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RESEARCH REPORT

Repeated Use of Emergency Departments for Non-Traumatic Dental Conditions

Factors Associated with Being a "Superutilizer"

SUGGESTED CITATION:
Thakkar-Samtani, Madhuli; Bodek, Benjamin; Heaton, Lisa J; Sonnek, Adrianna C; and Tranby, Eric P. *Repeated Use of Emergency Departments for Non-Traumatic Dental Conditions: Factors Associated with Being a "Superutilizer".* Boston, MA: CareQuest Institute for Oral Health, June 2022. DOI: 10.35565/CQI.2022.2005

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Key Findings

- About 1 percent (1.1%) of annual emergency department (ED) visits for non-traumatic dental conditions (NTDCs) are made by "superutilizers," or individuals who visit the ED for NTDCs four or more times in a year.
- Superutilizers are more likely to be 30–40 years of age, female, and white.
- Superutilizers are more likely to have dental insurance coverage through Medicaid or Medicare or to be uninsured, and to live in zip codes in the lowest median income quartile.
- Superutilizers are more likely to seek treatment for dental caries (decay) and visit the ED on a weekday.
- Median treatment costs for superutilizers are considerably higher than for both visitors to the ED for non-dental reasons (76.4% higher) and for NTDC visitors who seek ED care fewer than four times in a year (82.2% higher).
- The lack of dental care capacity in EDs combined with a lack of dental benefits for adults on Medicaid to access regular dental care could lead to these repeat ED visits as well as increased burden of cost and suffering.
- Expansion of dental services for adults, particularly those on Medicaid, is needed to ensure that they can access timely preventive and restorative services and avoid the burden of dental crisis that requires a visit to the ED.

Introduction

The overutilization of emergency departments (EDs) for treatment of dental conditions is a well-documented problem in the United States (US).[1–7] With inadequate access to dental care, many patients turn to the ED for the treatment of non-traumatic dental conditions (NTDCs), which are often preventable oral conditions including dental caries and pulpal and periapical conditions, as well as gingival and periodontal conditions.[8] However, EDs are poorly equipped to manage dental conditions; they rely mostly on symptom relief, such as an opioid or antibiotic prescription, rather than treating the underlying dental condition.[1, 3, 6, 9–13]

Treatment for NTDCs through ED visits imposes a large burden on the US health care system, with more than 1.3 million visits each year and more than $1 billion in associated charges.[14] Patients who utilize the ED for NTDCs are more likely to be young adults, on Medicaid or uninsured, and to reside in low-income areas,[2, 7, 15–17] and a significant percentage of these patients will seek treatment in the ED for dental care multiple times.[7, 15, 18] There is a lack of literature evaluating why individuals might be "superutilizers," or visit the ED for NTDCs four or more times per year. This study has three goals: determine characteristics of superutilizers in New York, Wisconsin, and Florida; investigate cost and charge trends in superutilizers; and develop a predictive model to identify factors associated with being a superutilizer.

Methods

This study uses data obtained from the State Emergency Department Databases (SEDD), a set of databases released by state and year which contain deidentified information on each ED visit that did not result in admittance to the hospital.[19] The fields available for each ED visit vary by state and year, but generally include demographic (age, race, income, sex); geographic; diagnosis; cost; and payer information. The data chosen for analysis was limited to states and years containing an identifier used to track a unique patient across multiple ED visits within a state.[20] This study includes SEDD data from the Florida 2018 database, the New York 2017 database, and the Wisconsin 2018 database. This study excluded visitors with missing information on age and income quartile, as well as those who lacked the identifier described above or who died upon admittance to the ED.

Dependent Variable

The dependent variable of superutilizer was defined as an individual who had visited an ED for an NTDC four or more times in a given calendar year.[21] The International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM codes) was used to identify dental conditions defined by the Association of State and Territorial Dental Directors (ASTDD) as NTDCs (see Appendix A).[8] NTDC visits were defined as ED visits whose primary diagnosis was an NTDC.

Independent Variables and Data Selection

We examined patient and visit characteristics of NTDC ED visitors, including: age in years; sex (coded as male or female); race (coded as Black, Hispanic, white, Other or Unknown); state of residence (New York, Wisconsin, or Florida); primary insurance payor (coded as Medicare, Medicaid, private insurance, uninsured, or other); median household income quartiles within the state of residence, estimated using zip codes (fourth quartile being the highest income); the ICD-10-CM diagnosis code associated with the dental visits (coded as K02 (dental caries), K04 (diseases of pulp and periapical tissues), K08 (other disorders of teeth and supporting structures), K11 (diseases of salivary glands), K12 (stomatitis and related lesions), and/or other; see Appendix A); and time of the week (coded as week or weekend).

