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ORIGINAL RESEARCH

Frequent nightmares in Chinese patients undergoing methadone maintenance therapy: prevalence, correlates, and their association with functional impairment

Bao-Liang Zhong[1,2]
Yan-Min Xu[2]
Wu-Xiang Xie[3]
Jin Lu[4]

[1]Research Center for Psychological and Health Sciences, China University of Geosciences, Wuhan, Hubei Province, People's Republic of China; [2]Affiliated Wuhan Mental Health Center, Tongji Medical College of Huazhong University of Science & Technology, Wuhan, Hubei Province, People's Republic of China; [3]Peking University Clinical Research Institute, Peking University Health Science Center, Beijing, People's Republic of China; [4]Department of Psychiatry, The First Affiliated Hospital of Kunming Medical University, Kunming, People's Republic of China

Purpose: Nightmares are associated with many negative health outcomes; however, little is known about the characteristics of nightmares in heroin-dependent patients (HDPs). This study examined the prevalence and correlates of frequent nightmares (FNs) and their association with functional impairment in Chinese patients undergoing methadone maintenance therapy (MMT).

Patients and methods: In total, 603 Chinese HDPs from three MMT clinics in Wuhan, China, completed this survey. FNs were defined as reporting nightmares at least once a week. The Sheehan Disability Scale (ShDS) was used to assess the severity of functional impairment of patients. A standardized questionnaire was used to collect data on socio-demographics, drug use characteristics, physical health, mental health, and insomnia.

Results: The prevalence of FNs in Chinese HDPs receiving MMT was 25.9%. Factors significantly associated with nightmares among MMT HDPs included an educational attainment of senior high school and above (OR=2.73, $P<0.001$), unemployment (OR=3.16, $P<0.001$), a history of re-education through forced labor (OR=3.14, $P<0.001$), injecting heroin before MMT (OR=3.62, $P=0.002$), a high dose of methadone (>70 mg/day) (OR=2.03, $P=0.006$), use of hypnotics (OR=1.91, $P=0.044$), the presence of hepatitis B virus core antibody (OR=4.63, $P<0.001$), pain (OR=3.20, $P<0.001$), anxiety (OR=2.06, $P=0.039$), and insomnia (OR=5.75, $P<0.001$). After controlling for potential confounders, nightmares were still significantly associated with a higher ShDS score ($\beta=2.718$, $P=0.006$).

Conclusion: FNs are prevalent among Chinese HDPs receiving MMT and significantly associated with functional impairment. Nightmares are a clinically relevant phenomenon in Chinese MMT clinics, which deserves more clinical and research attention.

Keywords: nightmare, methadone maintenance therapy, functional impairment, sleep disorder

Introduction

A nightmare is a disturbing dream that leads to intense emotional reactions such as anxiety, distress, and fear and often wakes the dreamer.[1] Nightmares are common in the general population, occurring weekly in 2–6% and 20% of the adults and children in western countries, and in 5.1% and 5.2% of the adults and children in China, respectively.[2–6] Although the underlying etiology of nightmares is still unclear, accumulating evidence suggests that frequent nightmares (FNs) are significantly associated with considerable personal distress, a constellation of

Correspondence: Jin Lu
Department of Psychiatry, The First Affiliated Hospital of Kunming Medical University, No. 295 Xichang Road, Wuhua District, Kunming 650032, Yunnan Province, People's Republic of China
Tel +86 1 352 922 8812
Email jinlu2000@163.com

psychopathological symptoms, fatal and non-fatal suicidal behaviors, insomnia, and poor sleep quality.[5,7–10] Compared to the general population, patients with mental disorders experience more FNs and have a greater number of nightmare episodes.[3,9,11] Further studies have revealed the significant associations of FNs with higher risk of suicide in patients with major depression, greater level of distress in patients with schizophrenia, poorer sleep quality and greater delusion severity in patients with psychosis, and interrupted rapid eye movement (REM) sleep and poorer treatment outcome in patients with post-traumaticstress disorder.[12–16]

Sleep disorders are a major health concern for both patients with heroin dependence and heroin-dependent patients (HDPs) receiving methadone maintenance therapy (MMT).[17] It has been estimated that prevalence rates of difficulty in initiating sleep (DIS), difficulty in maintaining sleep (DMS), and poor sleep quality of clients receiving MMT are 30.8%, 29.8%, and 80.8%, respectively.[18–20] However, in contrast to the numerous studies on sleep quality and insomnia of HDPs, few studies have investigated nightmares in HDPs, including those under MMT. As far as we know, only one previous qualitative study with a small sample of 32 MMT clients described "horrible nightmares" as a negative effect of MMT, but provided little information on the clinical characteristics of nightmares.[21] Nightmares can be triggered or caused by many factors, including traumatic events, medications, depression and other psychiatric disorders, and withdrawal from psychoactive drugs such as heroin.[22–24] In the case of MMT HDPs, because they frequently suffer from depression and anxiety, use multiple drugs, and are in the prolonged withdrawal period, it would be reasonable to hypothesize that nightmares would be very prevalent among HDPs undergoing MMT, and they will be associated with a number of drug use characteristics and clinical factors.[25–28] Nonetheless, empirical evidence for this is lacking.

