# Healthcare utilization and comorbidity history of North Carolina Medicaid beneficiaries in a controlled substance "lock-in" program

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## Abstract

**Background:** Medicaid "lock-in" programs (MLIPs) are a widely used strategy for addressing potential misuse of prescription drugs (particularly opioids) among beneficiary populations. However, little is known about the health care needs and attributes of beneficiaries selected into these programs. Our goal was to understand the characteristics of those eligible, enrolled, and retained in a state MLIP.

**Methods:** Demographics, comorbidities, and healthcare utilization were extracted from Medicaid claims from June 2009 through June 2013. Beneficiaries enrolled in North Carolina's (NC) MLIP were compared to those who were MLIP-eligible but not enrolled. Among enrolled beneficiaries, those completing the 12-month MLIP were compared to those who exited prior to 12 months.

**Results:** Compared to beneficiaries who were eligible for, but not enrolled in the MLIP (n=11,983), enrolled beneficiaries (n=5,424) were more likely to have 1) substance use (23% vs. 14%) and mental health disorders, 2) obtained controlled substances from multiple pharmacies, and 3) visited more emergency departments (mean: 8.3 vs. 4.2 in the year prior to enrollment). One-third (n=1,776) of those enrolled in the MLIP exited the program prior to completion.

**Limitations:** Accurate information on unique prescribers visited by beneficiaries was unavailable. Time enrolled in Medicaid differed for beneficiaries, which may have led to underestimation of covariate prevalence.

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**Conclusions:** NC's MLIP appears to be successful in identifying subpopulations that may benefit from provision and coordination of services, such as substance abuse and mental health services. However, there are challenges in retaining this population for the entire MLIP duration.

## Introduction

Between 2000 and 2013, the annual prescription drug overdose death rate in the U.S. more than doubled from 2.8 to 7.1 deaths per 100,000 population [1,2]. Of the 22,767 lives lost to prescription drug overdoses in 2013, seven out of ten deaths involved an opioid analgesic and three out of ten involved a benzodiazepine [1,2]. Because both types of drugs act as central nervous system depressants, combined use considerably increases risk of overdose [3]. North Carolina (NC) has followed national trends, with the state also experiencing substantial increases in fatal overdoses, and during the same time period, more than 8,000 people died from a prescription opioid overdose in NC [1].

Medicaid beneficiaries are a high-risk population for prescription drug overdose. They are prescribed opioids at twice the rate of persons without Medicaid benefits and have prescription opioid overdose death rates three to eight times that of those without Medicaid benefits [4–8]. With the goal of curbing potential misuse of prescription drugs in Medicaid populations, several states have implemented Medicaid "lock-in" programs (MLIPs) [9,10]. MLIPs are designed to identify Medicaid beneficiaries demonstrating potential overutilization of high risk prescription drugs (e.g., opioids, benzodiazepines) and to limit access, generally by requiring beneficiaries to use a single prescriber and/or pharmacy to obtain these drugs [10].

Despite limited evaluation of these programs and knowledge of the populations impacted [11,12], "lock-in" programs are increasingly being implemented in new beneficiary populations [13–15]. In order to understand and improve the utility of these programs, more information is needed about both the specific attributes of beneficiaries selected into these programs, including their health care needs, and the effects of these programs. Examining the attributes of the population impacted by the MLIP can provide key insights into the generalizability of observed program impacts to other target populations and opportunities for improved care models among "lock-in" program populations. Therefore, the purpose of this study was to obtain a thorough understanding of the demographics, healthcare utilization, and comorbidities of beneficiaries enrolled in a state MLIP. Comparisons were made between the general NC Medicaid population, those enrolled in NC's MLIP, and individuals found eligible for MLIP enrollment but not enrolled into the program. Additionally, to gain a more complete understanding of those impacted by the program, we examined the attributes of those retained in the MLIP for the entire one-year program period as compared to those who exited the MLIP prior to program completion.

## Methods

### North Carolina MLIP enrollment

NC's MLIP originated in October 2010 [16]. Medicaid beneficiaries were eligible for the MLIP if they filled, within two consecutive calendar months: (1) more than six opioid

prescriptions, (2) more than six benzodiazepine prescriptions, or (3) opioid or benzodiazepine prescriptions that were written by more than three different prescribers [16]. Each month a vendor, contracting with the NC Division of Medical Assistance (DMA), reviewed prescription dispensing data for all Medicaid beneficiaries in the previous two calendar months to determine who met MLIP eligibility criteria. The vendor then ranked the MLIP-eligible pool of beneficiaries using a proprietary algorithm. This was combined with a clinical review process by pharmacists employed by the vendor. Approximately 200 of the highest ranking beneficiaries (due to resource constraints) were then recommended to DMA for MLIP enrollment each month. Therefore, not everyone who was eligible was selected for MLIP enrollment. The specific algorithm and review process details were proprietary and thus unavailable; however, as outlined below, our analysis was structured to gain insight into the attributes considered in these processes, as well as characteristics that may not have been included in these processes but could indicate important health needs of the beneficiaries examined.

Upon approval from the DMA, the approximately 200 selected beneficiaries each month were each sent a letter notifying them of their upcoming enrollment in the program and that the MLIP restricted them to using one prescriber and one pharmacy location to obtain prescriptions categorized as opioids or benzodiazepines for a one-year period. Beneficiaries were given 30 days to choose a preferred prescriber and pharmacy before these mandatory restrictions began. Those who did not respond to the DMA were assigned to a prescriber and pharmacy. Once restrictions began, claims submitted for an opioid or benzodiazepine that were not associated with the beneficiary's assigned MLIP prescriber and pharmacy were denied.

### Data and study cohorts

NC Medicaid claims data from June 2009 through June 2013 were obtained from the NC DMA. In NC, Medicaid beneficiaries' medical services are primarily reimbursed on a fee-for-service basis with the exception of the state's public mental health safety net, which operates on a capitated fee basis [17]. All NC Medicaid data was obtained from the DMA's Data Retrieval Information and Validation Engine (DRIVE). Data available through DRIVE included beneficiaries' demographic information, periods of enrollment in Medicaid and the MLIP (if applicable), and adjudicated pharmacy and medical claims.