Statistical Analyses

First, the authors used descriptive statistics to summarize the trends in NTDC ED superutilization, including visit rates and costs, across the states and years included in this analysis. Second, authors used the independent variables to describe the characteristics of ED visitors stratified by visitor type: general ED visitor (visits for non-NTDC reasons), NTDC visitor (<4 NTDC visits in a calendar year), and superutilizers (4+ NTDC visits in a calendar year). Third, a predictive model, using multivariable logistic regression, was developed to predict the likelihood of an NTDC visitor becoming a superutilizer based on the characteristics of their first NTDC ED visit (age, sex, race, primary payor, income quartile, ICD-CM-Code group, and time of week).

For model development, data in a Training group (80% of the data) was used to fit the logistic regression model. Data in a Validate group (10%) was used for initial model evaluation to test the effectiveness of features and hyperparameters. After identifying the optimal model based on performance as measured by ROC-AUC (Receiver Operator Characteristic-Area Under the Curve) score on the Validation data, a final model was trained on all data combined from the Training and Validation groups and final model performance was evaluated on the remaining data (Holdout group (10%)).

Results

Table 1 presents demographic characteristics of ED visitors stratified by visitor type for New York (2017), Wisconsin (2018), and Florida (2018). Of the total number of ED visitors, 2,473 (0.03%) were categorized as superutilizers, representing about 1 percent (1.1%) of those visiting for NTDCs. Superutilizers were younger than individuals visiting an ED for reasons other than NTDCs and those visiting for NTDCs fewer than four times in a year. Superutilizers were more likely to be female, white, and in the lowest median income quartile, which was consistent with the overall ED visitor demographic characteristics.

While ED visitors overall were most likely to have private insurance, individuals visiting for NTDC (fewer than four times in a year) and superutilizers were most likely to have Medicaid coverage (Table 1). The most common dental-specific visit reason for superutilizers was for "other disorders of teeth and supporting structures" (ICD-10 code K08), followed by "dental caries" (K02), and "diseases of pulp and periapical tissues" (K04). Approximately three-quarters of visitors across all visitor types visited an ED on a weekday, as opposed to a weekend.

Individuals having Medicaid or Medicare coverage were nearly three times more likely to be NTDC superutilizers compared to individuals with private insurance.

Table 1: ED Visitors Stratified by Visitor Type for New York (2017) and Wisconsin and Florida (2018; N (%) except where specified otherwise)

			Grouped by Visitor Type		
		Overall	**General ED Visitor** (excluding NTDC visitors and superutilizers)	**NTDC Visitor** (excluding superutilizers)	**Superutilizers**
	N (number of visitors)	9,556,828	9,324,875 *(97.6)*	229,480 *(2.4)*	2,473 *(0.03)*
	Age, mean (SD)	41.1 (23.6)	41.3 *(23.7)*	35.1 *(16.8)*	34.1 *(10.7)*
Sex	Female	5,298,837 *(55.4)*	5,175,676 *(55.5)*	121,753 *(53.1)*	1,408 *(56.9)*
	Male	4,257,991 *(44.6)*	4,149,199 *(44.5)*	107,727 *(46.9)*	1,065 *(43.1)*
Race	White	4,939,533 *(51.7)*	4,829,343 *(51.8)*	108,904 *(47.5)*	1,286 *(52.0)*
	Black	2,038,125 *(21.3)*	1,966,996 *(21.1)*	70,258 *(30.6)*	871 *(35.2)*
	Hispanic	1,651,048 *(17.3)*	1,618,973 *(17.4)*	31,867 *(13.9)*	208 *(8.4)*
	Other or Unknown	928,122 *(9.7)*	909,563 *(9.8)*	18,451 *(8.0)*	108 *(4.4)*
Insurance	Private Insurance	3,217,698 *(33.7)*	3,168,813 *(34.0)*	48,641 *(21.2)*	244 *(9.9)*
	Medicaid	2,666,919 *(27.9)*	2,573,532 *(27.6)*	92,190 *(40.2)*	1,197 *(48.4)*
	Medicare	1,996,894 *(20.9)*	1,973,136 *(21.2)*	23,547 *(10.3)*	211 *(8.5)*
	Uninsured	1,207,285 *(12.6)*	1,149,576 *(12.3)*	56,987 *(24.8)*	722 *(29.2)*
	Other or Unknown	468,032 *(4.9)*	459,818 *(4.9)*	8,115 *(3.5)*	99 *(4.0)*
Median Household Income Quartile by Zip Code of Residence	1.0	2,942,584 *(31.2)*	2,853,325 *(31.0)*	88,203 *(39.0)*	1,056 *(43.4)*
	2.0	2,975,246 *(31.5)*	2,898,483 *(31.5)*	75,899 *(33.5)*	864 *(35.5)*
	3.0	2,092,555 *(22.2)*	2,051,267 *(22.3)*	40,915 *(18.1)*	373 *(15.3)*
	4.0	1,429,321 *(15.1)*	1,407,765 *(15.3)*	21,416 *(9.5)*	140 *(5.8)*
ICD-10-CM Codes Groups*	K02	28,231 *(0.3)*	n/a	27,843 *(12.1)*	388 *(15.7)*
	K04	40,182 *(0.4)*	n/a	39,832 *(17.4)*	350 *(14.2)*
	K08	51,748 *(0.5)*	n/a	51,161 *(22.3)*	587 *(23.7)*
	K11	6,022 *(0.1)*	n/a	6,011 *(2.6)*	11 *(0.4)*
	K12	6,959 *(0.1)*	n/a	6,944 *(3.0)*	15 *(0.6)*
	other	9,423,686 *(98.6)*	9,324,875 *(100.0)*	97,689 *(42.6)*	1,122 *(45.4)*
Time of Week	Weekday	6,941,125 *(72.6)*	6,778,113 *(72.7)*	161,194 *(70.2)*	1,818 *(73.5)*
	Weekend	2,615,703 *(27.4)*	2,546,762 *(27.3)*	68,286 *(29.8)*	655 *(26.5)*

