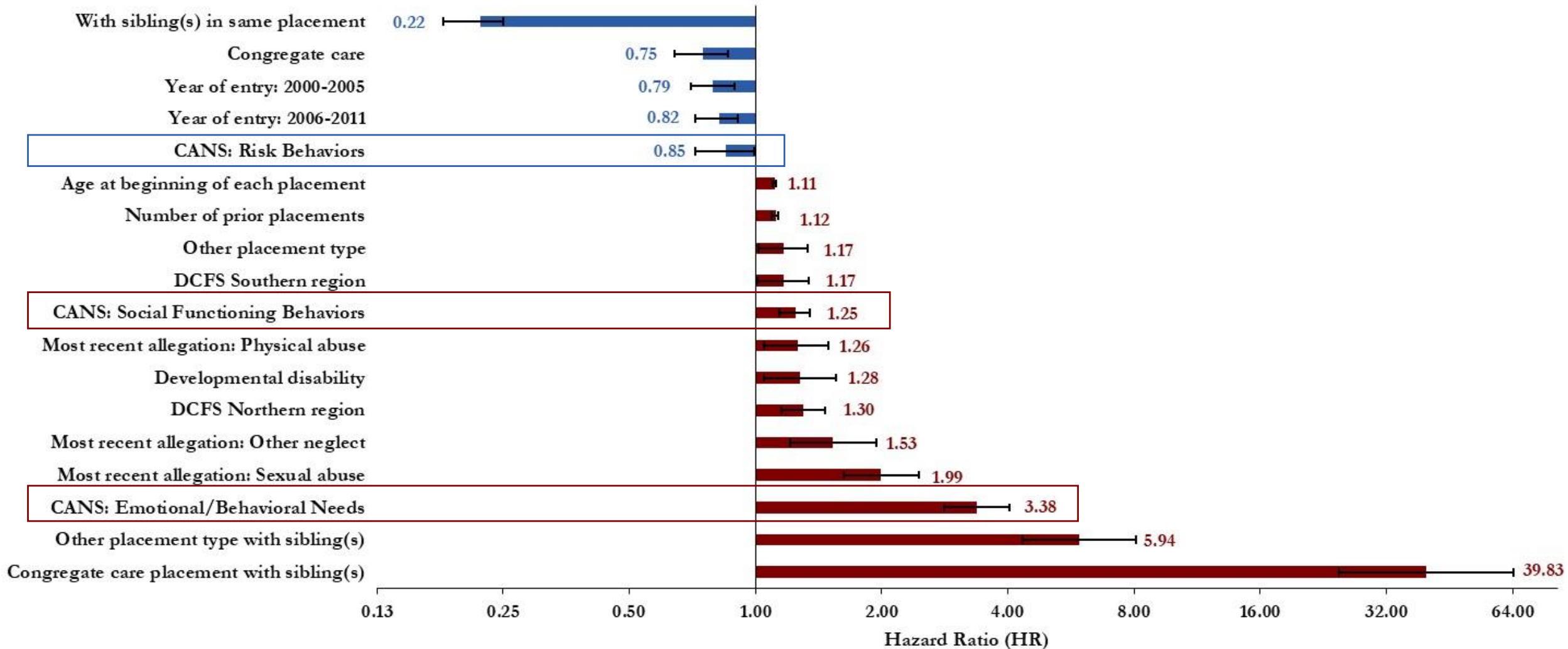
CANS Domain	CANS Items
Risk Behaviors (11 items)	Suicide Risk
	Self Mutilation
	Other Self-Harm
	Danger to Others
	Sexual Aggression
	Runaway
	Delinquency
	Judgment
	Fire Setting
	Social Behavior
	Sexually Reactive Behaviors

CANS Domain	CANS Items
Social Functional Behaviors (3 Items)	Social Functioning
	School Behavior
	Social Behavior

