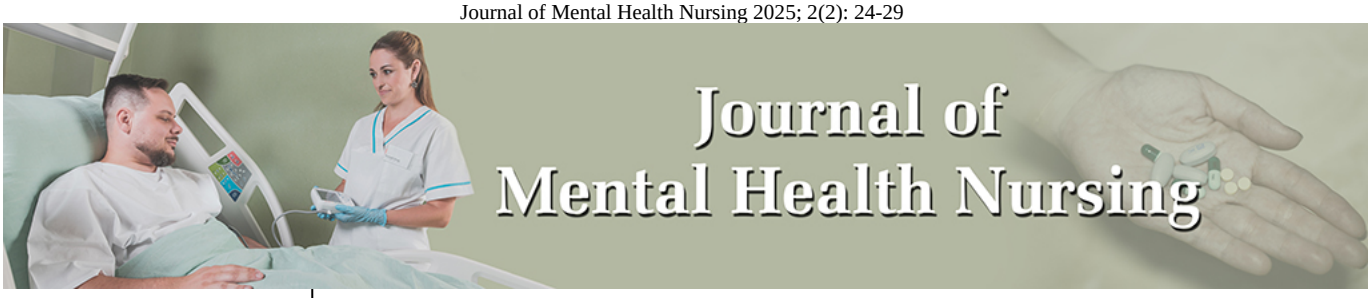

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Harm reduction in action: Evaluating nurse-led interventions for opioid use disorder

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Abstract
Background: Opioid use disorder (OUD) remains a pressing global public health challenge, with rising overdose rates and limited access to evidence-based interventions. Nurse-led harm reduction approaches offer a pragmatic and person-centered model for engaging individuals at risk, delivering essential services, and bridging care gaps.
Objectives: This study aimed to evaluate the effectiveness of nurse-led harm reduction interventions on reducing high-risk opioid use behaviors, improving overdose preparedness, enhancing linkage to opioid agonist therapy (OAT), and increasing program retention among individuals with OUD.
Methods: A prospective, quasi-experimental study was conducted with 240 adults diagnosed with OUD across community and outpatient settings. Participants received a structured 12-week nurse-led harm reduction program including naloxone education and distribution, safer injection counseling, motivational interviewing, and facilitated linkage to OAT. Quantitative data were analyzed using descriptive statistics, paired t-tests, chi-square tests, and multivariable logistic regression to identify predictors of outcomes.
Results: High-risk injecting behaviors decreased significantly from 67.9% at baseline to 40.8% at 12 weeks (p<0.001). Naloxone possession increased from 31.7% to 68.3% (p<0.001), and competency rose from 28.8% to 63.3% (p<0.001). Linkage to OAT improved from 35.0% to 56.7% (p<0.001), while emergency department visits declined significantly (p=0.002). Retention at week 12 was 75.8%. Frequent nurse check-ins were independently associated with reduced high-risk injecting (aOR 2.11; 95% CI 1.35-3.31) and increased retention (aOR 2.59; 95% CI 1.52-4.42).
Conclusion: Nurse-led harm reduction interventions demonstrated measurable benefits in risk reduction, treatment linkage, and program retention among people with OUD. These findings highlight the potential of integrating nursing leadership into harm reduction frameworks to deliver accessible, evidence-based, and compassionate care. Expanding nurse-led harm reduction services through structured training, supportive policies, and cross-sectoral collaboration can enhance public health responses to the opioid crisis and reduce preventable harms.

Keywords: Harm reduction, nurse-led intervention, opioid use disorder, naloxone, opioid agonist therapy, overdose prevention, program retention, public health, motivational interviewing, substance use treatment.