SD = Standard Deviation

*K02 = dental caries; K04 = periapical periodontitis; K08 = other disorders of teeth and supporting structures; K11 = diseases of salivary glands; K12=stomatitis and related lesions

Figure 1 shows the median per-patient total charges by patient type and state. Overall, the median charges for superutilizers were 76.4% higher than for general ED visitors and 82.2% higher than for those visiting for NTDCs fewer than four times in a year. Across all states, median charges were higher for general ED patients than for NTDC patients with fewer than four visits in a year. In turn, median per-patient charges were higher for superutilizers than for general ED patients and for NTDC patients with fewer than four visits in a year.

Median per-patient charges were higher for superutilizers than for general ED patients and for NTDC patients with fewer than four visits in a year.

Figure 1: Median Total Calendar Year ED Charges per patient ($USD)

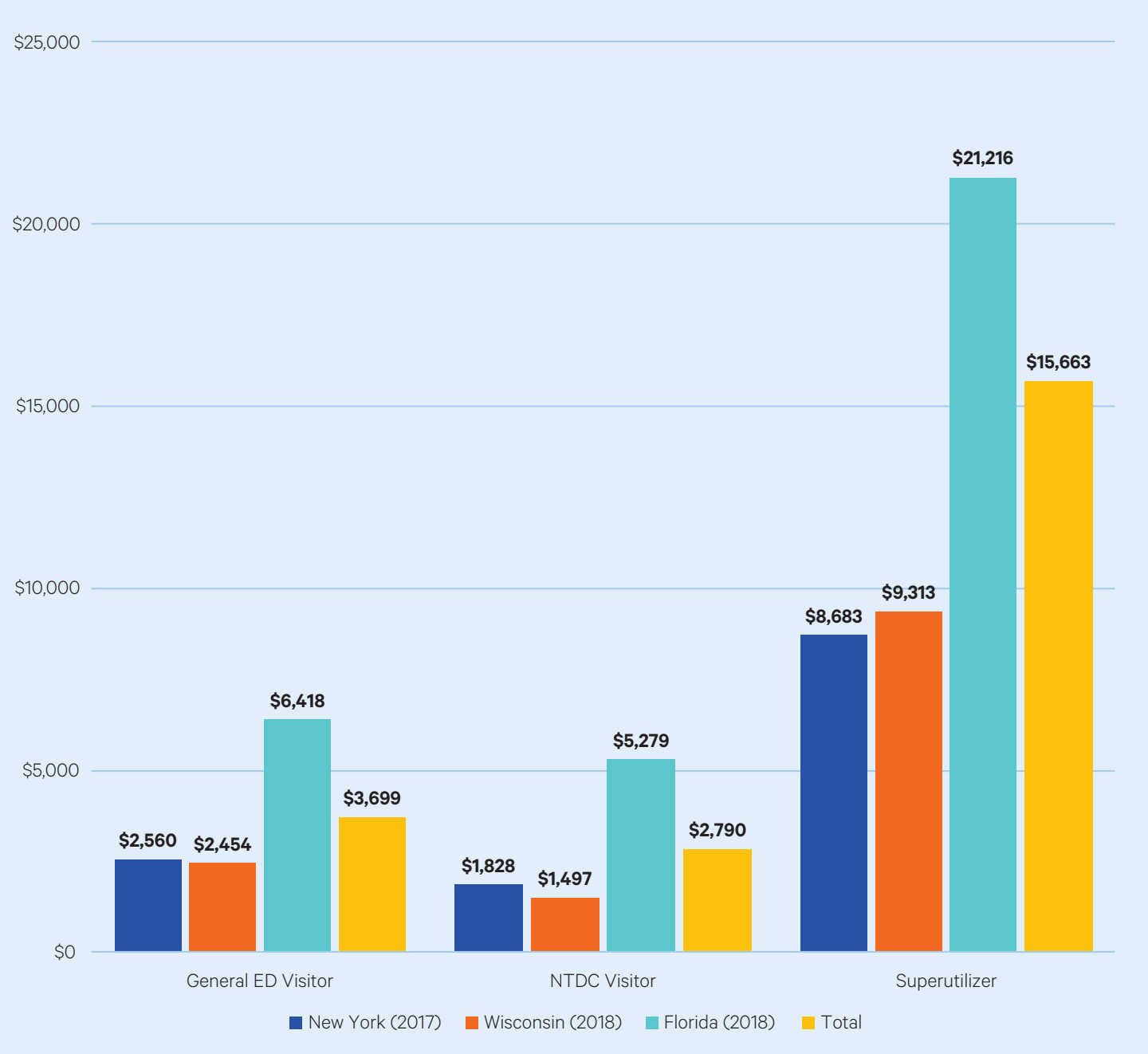


Table 2: Multivariable logistic regression model with Target NTDC Superutilizer Defined as 4+ NTDC ED Visits

	aOR*	95% CI	p-value
Age	1.15	[1.14,1.17]	<0.001
Age as a Quadratic Term	0.98	[1.00,1.00]	<0.001
Sex			
Male		**Reference**	
Female	1.04	[0.98,1.10]	0.244
Race			
White		**Reference**	
Black	0.90	[0.85,0.97]	0.002
Hispanic	0.60	[0.54,0.67]	<0.001
Other or Unknown	0.62	[0.52,0.73]	<0.001
State			