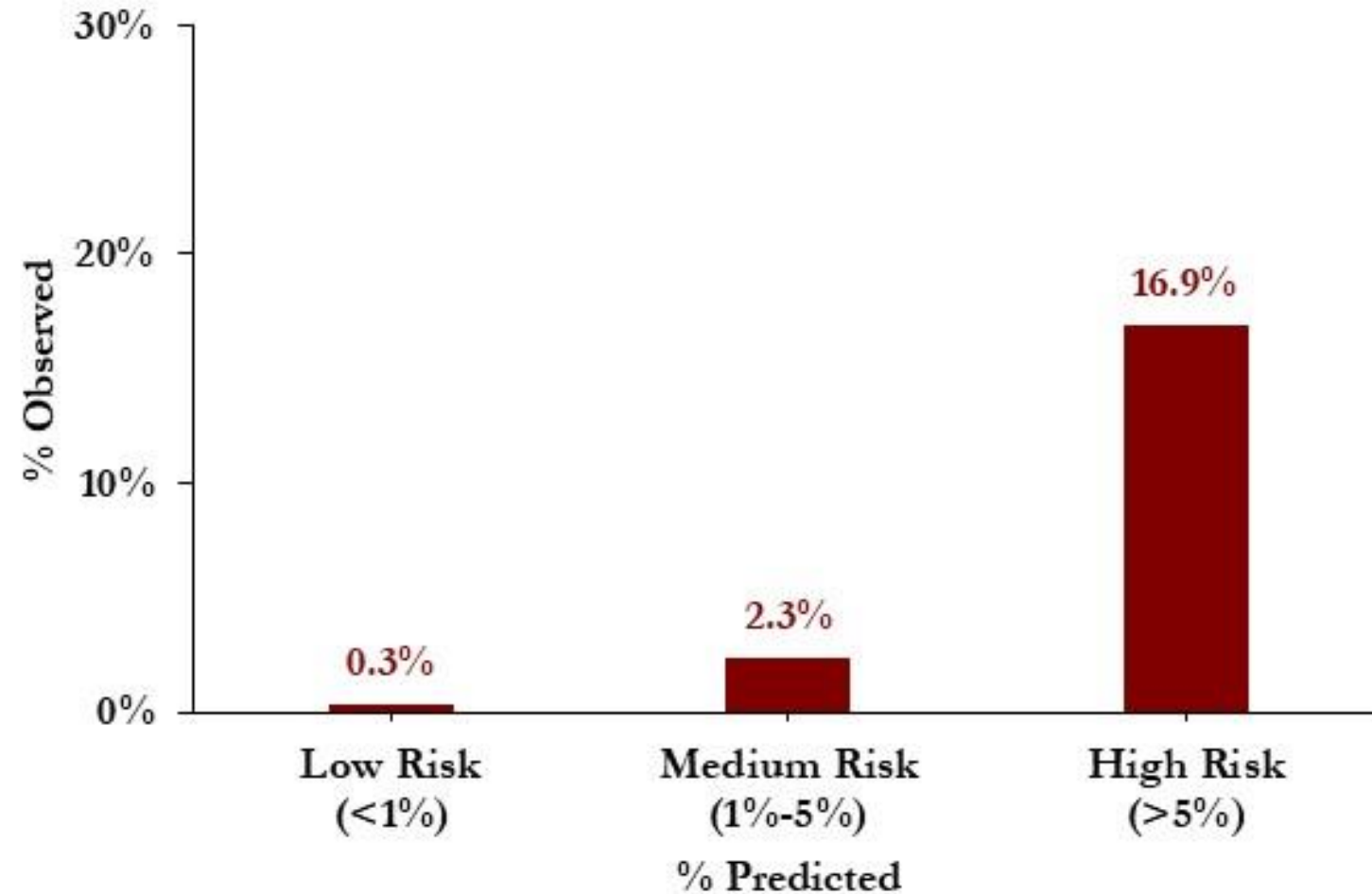
Descriptive Comparisons: Average Baseline CANS Domain Scores



Factors Associated with Decreased vs. Increased Risk of First Psychiatric Hospitalization



Psychiatric Hospitalization Risk within First 90 Days of Entry to DCFS Custody



Model Accuracy

Index	Original Cohort	Bootstrap Models Applied to Bootstrap Samples	Models Trained from Bootstrap Samples Applied to Original Cohort	Optimism/Bias Correction	Corrected Index	Number of Bootstrap Resample
Somers' D_{xy}	0.7729	0.7744	0.7715	0.0029	0.7700	200
c-statistics	0.8865	0.8872	0.8858	0.0015	0.8850	200
Naglkerke R^2	0.1370	0.1380	0.1362	0.0019	0.1351	200
Shrinkage slope	1.0000	1.0000	0.9893	0.0107	0.9893	200