The overall study population consisted of adults ages 18–64 years enrolled in Medicaid at any point between June 2010 and December 2012. First, the MLIP-eligible population was identified by examining Medicaid-reimbursed opioid and benzodiazepine prescription fills from June 2010 through December 2012. Consistent with MLIP eligibility criteria, beneficiaries with more than six opioid or benzodiazepine prescriptions in a consecutive two-month period were defined as MLIP-eligible (Figure 1).

Within the MLIP-eligible population, a second study cohort was then identified; a cohort that was enrolled in the MLIP (Figure 1). As specified in this figure, this cohort was then further stratified based on time spent in the MLIP, categorized as (Group 1) those spending no time in the MLIP, because they no longer possessed Medicaid coverage during the time they would have been enrolled; (Group 2) those who were enrolled in the MLIP for part of

their assigned period but discontinued Medicaid coverage at some point during their entire observed and assigned MLIP period; (Group 3) those who possessed Medicaid coverage during the proportion of their MLIP period observed in our data (i.e., through June 2013), but their entire one year MLIP period exceeded the time observed in our dataset (i.e., they were administratively censored); and (Group 4) those who were observed for their full 12-month MLIP enrollment period and possessed Medicaid coverage during the entire time. Due to similarities, the first two groups and last two groups were collapsed in several analyses in which the combined first two groups were termed the "early exiters" and the combined last two groups, the "completers."

Finally, to place our findings within the context of the larger Medicaid population, these distinct cohorts were compared to a sample of the general NC Medicaid population restricted to the same age range and within the same time period (i.e., any NC Medicaid beneficiary ages 18–64 years with at least one pharmacy claim between October 2009 and September 2010).

### Measures

For MLIP-eligible beneficiaries, demographic characteristics were assessed at the time they became MLIP-eligible. For the general Medicaid sample, demographic characteristics were assessed at the time of the first pharmacy claim in our data. Demographic characteristics included age, sex, race, urbanicity of county of residence [18], drug overdose death rate in county of residence [19], Medicaid aid category [20], and Medicaid class code [20]. For the MLIP-eligible population, beneficiary-level clinical characteristics were also examined, including controlled substance-related characteristics, overall health care utilization, and other comorbid conditions in the 12 months prior to MLIP eligibility. Controlled substance-related characteristics included MLIP eligibility criteria met, number of unique pharmacies visited in the two-month period prior to MLIP eligibility, and history of medication-assisted treatment or overdose in the previous year [21, 22]. Healthcare utilization measures included numbers of emergency department (ED) visits and inpatient admissions and the number of days with Medicaid coverage in the prior year. Finally, the prevalence of various pain-related, mental health, substance use-related, and other comorbid diagnoses was estimated. Detailed reference information regarding the definitions used to define each specific condition have been previously published [23].

### Statistical Methods

The prevalence of demographic and clinical characteristics of beneficiaries enrolled in the MLIP was estimated and compared to those who were eligible, but not enrolled. These groups were also compared to the general Medicaid population with respect to key demographic characteristics. Lastly, prevalences of demographic and clinical characteristics of beneficiaries enrolled in the MLIP, stratified by time spent in the MLIP, were compared. For categorical variables, counts and percentages were obtained. For continuous variables, means and standard deviations were calculated. For heavily skewed continuous variables (i.e., health care utilization measures), means and $25^{th}$, $50^{th}$ (median), and $75^{th}$ percentiles were reported.

For all variables, standardized differences between those enrolled in the MLIP and those eligible but not enrolled were calculated, as well as between MLIP "early exiters" and "completers" [24]. Standardized differences provide a measure of the similarity or dissimilarity of two groups with respect to specific covariates. This study was approved by the University of North Carolina at Chapel Hill's Institutional Review Board.

## Results

### Demographics of MLIP-eligible, MLIP-enrolled, and MLIP-completers

Between June 2010 and December 2012, a total of 17,407 NC Medicaid beneficiaries ages 18–64 years received more than 6 opioid prescriptions and/or more than 6 benzodiazepine prescriptions through Medicaid in a two consecutive calendar month period, qualifying them for the MLIP (Table 1). Compared to the general NC Medicaid population, those who met MLIP eligibility criteria tended to be older (mean age: 39.8 vs. 35.1), more often male (34.9% vs. 25.7%), more often white (75.5% vs. 52.6%), more often from counties with high overdose death rates, and less likely to receive Medicaid benefits due to a pregnancy (2.4% vs. 10.0%).

Among those eligible for the MLIP, 31% were enrolled in the MLIP (Table 1). Compared to those not enrolled, MLIP-enrolled beneficiaries were more often younger (mean age: 37.1 vs. 41.0) and female (69.1% vs. 63.2%), and less often qualified for Medicaid benefits due to disability (36.1% vs. 48.3%) (Table 1, Figure 2A).

Among those enrolled, 41% remained in the program for a full 12 months, and another 25% remained in the MLIP until the point of administrative censoring. Together, these beneficiaries are referred to as "completers." Another 25% spent less than 12 months in the MLIP despite our ability to follow them and observe them for a longer period of time, and 8% spent no time in the MLIP. Together, these beneficiaries are referred to as "early exiters." The two groups constituting MLIP "completers" were generally similar in terms of characteristics, as were the two groups constituting "early exiters."

Compared to MLIP "completers," the "early exiters" tended to be younger, white, more often from counties with high overdose death rates, more often received aid as a family with dependent children or due to a pregnancy, and more often qualified as medically needy (Table 1, Figure 2B).