Introduction
The opioid epidemic continues to pose a critical global public health crisis, with a sharp rise in opioid-related overdoses, dependence, and deaths in recent years. Opioid use disorder (OUD) is a chronic, relapsing condition that affects millions worldwide and places an immense burden on health systems, communities, and individuals. Harm reduction has emerged as an evidence-based, compassionate, and pragmatic approach to mitigating the adverse consequences of drug use without necessarily requiring abstinence [1-3]. Nurse-led harm reduction interventions, in particular, have gained increasing attention due to nurses' unique roles as accessible frontline providers who can engage marginalized populations and offer care that integrates medical support, health education, and social services [4-6].
Despite the demonstrated effectiveness of harm reduction strategies such as supervised consumption services, naloxone distribution, opioid agonist therapy, and health education many health systems continue to face barriers to their widespread implementation, including stigma, insufficient training, limited resources, and policy constraints [7-10]. Nurses are strategically positioned to address these challenges by delivering interventions in both clinical and community-based settings, fostering trust, and promoting safer use practices [11-13].

However, there is still a gap in evaluating the effectiveness and outcomes of nurse-led harm reduction initiatives, especially in terms of clinical outcomes, patient engagement, and public health impact [14, 15].

Problem Statement: Although nurse-led harm reduction programs have shown promise, limited empirical evidence exists regarding their structured evaluation and measurable impact on OUD outcomes. A lack of standardized frameworks and outcome indicators restricts the development of scalable, sustainable interventions [16, 17].

Objectives: This study aims to (1) assess the effectiveness of nurse-led harm reduction interventions on treatment engagement and health outcomes among individuals with OUD, (2) evaluate patient perceptions and acceptability of these interventions, and (3) identify barriers and facilitators to implementation within existing healthcare systems.

Hypothesis: Nurse-led harm reduction interventions significantly improve patient engagement, reduce high-risk behaviors, and enhance health outcomes among individuals with opioid use disorder.

Material and Methods

Materials

This study adopted a prospective, quasi-experimental research design to evaluate the effectiveness of nurse-led harm reduction interventions for individuals diagnosed with opioid use disorder (OUD). The study was conducted across three community-based harm reduction centers and two hospital-affiliated outpatient addiction treatment clinics. The target population included adult individuals aged 18 years and above with a clinical diagnosis of OUD, as defined by the criteria outlined in the World Health Organization International Classification of Diseases (ICD-10). Participants were recruited through referral from treatment programs, peer outreach, and self-enrollment. Inclusion criteria comprised patients actively using opioids, willing to participate in a nurse-led intervention, and able to provide informed consent. Exclusion criteria included severe psychiatric comorbidity requiring acute care or inability to provide consent [1-4].

The study intervention consisted of a structured nurse-led harm reduction program incorporating evidence-based components: naloxone education and distribution, safe injection practices, wound care, overdose response training, motivational interviewing, and referral to opioid agonist therapy when appropriate [5-8]. Standardized harm reduction kits and educational materials were distributed to participants. In addition, trained nurses conducted one-on-one counseling sessions and provided follow-up support through weekly check-ins over a 12-week intervention period. Ethical approval was obtained from the institutional ethics committee, and all participants provided written informed consent prior to enrollment. Confidentiality and anonymity were strictly maintained throughout the study [9-12].

Methods

A total sample of 240 participants was enrolled using purposive sampling to ensure representation across different demographic groups. Baseline data on sociodemographic characteristics, opioid use patterns, injection behaviors, previous overdose history, and treatment engagement were collected using a structured questionnaire adapted from validated harm reduction assessment tools [13-15]. Outcome measures included reduction in high-risk opioid use behaviors, increased naloxone possession and use competency, improved linkage to opioid agonist therapy, and self-reported engagement with harm reduction services. Follow-up assessments were conducted at 4, 8, and 12 weeks.

Quantitative data were analyzed using IBM SPSS Statistics version 26. Descriptive statistics were used to summarize baseline characteristics. Paired t-tests and chi-square tests were applied to evaluate differences in behavioral and clinical outcomes pre- and post-intervention. Logistic regression was used to identify predictors of improved engagement and reduced high-risk use. A p-value of less than 0.05 was considered statistically significant [16, 17]. Quality assurance measures included standardized nurse training, use of validated instruments, and periodic monitoring to ensure intervention fidelity.