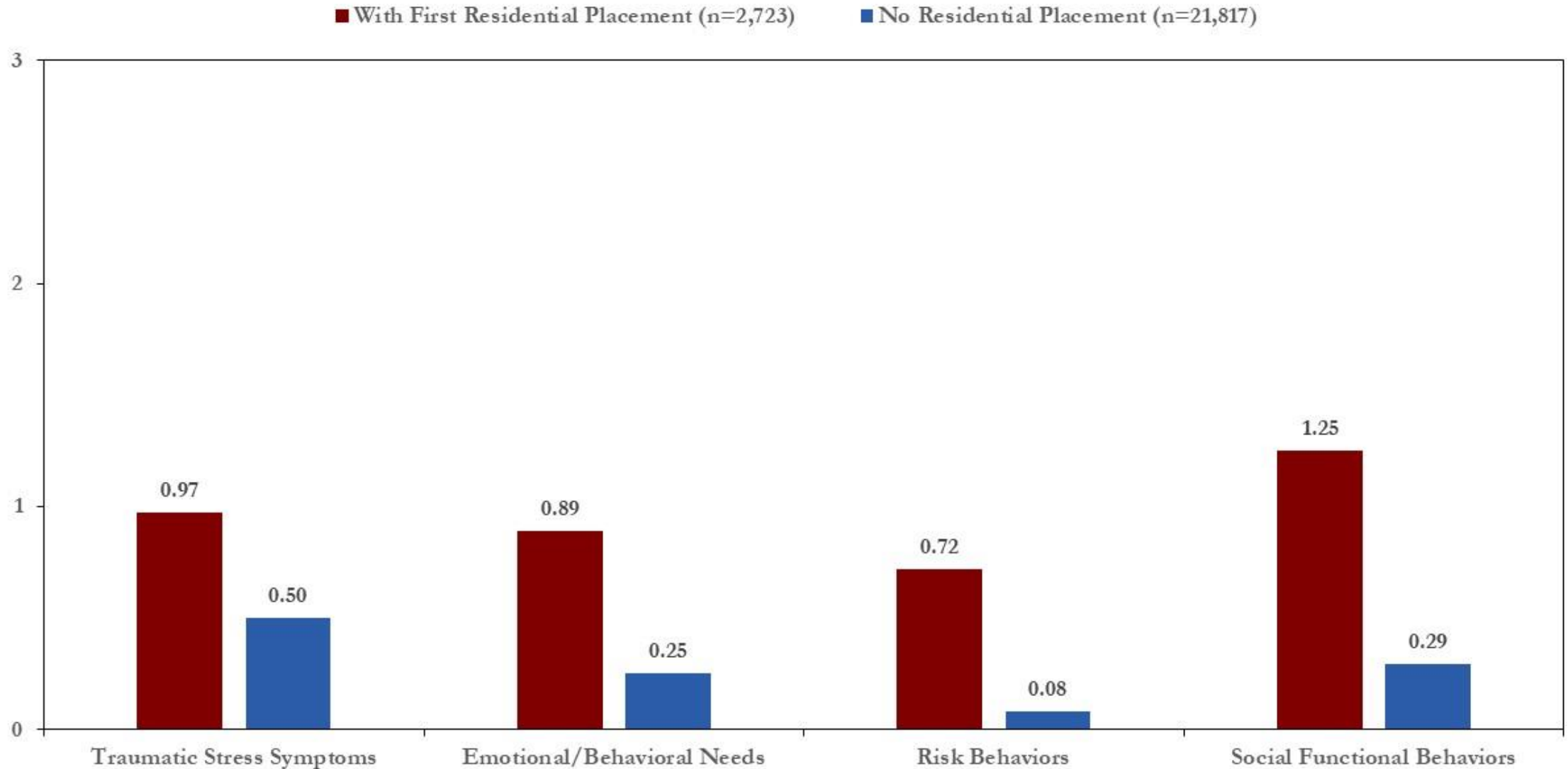
Predicting First Residential Placement at Entry to the Illinois Child Welfare System

- **Goal:** Estimate the risk of first residential placement among youth upon entering custody of DCFS in order to provide preventive interventions
- **Cohort:** DCFS legal custody spells of youth who entered DCFS custody between 1/1/10 and 12/31/18 who had a CANS within 90 days of the legal custody spell (n=24,540)
- **Predictive Analytic Model:** Cox proportional-hazards regression predicting first residential placement