Florida	**Reference**		
New York	0.59	[0.54,0.64]	<0.001
Wisconsin	0.63	[0.57,0.70]	<0.001
Insurance			
Private Insurance		**Reference**	
Medicaid	2.79	[2.51,3.10]	<0.001
Medicare	2.95	[2.55,3.41]	<0.001
Uninsured	1.94	[1.74,2.17]	<0.001
Other or Unknown	1.83	[1.52,2.20]	<0.001
Median Household Income by Residence Zip Code, Quartile			
1		**Reference**	
2	0.93	[0.87,0.99]	0.032
3	1.01	[0.93,1.10]	0.833
4	0.77	[0.66,0.90]	0.001
ICD-10-CM Code Groups*			
K02		**Reference**	
K04	0.7	[0.64,0.76]	<0.001
K08	0.96	[0.89,1.03]	0.237
K11	0.21	[0.14,0.31]	<0.001
K12	0.23	[0.17,0.31]	<0.001
Other	0.58	[0.52,0.65]	<0.001
Time of Week			
Weekday		**Reference**	
Weekend	0.91	[0.86,0.97]	0.005

* aOR = adjusted odds ratio

**K02 = dental caries; K04 = periapical periodontitis; K08 = other disorders of teeth and supporting structures; K11 = diseases of salivary glands; K12=stomatitis and related lesions

Table 2 shows results of the logistic regression model, indicating factors predictive of being a superutilizer. Superutilization for NTDCs followed a curvilinear path where probability increased until 40 years of age and then gradually decreased (Figure 2). Black, Hispanic, and individuals who reported an "other" race or whose race was "unknown" were less likely to be superutilizers than white individuals. Compared with individuals in Florida, individuals in New York and in Wisconsin were less likely to be superutilizers.