### Substance-related and health care utilization of MLIP-eligible, MLIP-enrolled, and MLIP-completers

Nearly all of those who became eligible for the MLIP met the opioid eligibility criterion; however, those enrolled in the MLIP also visited more unique pharmacies to fill their opioid and/or benzodiazepine prescriptions than did those not enrolled (Table 2; Figure 2). Twenty-nine percent of those enrolled obtained these drugs from more than three different pharmacies in a two-month period, as opposed to 7.8% of those not enrolled. Moreover, "early exiters" had an even higher prevalence than "completers" of using many different pharmacies.

With the exception of ED use, other healthcare utilization measures were generally similar between those who were and were not enrolled in the MLIP. Those enrolled had, on average, twice as many ED visits (mean: 8.3 vs. 4.2) in the year prior to becoming eligible (Table 3; Figure 2). MLIP-enrolled and non-enrolled cohorts tended to have similar Medicaid coverage in the prior year (mean days with coverage in past year: 310.1 vs. 308.7). However, stratification by time spent in the MLIP revealed that "early exiters" tended to have less stable Medicaid coverage in the prior year (i.e., fewer days enrolled in Medicaid in the prior year).

### Comorbid conditions of MLIP-eligible, MLIP-enrolled, and MLIP-completers

Beneficiaries enrolled in the MLIP tended to a have a higher prevalence of pain, mental health, and substance use-related conditions (Table 3; Figure 2). Of note, nearly a quarter of those enrolled had a substance use disorder diagnosis in the year prior (23.3%), almost double that of those not enrolled (13.5%). The prevalence of other comorbid conditions was generally similar between MLIP-enrolled and non-enrolled cohorts (absolute standardized differences all <10%) except that the latter had a higher proportion of recent cancer diagnoses (13.3% vs. 0.8%). Stratification by time spent in the MLIP revealed an even higher prevalence of pain, mental health, and substance use-related conditions among those who completed the MLIP (e.g., range of standardized differences for pain conditions comparing "early exiters" to "completers": −3 to −26%; for mental health and substance use-related conditions: −6 to −17%).

## Discussion

This study identified a number of differences between the NC MLIP target population (as defined by program selection criteria) and the actual population enrolled in and impacted by the program. Selection for the MLIP included a prioritization process of all eligible beneficiaries since, due to resource constraints, only a limited number of those eligible could be enrolled in any given month. Those enrolled in the MLIP tended to be younger, female, and less often qualified for Medicaid benefits due to a disability. Additionally, those enrolled tended to visit more pharmacies to fill their opioid and/or benzodiazepine prescriptions, have more ED visits, have a higher prevalence of pain-, mental health-, and substance use-related conditions, and have a lower prevalence of recent cancer diagnoses relative to those eligible but not enrolled in the MLIP. Beneficiaries with cancer diagnoses were generally excluded from MLIP enrollment. These findings are consistent with previous research on characteristics of those most at risk of opioid misuse and overdose [1,30–36].

To further understand the extent to which beneficiaries were exposed to the program, we stratified the population of those enrolled by time spent in the MLIP. Those who exited the program early were more often younger, white, and from counties with high overdose death rates, compared to those who remained in the program. Additionally, we found that "early exiters" more often received aid as a family with dependent children or due to a pregnancy, visited more unique pharmacies to fill their opioid and/or benzodiazepine prescriptions, had less stable Medicaid coverage in the prior year, and a lower prevalence of diagnoses for pain-, mental health-, and substance use-related conditions. Unstable Medicaid coverage,

which led to unstable MLIP exposure for some enrolled in the program, has been shown to be more prevalent among certain populations, such as younger individuals [37]. Moreover, many women only qualify for Medicaid benefits while pregnant and in the 60 days following delivery, after which they often lose coverage [38]. Other attributes, such as county overdose death rates, and their potential associations with Medicaid coverage instability warrant additional research. Many of the observed differences and overall cohort profiles illuminate both important generalizability considerations, as well as care coordination barriers and opportunities for future MLIP design.

The generalizability of MLIP evaluation findings is an important consideration as the medical community continues to grapple with the surging opioid epidemic and "lock-in" programs are implemented more broadly. "Lock-in" programs have been increasingly utilized in new and different beneficiary populations, including private insurance plans, other Medicaid populations, and will soon be incorporated into Medicare [13–15]. While the evidence base for these programs is sparse, recent evaluation findings from NC's MLIP have begun to provide some understanding of both intended and unintended consequences of the MLIP, including reductions in Medicaid-reimbursed opioid prescriptions but increases in out-of-pocket payment for such prescriptions [39,40]. As the evidence base develops and as these programs are designed and refined, evaluations from other "lock-in" programs are needed that not only present a range of program impacts, but that are also coupled with a clear depiction of the affected population. Overall, North Carolina's Medicaid population was similar demographically (i.e., age, sex, race) to the national Medicaid population profile at the time of this study [41]. Therefore, from a broad demographic perspective, evaluation findings related to NC's program may be generalizable to other similar Medicaid programs. However, the larger policy and prescribing landscape within which these programs are embedded should also be considered when evaluating potential generalizability of findings. Moreover, the extent to which observed program impacts (e.g., reductions in Medicaid-reimbursed, but increases in out-of-pocket, opioid prescriptions) in this beneficiary population transfer to "lock-in" programs in private insurance, older adult, and other populations is not known and will be an important consideration for future research.