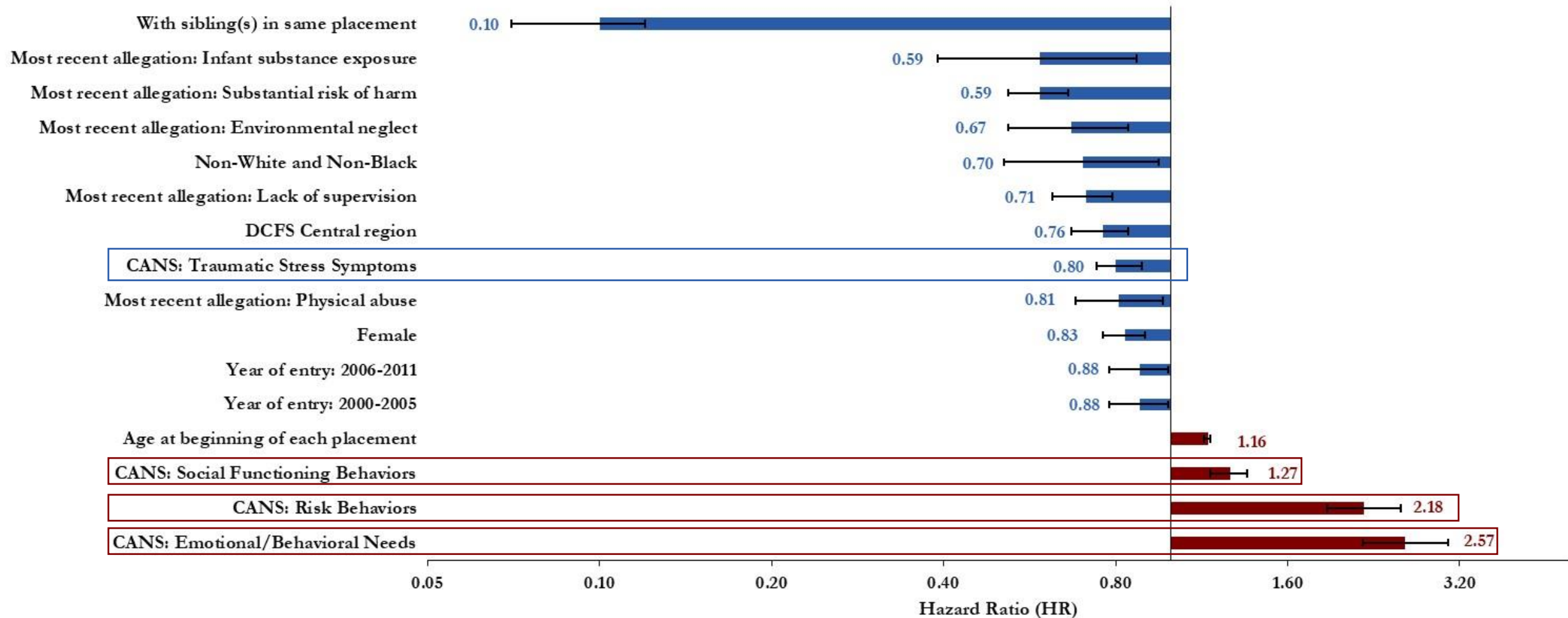
Predicting First Residential Placement at Entry to the Illinois Child Welfare System

- **Fixed Predictors:** Gender, ethnicity, developmental disability status, DCFS region, year of entry to DCFS custody, number of prior DCFS legal custody spells, baseline CANS (average domain scores)
- **Time-Varying Predictors:** Age at beginning of each placement, most recent allegation type, number of prior placements, number of siblings in the same placement
- **Outcome:** Residential placement as defined by DCFS living arrangement codes
- **Model Validation:** Using 200 bootstrap samples, examine model prediction accuracy using bias-corrected indices