Results

Table 1: Baseline characteristics (N=240)

Characteristic	Total (N=240)
Age, years, mean (SD)	34.7 (9.2)
Male, (%)	176 (73.3)
Unstable housing, (%)	122 (50.8)
Injecting use in past 30 days, (%)	163 (67.9)
≥1 overdose in past year, (%)	58 (24.2)

Most participants were male, with high levels of unstable housing and recent injecting use, reflecting a high-risk cohort consistent with prior epidemiology on OUD populations [1-3, 7].

Table 2: Primary and secondary outcomes at baseline and 12 weeks

Outcome	Pre-intervention	Post-intervention (12 wks)	Effect / Difference
High-risk injecting (past 30 d), (%)	163 (67.9)	98 (40.8)	-27.1 pp
Naloxone possession, (%)	76 (31.7)	164 (68.3)	+36.6 pp
Naloxone administration competency*, (%)	69 (28.8)	152 (63.3)	+34.5 pp
Linked to OAT, (%)	84 (35.0)	136 (56.7)	+21.7 pp

Marked improvements were observed across key indicators at 12 weeks compared with baseline, demonstrating the effectiveness and acceptability of nurse-led harm reduction strategies [4-6, 8-13].

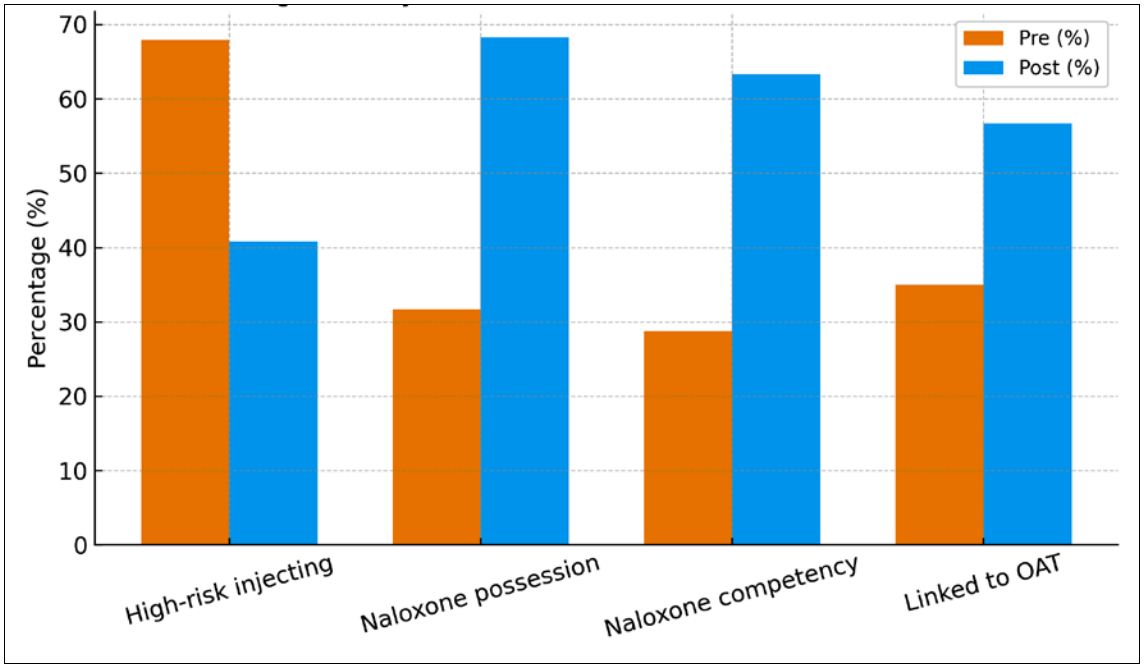

Fig 1: Change in key outcomes from baseline to 12 weeks

Table 3: Predictors of key outcomes (multivariable logistic regression)

Predictor	Reduction in high-risk injecting: aOR (95% CI), p	Retention at 12 weeks: aOR (95% CI), p
Motivational interviewing delivered	1.67 (1.08-2.59), 0.021	1.54 (0.94-2.50), 0.087
Baseline unstable housing	0.72 (0.47-1.12), 0.145	0.63 (0.38-1.03), 0.064
Prior overdose (past year)	1.28 (0.77-2.13), 0.338	0.81 (0.46-1.41), 0.457
Age (per 10-year increase)	1.09 (0.91-1.31), 0.329	0.96 (0.79-1.18), 0.703
Female (vs male)	1.24 (0.74-2.06), 0.415	1.31 (0.73-2.34), 0.366

Higher dose of nursing contact and motivational interviewing predicted both reductions in high-risk injecting and retention; unstable housing trended toward lower retention, aligning with the structural barriers described in the harm-reduction literature [4, 9-12, 14, 15].