Even with our limited view of complete "lock-in" program effects, these programs theoretically provide a unique opportunity to efficiently deliver services capable of improving patient health and saving healthcare dollars. This study showed that beneficiaries enrolled in the MLIP tended to have a high prevalence of comorbidities, including pain-, mental health-, and substance use-related conditions, and tended to show signs of uncoordinated care (e.g., high use of EDs and multiple pharmacies). The ability of "lock-in" programs to more effectively target the complex health needs of this beneficiary population is unknown, but has strong potential. In 2014, the Association for Community Affiliated Plans supported implementation of innovative MLIP pilot projects in Medicaid populations in four different states [42]. These pilot projects offered a more holistic MLIP model, as compared to the more traditional MLIP model (like the one administered in NC). Program elements included connections to pain specialists, risk screenings, evaluation of barriers to critical needs (e.g., transportation, housing) and connection to resources, and screening and referral to substance use disorder treatment resources. While evaluation research was limited to short-term outcomes, preliminary results revealed cost savings and improved care

coordination. Pending further evaluation, such models, particularly when targeted to the needs of specific "lock-in" program beneficiary populations, may serve as a more effective framework. Based on our findings, inclusion and coordination of substance use disorder and mental health screenings and connection to substance use disorder, mental health, and alternative pain therapy services could serve as a useful starting point for improving and piloting a more comprehensive MLIP model in NC. Discussions around improved models of care within a MLIP framework also require some consideration of Medicaid "churn" (i.e., moving between an insured and uninsured status and/or between different coverage sources). While a complete discussion of "churn" and coverage issues is beyond the scope of this paper, refining MLIPs to improve care coordination within a larger system prone to coverage lapses and care disruptions for populations typically enrolled in MLIPs is an important barrier to address and warrants further research [43].

Our findings should be viewed in light of three limitations. First, the Medicaid data available did not include accurate information on numbers of unique prescribers visited. Therefore, we were unable to use the third MLIP criterion in constructing our MLIP-eligible population. However, given that almost all of the MLIP-enrolled cohort met the first criterion (i.e., more than six opioid prescriptions) and that there were likely relatively few people who visited several unique prescribers but did not also meet the prescription thresholds, this missing information was not expected to have excluded many beneficiaries from our analysis. Second, our measurement of overdoses in the prior year only captured overdoses involving some interaction with the health care system while a person had Medicaid coverage. Third, the presence of diagnoses (e.g., pain diagnoses) and measures of healthcare utilization (e.g., methadone treatment) in the year prior to meeting MLIP eligibility may be underestimated, particularly for "early exiters," as they also tended to have less Medicaid coverage in the prior year. However, research suggests that inclusion of any available data in a lookback period to assess presence of covariates results in less misclassification than restricting the data to a common lookback period [44].

Understanding demographic and clinical profiles of the population impacted by the MLIP provides key insights into the generalizability of MLIP impacts to other beneficiary populations and opportunities for tailored "lock-in" program design improvements. Future work is needed to examine which enrollment criteria are most useful for selecting beneficiaries who could benefit from such programs. Additionally, evaluations are needed to examine a broad range of potential positive and negative impacts of these programs, combined with a clear description of studied populations, so that future program designs can be informed by the most comprehensive and relevant research. While "lock-in" program administrators should aim to gain a thorough understanding of the specific beneficiary populations impacted by their programs, our findings can help prepare administrators of new, similar programs for the magnitude of substance use, mental health disorders, and other comorbidity that may be likely in their populations.

## Acknowledgements

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**FIGURE 1.**

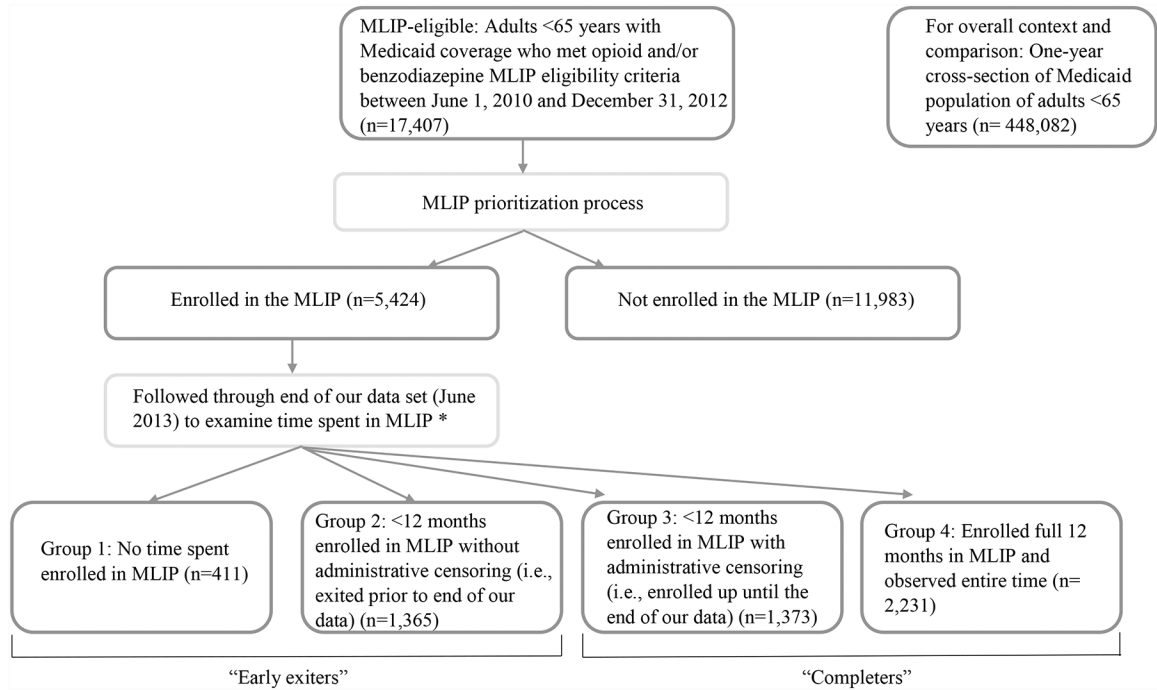Classification of persons who qualified for the North Carolina Medicaid Lock-in Program (MLIP) from June 2010 through December 2012, stratified by enrollment in the MLIP and time spent in the MLIP