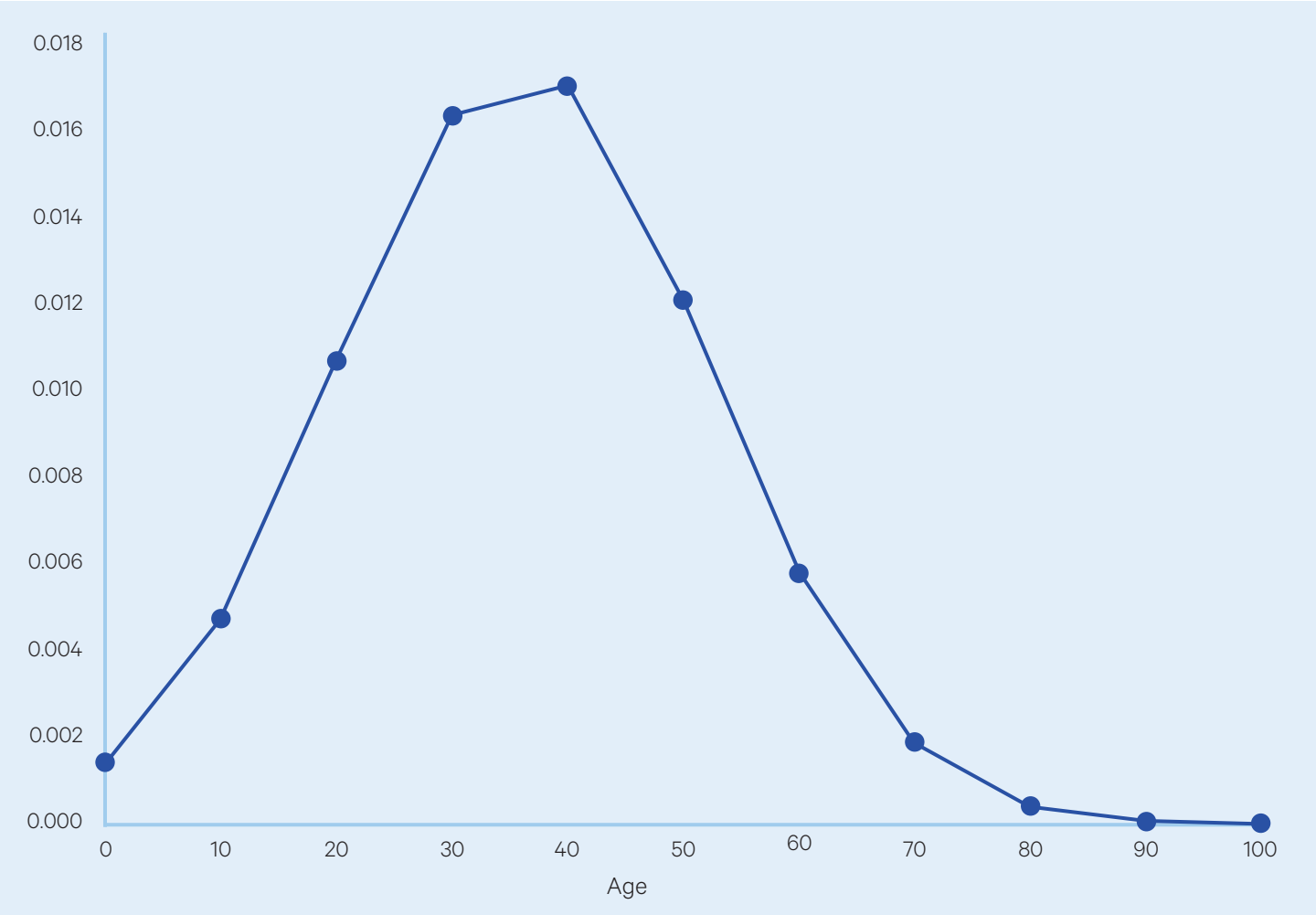
Enrollees in New York and Wisconsin, both states with "extensive" adult dental benefits, were nearly 40% less likely to be NTDC superutilizers compared to enrollees in Florida.

Individuals who were covered by Medicaid or Medicare, who were uninsured, who reported "other" insurance, or whose insurance status was "unknown" were more likely to be superutilizers than individuals with private insurance (Table 2). Compared with those in the lowest median household income quartile, those in the highest quartile were less likely to be superutilizers. Compared with those presenting with dental caries (K02), individuals were less likely to be superutilizers if they presented with periapical periodontitis (K04), diseases of the salivary glands (K11), stomatitis and related disorders (K12), or "other" conditions (Table 2). Finally, individuals who sought care through the ED on a weekend were less likely to be superutilizers compared to those who visited the ED on a weekday.

Appendix B shows the evaluation of the final logistic regression model with "NTDC ED superutilizer" as the outcome variable (defined as four or more visits in one year). The ROC-AUC score for this model was 0.687. The ROC-AUC score for the model with this outcome was 0.702 when the model was trained on the Training dataset and evaluated on the Validation dataset (Appendix C).

Individuals in the lowest income quartile, those with dental caries (decay), those who sought ED care on a weekday, and individuals in Florida were more likely to be superutilizers.

Figure 2: Adjusted Predicted Probability of Being a Superutilizer for NTDCs by Age



Discussion

The results of this study demonstrate that individuals who seek ED care for NTDCs four or more times in a year are more likely to be 30–40 years of age, female, white, have insurance coverage through Medicaid or Medicare or to be uninsured, live in zip codes in the lowest median income quartile, seek treatment for dental caries, and visit the ED on a weekday.

Individuals living in Florida were more likely to be superutilizers than those living in New York or Wisconsin. Adult dental benefits for Medicaid enrollees in New York and Wisconsin are considered to be "extensive," while Florida's benefits include only emergency dental services for adults.[22, 23] Starting in December 2018, the Florida Agency for Health Care Administration (ACHA) announced that Medicaid enrollees would be covered by commercial dental plans.[24] Further research is needed to determine whether Florida's coverage of dental care by commercial plans after 2018 for Medicaid enrollees has made a significant difference in ED NTDC utilization.