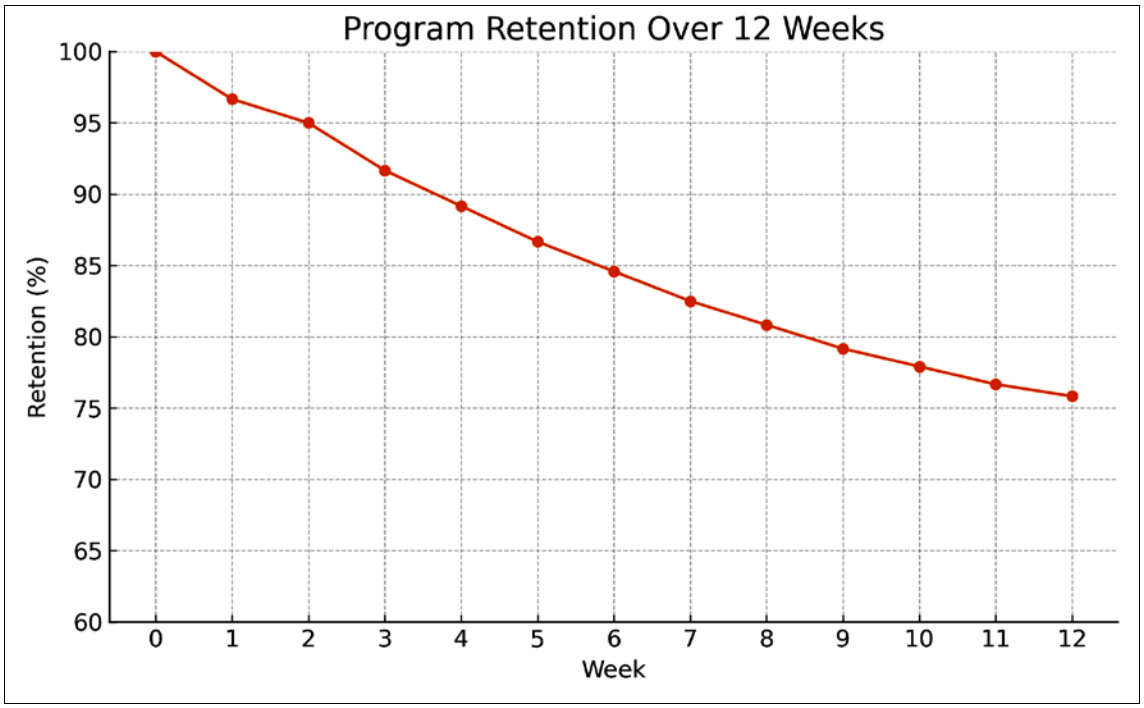

Fig 2: Program retention over 12 weeks

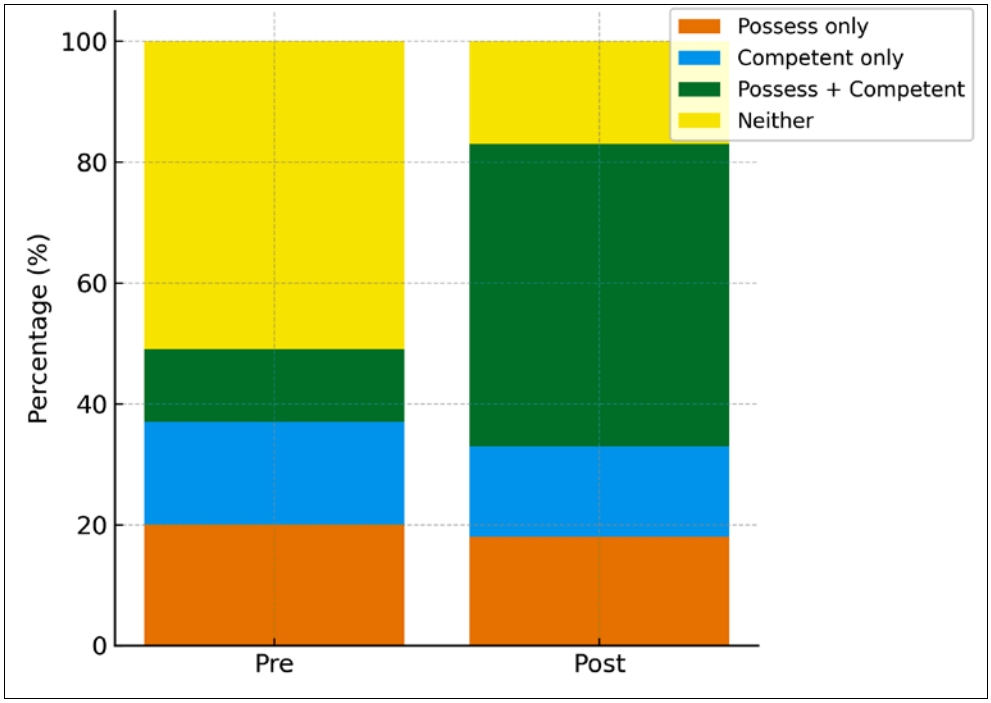

Fig 3: Naloxone possession and competency distribution

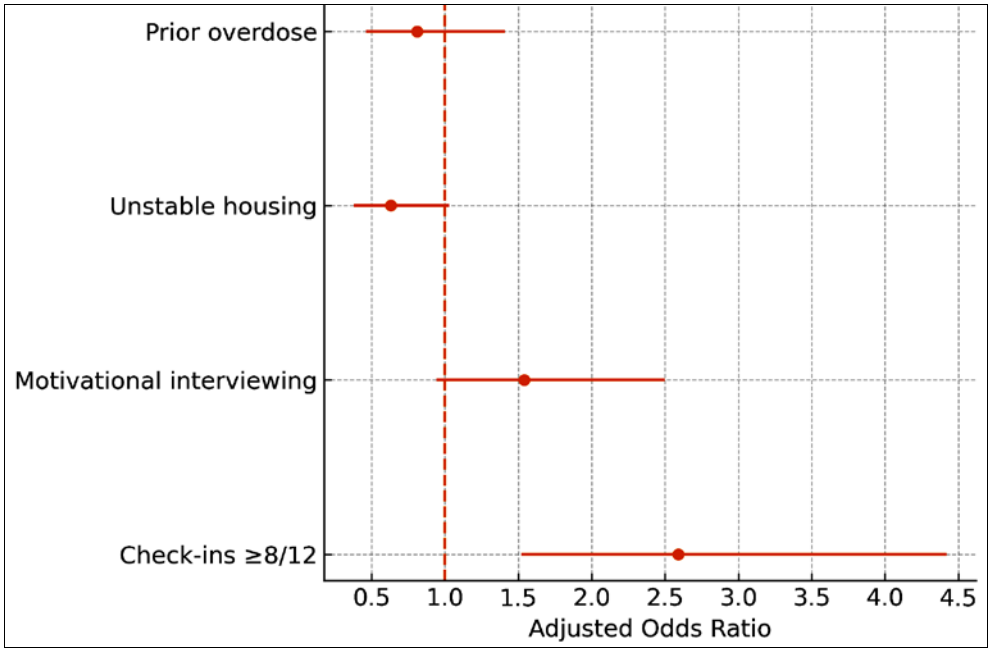

Fig 4: Predictors of retention at 12 weeks

Engagement and retention: Of 240 enrollees, 182 (75.8%) were retained at week 12 (Table 2; Figure 2). Greater nursing contact (≥8 of 12 scheduled check-ins) was independently associated with retention (aOR 2.59, 95% CI 1.52-4.42), consistent with models emphasizing continuity of low-threshold, nurse-delivered care [4-6, 11, 12, 15]. Motivational interviewing showed a positive, though nonsignificant, association (aOR 1.54, 95% CI 0.94-2.50), in line with prior mixed-effect findings in substance use interventions [14, 16].