**Note:** Dark grey boxes represent groups compared. Light grey boxes represent processes.

* 44 persons were enrolled in the MLIP for longer than a year and are not included in the analysis stratified by time spent in the MLIP.
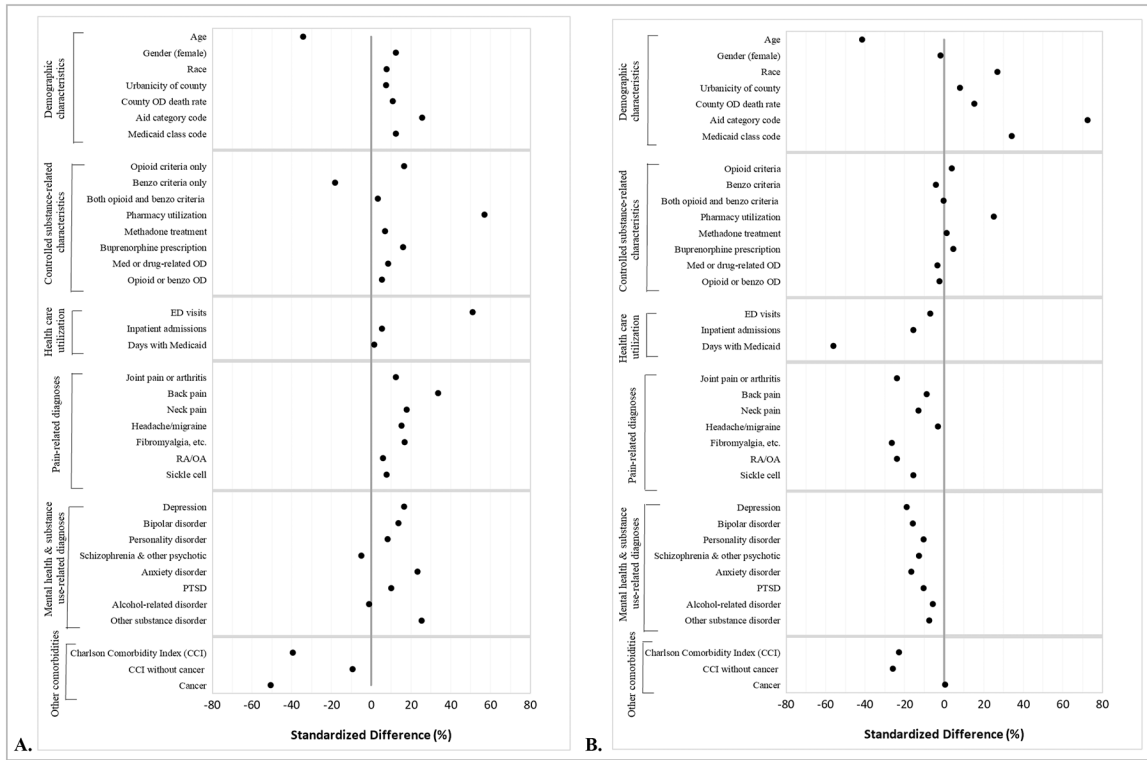
**FIGURE 2.**

Standardized differences* in characteristics** of beneficiaries*** who were enrolled vs. not
enrolled (reference group) in the Medicaid Lock-in Program (MLIP) (Panel A) and among
those enrolled, differences in characteristics between MLIP "early exiters" vs. "completers"
(reference group) (Panel B)

* Standardized differences provide a measure of the similarity or dissimilarity of two groups
with respect to specific covariates. For continuous and binary covariates, standardized
differences were used to compare the means of two groups in units of the pooled standard
deviation of the two groups. For categorical variables with more than two levels, an overall
standardized difference was calculated, using a multivariate Mahalanobis distance method.

** Additional variable details and definitions for demographic characteristics can be found
in Table 1, for controlled substance-related characteristics in Table 2, and for all other
variables in Table 3.

*** Number of unique beneficiaries enrolled: 5,424; not enrolled: 11,983. Of those enrolled,
number of beneficiaries classified as "completers": 3,604; "early exiters": 1,776. Forty-four
beneficiaries were enrolled in the MLIP for longer than a year and are not included in the
analysis stratified by time spent in the MLIP (i.e., Panel B).

OD=overdose; benzo=benzodiazepine; rx=prescription; ED=emergency department;
fibromyalgia, etc.= fibromyalgia, chronic pain, and fatigue; RA/OA=rheumatoid arthritis/
osteoarthritis; PTSD=post-traumatic stress disorder; CCI=Charlson comorbidity index;
CHF=congestive heart failure; COPD=chronic obstructive pulmonary disease

**TABLE 1.**

Demographic characteristics* of adults <65 years with Medicaid coverage overall and who met Medicaid Lock-in Program (MLIP) eligibility criteria from June 2010 through December 2012, stratified by enrollment in the MLIP and time spent in the MLIP