In our study, individuals who were Black, Hispanic, or identified as an "other" race were less likely to be superutilizers than white Medicaid enrollees. Prior similar research of individuals enrolled in Medicaid has found that while Black and Indigenous enrollees were more likely to visit an ED for NTDCs than white individuals,[25] white individuals were more likely to make return visits to an ED for NTDCs than Black or Hispanic individuals.[26] It may be that, while Black, Indigenous, and Hispanic individuals enrolled in Medicaid may visit EDs for NTDCs more often than white enrollees, they are less likely to make *repeated* visits. This pattern warrants additional investigation across multiple states.

Individuals diagnosed with dental caries were significantly more likely to be superutilizers than individuals with "other dental diagnoses" (with the exception of the broad diagnosis of "other disorders of teeth and supporting structures"). Given the chronic and multifactorial nature of dental caries,[27] it is not surprising that individuals would seek ED care repeatedly for a condition that is not remedied with a single procedure or treatment. The availability of dentists in ED settings varies greatly by each hospital, and many EDs do not have dentists integrated within their staff who can properly address the cause of the dental problem. This leads to individuals receiving primarily palliative care, including prescriptions for opioid or antibiotic medications,[13, 28, 29] rather than definitive and restorative care. Finally, median treatment costs for superutilizers were considerably higher than for both visitors to the ED for non-dental reasons and for NTDC visitors who sought ED care fewer than four times in a year.

Conclusion

The lack of dental care capacity in EDs combined with a lack of dental benefits for adults on Medicaid to access regular dental care could lead to repeat ED visits for NTDCs as well as increased burden of cost and suffering. Individuals with Medicaid coverage would benefit from knowledge of the gaps in dental care received through the ED as well as the benefits of early intervention, prevention, and disease management in a dental home when possible. Most importantly, expansion of dental services for adults, particularly those with Medicaid coverage, is needed to ensure that they can access timely preventive and restorative services and avoid the burden of dental crisis that requires a visit to the ED.

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Appendices

Appendix A. ICD-10-CM NTDC codes

ICD-10 Code	Description
K02	Dental caries
K023	Arrested dental caries
K025	Dental caries on pit and fissure surface
K0251	Dental caries on pit and fissure surface limited to enamel
K0252	Dental caries on pit and fissure surface penetrating into dentin
K0253	Dental caries on pit and fissure surface penetrating into pulp
K026	Dental caries on smooth surface
K0261	Dental caries on smooth surface limited to enamel
K0262	Dental caries on smooth surface penetrating into dentin
K0263	Dental caries on smooth surface penetrating into pulp
K027	Dental root caries
K029	Dental caries, unspecified
K04	Diseases of pulp and periapical tissues
K040	Pulpitis
K0401	Reversible pulpitis
K0402	Irreversible pulpitis
K041	Necrosis of pulp
K042	Pulp degeneration
K043	Abnormal hard tissue formation in pulp
K044	Acute periapical periodontitis of pulpal origin
K045	Chronic periapical periodontitis
K046	Periapical abscess with sinus
K047	Periapical abscess without sinus
K048	Radicular cyst
K049	Other and unspecified diseases of pulp and periapical tissues
K0490	Unspecified diseases of pulp and periapical tissues
K0499	Other diseases of pulp and periapical tissues
K08	Other disorders of teeth and supporting structures
K080	Exfoliation of teeth due to systemic causes
K081	Complete loss of teeth
K0810	Complete loss of teeth, unspecified cause
K08101	Complete loss of teeth, unspecified cause, class I
K08102	Complete loss of teeth, unspecified cause, class II
K08103	Complete loss of teeth, unspecified cause, class III
K08104	Complete loss of teeth, unspecified cause, class IV
K08109	Complete loss of teeth, unspecified cause, unspecified class
K08111	Complete loss of teeth due to trauma, class I
K08112	Complete loss of teeth due to trauma, class II
K08113	Complete loss of teeth due to trauma, class III
K08114	Complete loss of teeth due to trauma, class IV
K08119	Complete loss of teeth due to trauma, unspecified class
K0812	Complete loss of teeth due to periodontal diseases
K08121	Complete loss of teeth due to periodontal diseases, class I
K08122	Complete loss of teeth due to periodontal diseases, class II
K08123	Complete loss of teeth due to periodontal diseases, class III
K08124	Complete loss of teeth due to periodontal diseases, class IV
K08129	Complete loss of teeth due to periodontal diseases, unspecified class