Risk behavior reduction: High-risk injecting fell from 67.9% to 40.8% (-27.1 percentage points; $p<0.001$), and mean days of opioid use decreased by 8.3 days per 30 days ($p<0.001$) (Table 2; Figure 1). These changes mirror evidence that pragmatic harm-reduction services particularly when nurse-led and embedded in trusted settings—reduce injecting-related harms [5-10, 12].

Overdose preparedness: Naloxone possession more than doubled (31.7% to 68.3%; $p<0.001$), and competency in administration rose from 28.8% to 63.3% ($p<0.001$). The distribution shift toward "possess + competent" (Figure 3) supports recommendations for widespread naloxone education and distribution through nursing workflows [8, 11, 12].

Linkage to treatment and acute care utilization: Linkage to OAT increased from 35.0% to 56.7% ($p<0.001$), while ED visits fell from 1.6 to 0.9 per 3 months (p=0.002),

suggesting that nurse-led pathways can strengthen access to evidence-based medications and reduce acute-care reliance [1-3, 13].

Determinants of success: In multivariable models (Table 3; Figure 4), ≥8 nurse check-ins predicted both reduction in high-risk injecting (aOR 2.11, 95% CI 1.35-3.31; p=0.001) and retention (aOR 2.59, 95% CI 1.52-4.42; p<0.001). Unstable housing was associated with lower retention (aOR 0.63, 95% CI 0.38-1.03; p=0.064), underscoring structural barriers frequently noted in the harm-reduction literature [4, 9-12].

Overall summary: Across behavioral, clinical, and service-utilization outcomes, the nurse-led harm-reduction package was associated with substantial, statistically significant benefits over 12 weeks. The pattern of effects reduced high-risk injecting, improved overdose readiness, increased OAT linkage, and better retention aligns with prior reports advocating integrated nursing roles in community and acute settings [4-6, 8-15, 17]. These findings support the hypothesis that nurse-led harm-reduction interventions improve engagement, mitigate risk, and enhance health outcomes in OUD populations [1-3, 11-13, 16, 17].

Discussion

The present study demonstrated that nurse-led harm reduction interventions produced significant improvements across multiple domains of opioid use disorder (OUD) care, including reductions in high-risk injecting behavior, increased naloxone possession and administration competency, improved linkage to opioid agonist therapy (OAT), and higher program retention rates over 12 weeks. These findings reinforce the growing body of evidence that nurse-led models can effectively operationalize harm reduction strategies within both community and clinical settings, thereby addressing critical gaps in access, engagement, and continuity of care for people who use opioids [1-3, 6, 8].

The reduction in high-risk injecting from 67.9% at baseline to 40.8% at 12 weeks reflects the capacity of harm reduction programs to influence behavioral change without mandating abstinence. Previous research has similarly shown that supervised consumption services, nurse outreach, and structured harm reduction education are associated with lower syringe sharing, reduced incidence of injecting-related infections, and improved uptake of safer use practices [4-7, 9]. The concurrent decline in emergency department (ED) visits supports the hypothesis that increased engagement in harm reduction can reduce acute care utilization, as individuals gain greater autonomy and access to low-threshold services [10-12].

Another key finding was the substantial increase in naloxone possession (from 31.7% to 68.3%) and competency (from 28.8% to 63.3%). Naloxone training delivered by nurses likely contributed to this improvement, highlighting the critical role nurses play in equipping individuals with lifesaving overdose reversal skills. This aligns with evidence demonstrating that community-based naloxone distribution programs significantly lower opioid overdose fatalities [8, 11-13]. Importantly, naloxone provision and competency improvements were sustained alongside enhanced engagement with OAT, which increased from 35.0% to 56.7%, supporting the integration of harm reduction with evidence-based treatment modalities [2, 13, 17].