| | Medicaid beneficiary adult population <65 years** (N= 448,082) | Medicaid population eligible for MLIP enrollment | | | MLIP-enrolled*** | | |
|---|---|---|---|---|---|---|---|
| | | Not enrolled in MLIP (n= 11,983) | Enrolled in MLIP (n=5,424) | No time in MLIP (n=411) | <12 months in MLIP without administrative censoring (n=1,365) | <12 months in MLIP with administrative censoring (n=1,373) | Full 12 months in MLIP (n= 2,231) |
| | N (%) | N (%) | N (%) | N (%) | N (%) | N (%) | N (%) |
| *Age (years)*, mean (SD) | 35.1 (13.5) | 41.0 (11.9) | 37.1 (10.6) | 34.1 (10.0) | 34.4 (9.7) | 38.6 (10.8) | 38.5 (10.7) |
| *Women* | 332,735 (74.3) | 7,577 (63.2) | 3,750 (69.1) | 284 (69.1) | 933 (68.4) | 932 (67.9) | 1,568 (70.3) |
| *Race* | | | | | | | |
| White | 235,845 (52.6) | 8,980 (74.9) | 4,155 (76.6) | 349 (84.9) | 1,131 (82.9) | 996 (72.5) | 1,644 (73.7) |
| Black | 173,945 (38.8) | 2,381 (19.9) | 966 (17.8) | 45 (11.0) | 156 (11.4) | 308 (22.4) | 450 (20.2) |
| American Indian | 8,917 (2.0) | 275 (2.3) | 169 (3.1) | 7 (1.7) | 45 (3.3) | 36 (2.6) | 80 (3.6) |
| Other | 4,339 (1.0) | 26 (0.2) | 13 (0.2) | 2 (0.5) | 3 (0.2) | 2 (0.2) | 6 (0.3) |
| Unreported | 25,036 (5.6) | 321 (2.7) | 121 (2.2) | 8 (2.0) | 30 (2.2) | 31 (2.3) | 51 (2.3) |
| *Urbanicity of county of residence †* | | | | | | | |
| Metro areas of ≥ 1 mill. pop. | 109,402 (24.4) | 2,718 (22.7) | 1,399 (25.8) | 114 (27.7) | 362 (26.5) | 361 (26.3) | 553 (24.8) |
| Metro areas of < 1 mill. pop. | 197,021 (44.0) | 5,550 (46.3) | 2,457 (45.3) | 190 (46.2) | 580 (42.5) | 606 (44.1) | 1,059 (47.5) |
| Nonmetro, urban pop. of 20,000 | 74,873 (16.7) | 2,081 (17.4) | 891 (16.4) | 64 (15.6) | 218 (16.0) | 241 (17.6) | 358 (16.1) |
| Nonmetro, urban pop. of <20,000 or rural | 66,786 (14.9) | 1,628 (13.6) | 677 (12.5) | 43 (10.5) | 205 (15.0) | 165 (12.0) | 261 (11.7) |
| *Overdose death rate in county of residence (per 100,000 py) ‡* | | | | | | | |
| 20.0–32.2 | 70,733 (15.8) | 2,407 (20.1) | 1,020 (18.8) | 89 (21.7) | 290 (21.3) | 227 (16.5) | 408 (18.3) |
| 15.0–19.9 | 85,091 (19.0) | 3,131 (26.1) | 1,234 (22.8) | 103 (25.1) | 343 (25.1) | 296 (21.6) | 479 (21.5) |
| 11.1–14.9 | 100,266 (22.4) | 2,433 (20.3) | 1,268 (23.4) | 83 (20.2) | 282 (20.7) | 348 (25.4) | 538 (24.1) |
| 8.7–11.0 | 107,900 (24.1) | 2,501 (20.9) | 1,133 (20.9) | 76 (18.5) | 269 (19.7) | 296 (21.6) | 488 (21.9) |
| 2.6–8.6 | 84,092 (18.8) | 1,505 (12.6) | 769 (14.2) | 60 (14.6) | 181 (13.3) | 206 (15.0) | 318 (14.3) |
| *Aid category code §* | | | | | | | |

| | | Medicaid population eligible for MLIP enrollment | | | MLIP-enrolled*** | | |
|---|---|---|---|---|---|---|---|
| | Medicaid beneficiary adult population <65 years** (N= 448,082) | Not enrolled in MLIP (n= 11,983) | Enrolled in MLIP (n=5,424) | No time in MLIP (n=411) | <12 months in MLIP without administrative censoring (n=1,365) | <12 months in MLIP with administrative censoring (n=1,373) | Full 12 months in MLIP (n= 2,231) |
| | N (%) | N (%) | N (%) | N (%) | N (%) | N (%) | N (%) |
| Aid to families with dependents | 212,931 (47.5) | 5,809 (48.5) | 3,298 (60.8) | 335 (81.5) | 1,072 (78.5) | 725 (52.8) | 1,144 (51.3) |
| Aid to disabled | 162,792 (36.3) | 5,793 (48.3) | 1,956 (36.1) | 44 (10.7) | 226 (16.6) | 617 (44.9) | 1,048 (47.0) |
| Aid to pregnant women | 44,714 (10.0) | 282 (2.4) | 142 (2.6) | 29 (7.1) | 59 (4.3) | 22 (1.6) | 31 (1.4) |
| Other (e.g., aid to blind) | 27,645 (6.2) | 99 (0.8) | 28 (0.5) | 3 (0.7) | 8 (0.6) | 9 (0.7) | 8 (0.4) |
| *Medicaid class code* § | | | | | | | |
| Categorically needy | 369,806 (82.5) | 10,904 (91.0) | 5,084 (93.7) | 344 (83.7) | 1,213 (88.9) | 1,321 (96.2) | 2,164 (97.0) |
| Medically needy | 19,509 (4.4) | 1,015 (8.5) | 337 (6.2) | 65 (15.8) | 152 (11.1) | 52 (3.8) | 67 (3.0) |
| Other | 58,767 (13.1) | 64 (0.5) | 3 (0.1) | 2 (0.5) | 0 | 0 | 0 |

PY=person-years; SD= standard deviation

*
Demographic characteristics assessed at time of first pharmacy claim between Oct 2009 and Sept 2010 for general Medicaid population and at time of first becoming eligible for MLIP for MLIP-eligible population.

**
Cross-section of Medicaid population taken as beneficiaries ages 18–64 years who had at least one pharmacy claim between Oct 2009-Sept 2010.

***
44 people were enrolled in the MLIP for >12 months and are not included in analyses stratified by time spent in the MLIP.

†
6 persons in the "not enrolled in the MLIP" group were missing county information.

‡
North Carolina has 100 counties. Counties were categorized in overdose rate quintiles (i.e., 20 counties per quintile). Rates are presented as deaths per 100,000 population per year.

§
The aid category codes and Medicaid class codes provide information on reasons people became eligible for Medicaid. Those who were classified as "categorically needy" met Medicaid income requirements under a specific aid category (e.g., families with children, disabled, etc.) to qualify. Those qualifying as "medically needy" satisfied Medicaid's categorical eligibility requirements (e.g., disability) but may have not satisfied financial eligibility requirements (i.e., income was too high). However, these individuals may have stilled qualified for Medicaid if they had significant medical expenses that reduced their income below a certain level, through "medically needy" programs. "Other" includes "qualified beneficiaries" with Medicare and Medicaid benefits.