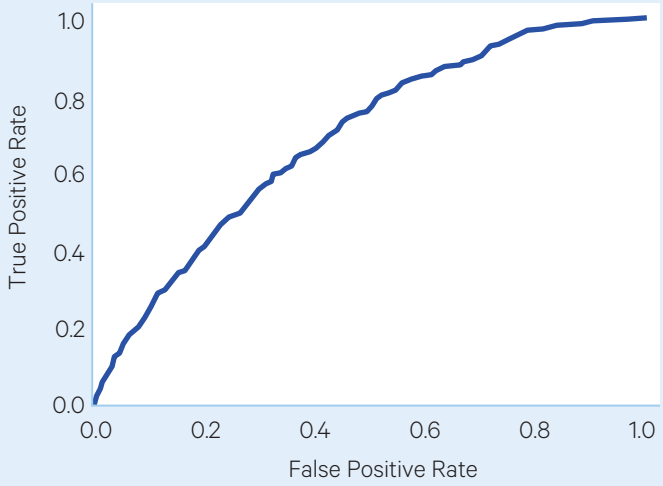
Appendix A, continued. ICD-10-CM NTDC codes

ICD-10 Code	Description
K0813	Complete loss of teeth due to caries
K08131	Complete loss of teeth due to caries, class I
K08132	Complete loss of teeth due to caries, class II
K08133	Complete loss of teeth due to caries, class III
K08134	Complete loss of teeth due to caries, class IV
K08139	Complete loss of teeth due to caries, unspecified class
K0819	Complete loss of teeth due to other specified cause
K08191	Complete loss of teeth due to other specified cause, class I
K08192	Complete loss of teeth due to other specified cause, class II
K08193	Complete loss of teeth due to other specified cause, class III
K08194	Complete loss of teeth due to other specified cause, class IV
K08199	Complete loss of teeth due to other specified cause, unspecified class
K082	Atrophy of edentulous alveolar ridge
K0820	Unspecified atrophy of edentulous alveolar ridge
K0821	Minimal atrophy of the mandible
K0822	Moderate atrophy of the mandible
K0823	Severe atrophy of the mandible
K0824	Minimal atrophy of the maxilla
K0825	Moderate atrophy of the maxilla
K0826	Severe atrophy of the maxilla
K083	Retained dental root
K084	Partial loss of teeth
K0840	Partial loss of teeth, unspecified cause
K08401	Partial loss of teeth, unspecified, class I
K08402	Partial loss of teeth, unspecified, class II
K08403	Partial loss of teeth, unspecified, class III
K08404	Partial loss of teeth, unspecified, class IV
K08409	Partial loss of teeth, unspecified, unspecified class
K08411	Partial loss of teeth due to trauma, class I
K08412	Partial loss of teeth due to trauma, class II
K08413	Partial loss of teeth due to trauma, class III
K08414	Partial loss of teeth due to trauma, class IV
K08419	Partial loss of teeth due to trauma, unspecified class
K0842	Partial loss of teeth due to periodontal diseases
K08421	Partial loss of teeth due to periodontal diseases, class I
K08422	Partial loss of teeth due to periodontal diseases, class II
K08423	Partial loss of teeth due to periodontal diseases, class III
K08424	Partial loss of teeth due to periodontal diseases, class IV
K08429	Partial loss of teeth due to periodontal diseases, unspecified class
K0843	Partial loss of teeth due to caries
K08431	Partial loss of teeth due to caries, class I
K08432	Partial loss of teeth due to caries, class II
K08433	Partial loss of teeth due to caries, class III
K08434	Partial loss of teeth due to caries, class IV
K08439	Partial loss of teeth due to caries, unspecified class
K0849	Partial loss of teeth due to other specified cause
K08491	Partial loss of teeth due to other specified cause, class I
K08492	Partial loss of teeth due to other specified cause, class II
K08493	Partial loss of teeth due to other specified cause, class III
K08494	Partial loss of teeth due to other specified cause, class IV
K08499	Partial loss of teeth due to other specified cause, unspecified class
K0850	Unsatisfactory restoration of tooth, unspecified
K0851	Open restoration margins of tooth
K0852	Unrepairable overhanging of dental restorative materials
K0853	Fractured dental restorative material
K08530	Fractured dental restorative material without loss of dental material
K08531	Fractured dental restorative material with loss of material
K08539	Fractured dental restorative material, unspecified
K0854	Contour of existing restoration of tooth biologically incompatible with oral health
K0855	Allergy to existing dental restorative material
K0856	Poor aesthetic of existing restoration of tooth
K0859	Other unsatisfactory restoration of tooth
K088	Other specified disorders of teeth and supporting structures
K0881	Primary occlusal trauma
K0882	Secondary occlusal trauma
K0889	Other specified disorders of teeth and supporting structures
K089	Disorder of teeth and supporting structures, unspecified
K11	Diseases of salivary glands
K110	Atrophy of salivary gland
K111	Hypertrophy of salivary gland
K112	Sialoadenitis
K1120	Sialoadenitis, unspecified
K1121	Acute sialoadenitis
K1122	Acute recurrent sialoadenitis
K1123	Chronic sialoadenitis
K113	Abscess of salivary gland
K114	Fistula of salivary gland
K115	Sialolithiasis
K116	Mucocele of salivary gland
K117	Disturbances of salivary secretion
K118	Other diseases of salivary glands
K119	Disease of salivary gland, unspecified
K12	Stomatitis and related lesions
K120	Recurrent oral aphthae
K121	Other forms of stomatitis
K122	Cellulitis and abscess of mouth
K123	Oral mucositis (ulcerative)
K1230	Oral mucositis (ulcerative), unspecified
K1231	Oral mucositis (ulcerative), due to antineoplastic therapy
K1232	Oral mucositis (ulcerative), due to other drugs
K1233	Oral mucositis (ulcerative), due to radiation
K1239	Other oral mucositis (ulcerative)