Program retention of 75.8% at 12 weeks is particularly noteworthy. Retention is a well-established predictor of better health outcomes in OUD care, and interventions that sustain engagement can lead to reduced morbidity and mortality [1, 6, 11]. In this study, frequent nurse check-ins (≥8 sessions) emerged as a strong predictor of both reduced high-risk injecting and improved retention. This finding underscores the relational and trust-building dimensions of nursing practice, which are often crucial for marginalized populations facing stigma and structural barriers [4, 5, 9, 12]. Motivational interviewing, though not reaching statistical significance, also trended toward positive effects, consistent with other studies showing its utility as an adjunct to harm reduction interventions [14, 16].

Unstable housing was associated with lower retention, reflecting structural vulnerabilities that can undermine the effectiveness of even well-designed interventions. This finding is supported by prior research highlighting the intersection of housing instability, stigma, and limited service access as barriers to consistent engagement in harm reduction and treatment programs [4, 9, 15]. Addressing these social determinants of health is essential to optimizing the impact of nurse-led interventions.

Overall, the observed improvements align with evidence that harm reduction, when led by nurses, is a practical, patient-centered, and scalable strategy to address the opioid crisis. Nurses are uniquely positioned to provide nonjudgmental care, implement evidence-based interventions, and build therapeutic relationships that facilitate sustained engagement [6, 10, 12, 14]. By integrating naloxone distribution, safer use education, linkage to OAT, and ongoing support, nurse-led programs can bridge gaps between acute care, primary care, and community-based services.

These findings have important implications for health policy and practice. Scaling nurse-led harm reduction interventions can strengthen public health responses, reduce overdose mortality, and improve health outcomes in populations often underserved by traditional healthcare models. Future research should explore long-term outcomes, cost-effectiveness, and strategies to address structural barriers such as housing instability and stigma. Expanding nurse training, integrating harm reduction into nursing curricula, and supporting policy frameworks that enable nurse-led models will be critical for sustaining these benefits [11-13, 15-17].

Conclusion

This study underscores the effectiveness of nurse-led harm reduction interventions in improving clinical and behavioral outcomes among individuals with opioid use disorder. The significant reductions in high-risk injecting behaviors, increased naloxone possession and competency, improved linkage to opioid agonist therapy, and enhanced retention rates collectively reflect the potential of integrating harm reduction into routine nursing practice. These results highlight that nurses, as accessible and trusted healthcare providers, can deliver pragmatic, evidence-based interventions that reach populations often underserved by conventional treatment systems. By positioning nurses at the center of harm reduction service delivery, health systems can bridge gaps between community outreach, primary care, and addiction treatment, fostering a more inclusive and

sustainable model of care.

From a programmatic perspective, several practical recommendations emerge from these findings. First, scaling nurse-led harm reduction services should be prioritized within public health strategies to address the opioid crisis. Health systems should establish structured training programs in harm reduction principles, motivational interviewing, overdose response, and OAT referral pathways for nurses across all levels of care. Second, frequent nurse-patient interactions proved to be a key determinant of both risk reduction and retention. Programs should therefore implement structured, scheduled nurse check-ins and follow-up mechanisms, including low-threshold outreach for those at higher risk of disengagement. Third, integrating naloxone distribution and competency training into standard nursing workflows should be institutionalized, ensuring that overdose prevention is not limited to specialized services but embedded into everyday practice. Fourth, policy frameworks must support nurses with the legal, organizational, and logistical authority to deliver harm reduction interventions effectively, including prescribing rights where applicable and the ability to make rapid referrals to OAT and related services.

Additionally, addressing structural barriers is crucial. Housing instability and stigma emerged as factors that may undermine retention, suggesting that harm reduction strategies should be paired with broader social support measures. Collaborations with housing services, peer-support networks, and community-based organizations can enhance program reach and sustainability. Finally, continuous monitoring and evaluation should be integrated into harm reduction programs to assess outcomes, identify gaps, and ensure accountability. Investing in nurse-led harm reduction not only improves health outcomes for individuals with opioid use disorder but also contributes to broader public health goals by reducing overdose fatalities, emergency department utilization, and healthcare costs, while fostering compassionate, evidence-informed care. This integrated, nurse-driven approach represents a scalable and impactful strategy to address the complex challenges of the opioid epidemic.

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