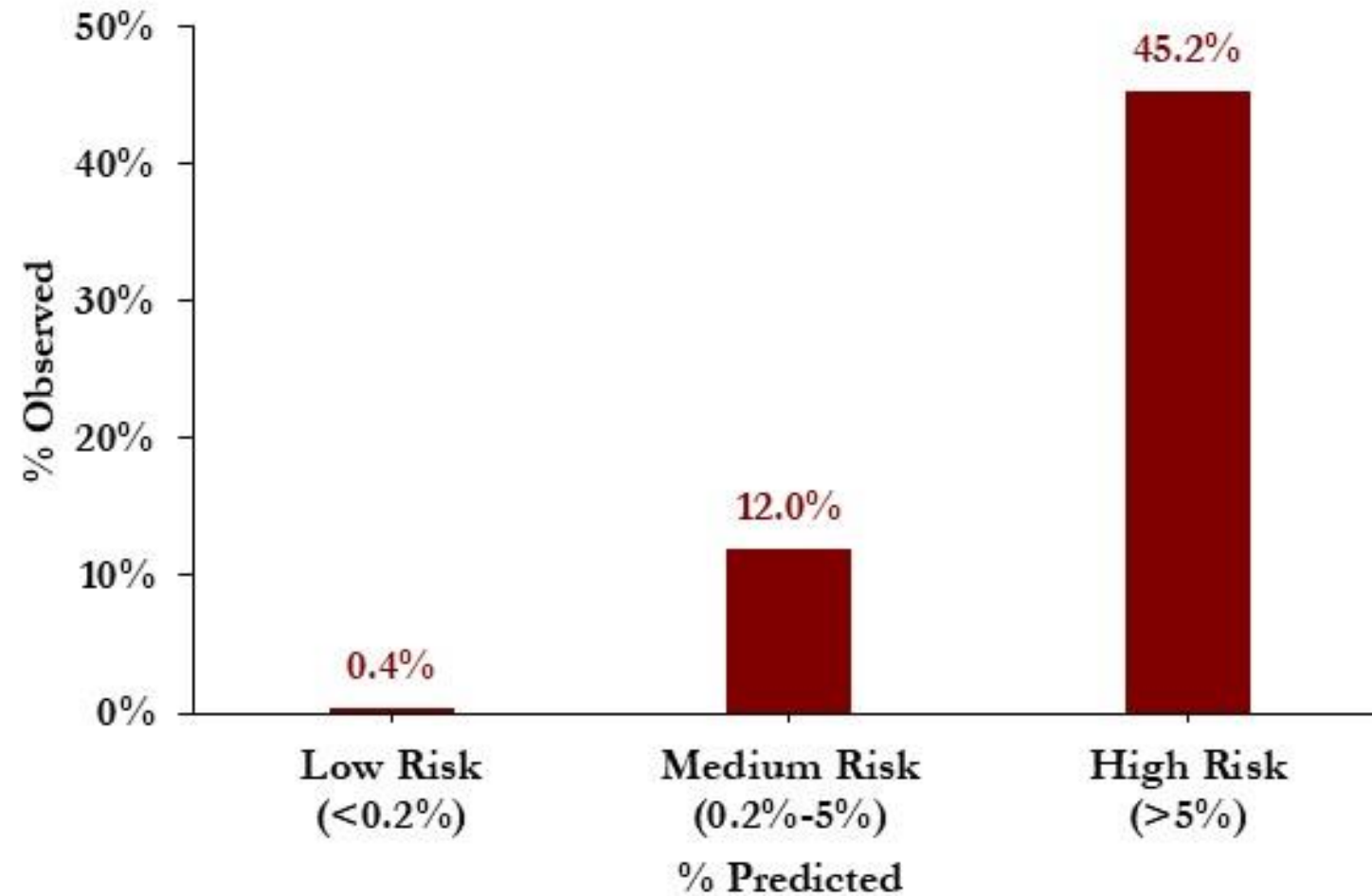
Descriptive Comparisons: Average Baseline CANS Domain Scores



Factors Associated with Decreased vs. Increased Risk of First Residential Placement



Residential Placement Risk within First 90 Days of Entry to DCFS Custody



Model Accuracy

Index	Original Cohort	Bootstrap Models Applied to Bootstrap Samples	Models Trained from Bootstrap Samples Applied to Original Cohort	Optimism/Bias Correction	Corrected Index	Number of Bootstrap Resample
Somers' D_{xy}	0.8561	0.8571	0.8555	0.0015	0.8545	200
c-statistics	0.9280	0.9285	0.9278	0.0008	0.9273	200
Naglkerke R^2	0.2124	0.2131	0.2119	0.0013	0.2112	200
Shrinkage slope	1.0000	1.0000	0.9913	0.0087	0.9913	200

Implications on Implementation and Practice

- Multiple baseline CANS domains were significantly associated with risk of psychiatric hospitalization and residential placement
- Leverage CANS by frontline caseworkers to make proactive recommendations for “preventive” services to deflect youth psychiatric hospitalization and residential placement

Implications on Implementation and Practice

- Embed predictive analytic models into child welfare system's operation
 - Does the child welfare system have internal capacity (e.g., technical, technological) to maintain, refine, and apply predictive analytic models?
 - How (e.g., dashboard), when (e.g., at case opening), and to whom (e.g., caseworker, supervisor) are the “risk scores” provided?
 - How are the models used to support but not to replace decision-making (e.g., prioritize youth, service planning, case closing, team meetings)?

Questions and Discussion



References

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