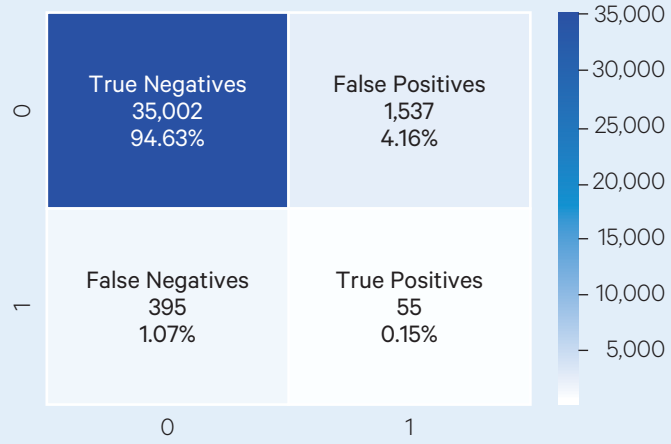
Appendix B:
Evaluation of final logistic regression model with NTDC ED superutilizer defined as 4+ visits in one year

The ROC-AUC score for the model with superutilizer as the outcome variable (defined as four or more visits in one year) was 0.687.

AUC of ROC Curve: 0.687



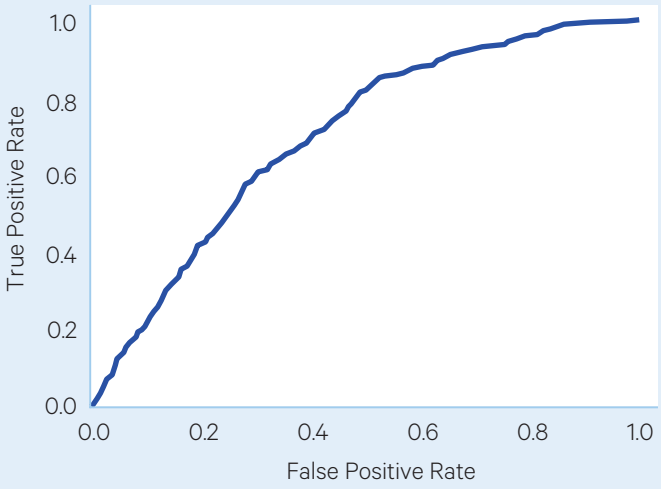
Threshold: 0.032
Precision = 0.034
Recall = 0.171
Accuracy = 0.948



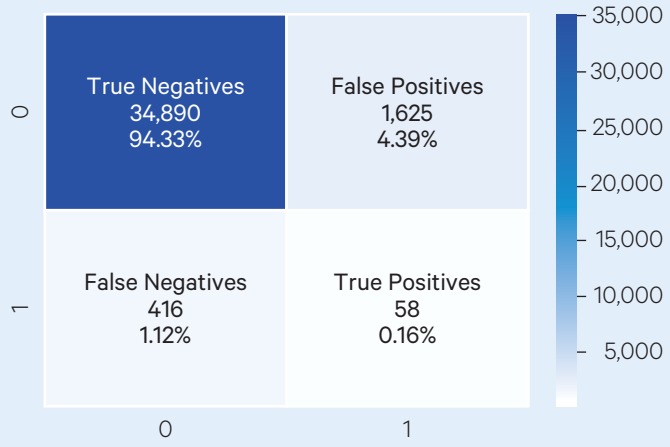
Appendix C:
Evaluation of logistic regression model with NTDC ED superutilizer defined as 4+ visits in one year, trained on Training dataset and evaluated on Validation dataset

When superutilizers were defined as those with five or more visits in a year, and the model was trained on the Training dataset and evaluated on the Validation dataset, the ROC-AUC score was 0.702

AUC of ROC Curve: 0.702



Threshold: 0.032
Precision = 0.034
Recall = 0.122
Accuracy = 0.945



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