**TABLE 2.**

Controlled substance-related characteristics of adults <65 years who met Medicaid Lock-in Program (MLIP) eligibility criteria from June 2010 through December 2012, stratified by enrollment in the MLIP and time spent in the MLIP

| | Medicaid population eligible for MLIP enrollment | | No time in MLIP (n=411) | MLIP-enrolled* | | |
|---|---|---|---|---|---|---|
| | Not enrolled in MLIP (n= 11,983) | Enrolled in MLIP (n=5,424) | | <12 months in MLIP without administrative censoring (n=1,365) | <12 months in MLIP with administrative censoring (n=1,373) | Full 12 months in MLIP (n= 2,231) |
| | N (%) | N (%) | N (%) | N (%) | N (%) | N (%) |
| *MLIP eligibility criteria met* ** | | | | | | |
| Opioid criteria only | 11,197 (93.4) | 5,260 (97.0) | 403 (98.1) | 1,327 (97.2) | 1,325 (96.5) | 2,162 (96.9) |
| Benzo. criteria only | 755 (6.3) | 139 (2.6) | 6 (1.5) | 32 (2.3) | 42 (3.1) | 58 (2.6) |
| Both opioid and benzo. criteria | 31 (0.3) | 25 (0.5) | 2 (0.5) | 6 (0.4) | 6 (0.4) | 11 (0.5) |
| *Pharmacy utilization* | | | | | | |
| Obtained opioids and/or benzos from >3 unique pharmacies when MLIP eligibility met | 931 (7.8) | 1,574 (29.0) | 166 (40.4) | 488 (35.8) | 326 (23.7) | 587 (26.3) |
| *Medication-assisted treatment in past year* | | | | | | |
| Methadone treatment *** | 112 (0.9) | 94 (1.7) | 8 (2.0) | 25 (1.8) | 18 (1.3) | 43 (1.9) |
| Buprenorphine prescription fill † | 154 (1.3) | 206 (3.8) | 9 (2.2) | 69 (5.1) | 46 (3.4) | 79 (3.5) |
| *Overdose in past year* | | | | | | |
| Any medication or drug-related‡ | 432 (3.6) | 290 (5.4) | 18 (4.4) | 68 (5.0) | 72 (5.2) | 130 (5.8) |
| Opioid- or benzo-related§ | 188 (1.6) | 125 (2.3) | 10 (2.4) | 27 (2.0) | 26 (1.9) | 61 (2.7) |

Benzo= benzodiazepine

*
44 people were enrolled in the MLIP for >12 months and are not included in analyses stratified by time spent in the MLIP.

**
Captures MLIP criteria met in first 2-month period of becoming MLIP-eligible

***
Any mention of CPT code H0020, "Alcohol and/or drug services; methadone administration and/or service (provision of the drug by a licensed program)".

†
Any prescription claim for a buprenorphine product indicated for use of opioid addiction treatment (i.e., medication assisted treatment).

‡
Any mention of the following ICD-9 diagnosis codes 960–979 or e-codes E850-E858, E950.0-E950.5, E962.0, E980.0-E980.5.

§
Any mention of the following ICD-9 diagnosis codes 965.00–965.09 (or 965.0), 969.4 or e-codes E850.0-E850.2.

^Any mention of the following ICD-9 diagnosis codes 965.02, 965.09, 969.4 or e-codes E850.1–E850.2.

**TABLE 3.**

Overall health care utilization and comorbid conditions * of adults <65 years who met Medicaid Lock-in Program (MLIP) eligibility criteria from June 2010 through December 2012, stratified by enrollment in the MLIP and time spent in the MLIP

| | Medicaid population eligible for MLIP enrollment | | No time in MLIP (n=411) | MLIP-enrolled** | | |
| --- | --- | --- | --- | --- | --- | --- |
| | Not enrolled in MLIP (n= 11,983) | Enrolled in MLIP (n=5,424) | | <12 months in MLIP without administrative censoring (n=1,365) | <12 months in MLIP with administrative censoring (n=1,373) | Full 12 months in MLIP (n=2,231) |
| | Mean [25th, 50th, 75th percentiles] | Mean [25th, 50th, 75th percentiles] | Mean [25th, 50th, 75th percentiles] | Mean [25th, 50th, 75th percentiles] | Mean [25th, 50th, 75th percentiles] | Mean [25th, 50th, 75th percentiles] |
| *Health care utilization in past year* | | | | | | |
| ED visits | 4.2 [1, 3, 5] | 8.3 [2, 5, 11] | 7.5 [2, 5, 10] | 8.0 [3, 6, 11] | 8.0 [2, 5, 10] | 8.9 [2, 6, 11] |
| Inpatient admissions | 1.0 [0, 0, 1] | 1.1 [0, 1, 1] | 0.9 [0, 0, 1] | 0.9 [0, 0, 1] | 1.2 [0, 1, 1] | 1.2 [0, 1, 2] |
| Days with Medicaid | 308.7 [273, 365, 365] | 310.1 [274, 365, 365] | 252.7 [153, 273, 365] | 282.9 [202, 335, 365] | 319.4 [305, 365, 365] | 331.2 [365, 365, 365] |
| | n (%) | n (%) | n (%) | n (%) | n (%) | n (%) |
| *Pain-related diagnoses in past year* | | | | | | |
| Any joint pain or arthritis *** | 9,620 (80.3) | 4,608 (85.0) | 316 (76.9) | 1,087 (79.6) | 1,193 (86.9) | 1,972 (88.4) |
| Back pain *** | 7,498 (62.6) | 4,219 (77.8) | 307 (74.7) | 1,029 (75.4) | 1047 (76.3) | 1,797 (80.6) |
| Neck pain *** | 3,247 (27.1) | 1,919 (35.4) | 112 (27.3) | 443 (32.5) | 496 (36.1) | 852 (38.2) |
| Headache/migraine *** | 1,652 (13.8) | 1,053 (19.4) | 67 (16.3) | 264 (19.3) | 255 (18.6) | 460 (20.6) |
| Fibromyalgia, chronic pain, or fatigue † | 3,990 (33.3) | 2,248 (41.5) | 114 (27.7) | 468 (34.3) | 591 (43.0) | 1,051 (47.1) |
| Rheumatoid arthritis or osteoarthritis ‡ | 2,091 (17.5) | 1,074 (19.8) | 47 (11.4) | 195 (14.3) | 303 (22.1) | 519 (23.3) |
| Sickle cell § | 87 (0.7) | 84 (1.6) | 0 | 7 (0.5) | 28 (2.0) | 49 (2.2) |
| *Mental health and substance use-related diagnoses in past year* | | | | | | |
| Depression ^ | 5,349 (44.6) | 2,871 (52.9) | 177 (43.1) | 650 (47.6) | 704 (51.3) | 1,315 (58.9) |
| Bipolar disorder † | 1479 (12.3) | 932 (17.2) | 48 (11.7) | 188 (13.8) | 221 (16.1) | 469 (21.0) |
| Personality disorder † | 230 (1.9) | 175 (3.2) | 7 (1.7) | 29 (2.1) | 36 (2.6) | 99 (4.4) |

| | Medicaid population eligible for MLIP enrollment | | MLP-enrolled** | | | |
|---|---|---|---|---|---|---|
| | Not enrolled in MLIP (n= 11,983) | Enrolled in MLIP (n=5,424) | No time in MLIP (n=411) | <12 months in MLIP without administrative censoring (n=1,365) | <12 months in MLIP with administrative censoring (n=1,373) | Full 12 months in MLIP (n=2,231) |
| | Mean [25th, 50th, 75th percentiles] | Mean [25th, 50th, 75th percentiles] | Mean [25th, 50th, 75th percentiles] | Mean [25th, 50th, 75th percentiles] | Mean [25th, 50th, 75th percentiles] | Mean [25th, 50th, 75th percentiles] |
| Schizophrenia and other psychotic disorders † | 482 (4.0) | 169 (3.1) | 5 (1.2) | 25 (1.8) | 52 (3.8) | 84 (3.8) |
| Anxiety disorder † | 3,017 (25.2) | 1,946 (35.9) | 113 (27.5) | 430 (31.5) | 522 (38.0) | 862 (38.6) |
| PTSD † | 444 (3.7) | 319 (5.9) | 17 (4.1) | 59 (4.3) | 76 (5.5) | 164 (7.4) |
| Alcohol-related disorder # | 795 (6.6) | 347 (6.4) | 19 (4.6) | 78 (5.7) | 94 (6.9) | 152 (6.8) |
| Other substance-related disorder # | 1,620 (13.5) | 1,261 (23.3) | 78 (19.0) | 297 (21.8) | 343 (25.0) | 530 (23.8) |
| *Other comorbid conditions in past year* | | | | | | |
| Mean Charlson co-morbidity index (SD) ~ | 1.68 (2.8) | 0.79 (1.5) | 0.47 (1.3) | 0.59 (1.4) | 0.91 (1.6) | 0.90 (1.5) |
| Mean Charlson co-morbidity index without cancer (SD) | 0.90 (1.6) | 0.76 (1.4) | 0.42 (1.1) | 0.55 (1.2) | 0.90 (1.6) | 0.85 (1.4) |
| Cancer ∞ | 1,598 (13.3) | 42 (0.8) | 3 (0.7) | 11 (0.8) | 4 (0.3) | 23 (1.0) |

ED= emergency department; PTSD=post-traumatic stress disorder; SD= standard deviation

*
Comorbid conditions and characteristics assessed in year prior to fully meeting MLIP eligibility criteria.

**
44 people were enrolled in the MLIP for >12 months and are not included in analyses stratified by time spent in the MLIP.

***
Pain categorizations used in previous research [25] and have been shown to be the most commonly reported chronic pain sites and reasons for long-term opioid use in a general medical population. Required any mention of specific ICD-9 diagnosis codes; see Sullivan et al. (2008) for additional details [25].

†
Centers for Medicare & Medicaid Services' (CMS) Chronic Conditions Data Warehouse definition used. Definition required at least 1 inpatient or 2 non-inpatient claims with specific ICD-9 diagnosis codes appearing more than once over a time span exceeding 30 days [26].

‡
CMS Chronic Conditions Data Warehouse definition used with slight modification. Required at least 1 inpatient or 2 non-inpatient claims with specific ICD-9 diagnosis codes appearing more than once over a time span exceeding 30 days [26].

§
Consistent with other studies and Agency for Healthcare Research and Quality's (AHRQ) Clinical Classification Software (CCS) definition, required at least 1 inpatient or 2 non-inpatient claims with specific ICD-9 diagnosis codes that appear more than once over a time span exceeding 30 days [27,28].

^
CMS Chronic Conditions Data Warehouse definition used. Definition requires at least 1 inpatient, skilled nursing facility, home health agency, hospital outpatient, or service/carrier claims with specific ICD-9 diagnosis codes within 1 year [26].

#
AHRQ's CCS definition used, which required at least 1 inpatient or 2 non-inpatient claims with the specific ICD-9 diagnosis codes that appear more than once over a time span exceeding 30 days [28].

~
The Charlson Comorbidity Index (CCI) is a method of categorizing comorbidities based on ICD codes. Each comorbidity is associated with a weight (from 1 to 6), and weights are based on the adjusted risk of mortality or resource use. CCI scores are calculated by summing an individual's weights; a score of zero indicates no comorbidities were detected. We used Quan's enhanced CCI macro which looks at 17 comorbidities. An individual comorbidity was considered present if there was at least 1 inpatient or 2 non-inpatient claims with the specific ICD-9 diagnosis codes that appeared more than once over a time span exceeding 30 days. Select specific comorbidities are listed below the mean indices and definitions can be found in Quan et al. (2005) [29].

∞
Captures any malignancy, including lymphoma and leukemia, except malignant neoplasms of the skin.