In China, MMT is a national strategy to address the issue of heroin and other opioids use. Chinese researchers have found that MMT is effective in relieving patients' withdrawal symptoms and cravings for heroin, improving patients' health and social well-being, and reducing the transmission of infectious diseases (ie, hepatitis and HIV) and criminal activities associated with heroin use.[29,30] However, results from comparative studies show that physical and psychological quality of life and functioning of Chinese MMT patients are still poorer than healthy controls, largely because most MMT clinics in China provide MMT only and many psychosocial and sleep problems of Chinese MMT patients are neglected and undertreated.[17,31–35] To increase health care providers' awareness on the importance of these issues and to meet the psychosocial needs of these patients, a first necessary step is to provide data on the magnitude and characteristics of these psychosocial and sleep problems. Because nightmares are treatable and they have been associated with many health and psychosocial issues, as we reviewed above, interventions aiming at reducing nightmares would produce multiple beneficial effects for the health of MMT patients.[36] Further, MMT clinics are very well-placed to provide psychosocial services to address nightmares of HDPs, because this patient population treated at MMT clinics is relatively stable and can be easily followed up. Unfortunately, so far, the lack of data on the clinical characteristics of nightmares in patients may have hindered the clinical application of several effective treatments for nightmares in China's MMT settings.

Social and occupational dysfunctions resulted from nightmares have been reported in studies with patients other than HDPs.[37] Although several factors such as depression and poor physical health have been found to be associated with functioning impairment in patients receiving MMT, it remains unclear whether nightmares are significantly associated with functional impairment of HDPs.[31] Given the ultimate treatment goal of "returning to a normal life" of MMT, it is also important to investigate potentially modifiable factors associated with functional impairment such as nightmares.[38]

The current study was carried out to examine the prevalence and correlates of FNs in a large sample of HDPs of Chinese MMT clinics and the relationship between nightmares and functional impairment.

Materials and methods
Participants

Participants were subjects of a previous cross-sectional study at three municipality-owned MMT clinics in Wuhan, a large metropolitan city with over 10 million inhabitants in central-south China.[27,39] Participants were outpatients of the three clinics during the study period. To be eligible for the study, patients must be at least 20 years old, meet Diagnostic and Statistical Manual of Mental Disorders, fourth edition (DSM-IV) criteria for a lifetime diagnosis of heroin dependence, be receiving MMT at the

time of the survey, and voluntarily join the study.[40] We excluded patients who suffered from severe physical illnesses, alcohol addiction, or psychotic symptoms. During the study period, all patients of the three selected clinics (n=743) were screened for eligibility and 652 met the study inclusion criteria. Because 33 patients did not complete the survey questionnaires and 16 withdrew informed consent, a final sample of 603 MMT patients was obtained for the current analysis.

Prior to the formal study, the study protocol was approved by the Ethics Committee of Wuhan Mental Health Center. The protocol including the methods was performed in accordance with the Declaration of Helsinki and the relevant ethical guidelines and regulations in China. All patients signed the informed consent before inclusion.

Procedures and instruments

After the informed consent, all patients were instructed to independently and anonymously complete the survey questionnaire, which was standardized and finalized after a pilot testing with a sample of 48 MMT patients. Trained investigators were assigned to assist patients who had difficulty in filling the questionnaires and collect patients' clinical data from their medical records, including methadone dose and infection status of hepatitis B virus (HBV) and hepatitis C virus (HCV).

The survey questionnaire had seven parts: a) sociodemographic variables (gender, age, education, marital status, and self-rated economic status); b) drug use characteristics (history of "re-education through forced labor," main route of heroin use, duration of heroin use, length of MMT, current methadone dose, currently smoking, currently drinking, and current use of hypnotics); c) physical health (infection status of HBV and HCV, and pain); d) mental health (depressive and anxiety symptoms); e) insomnia (DIS, DMS, and early morning awakening [EMA]); f) nightmares; and g) functional impairment.

Two questions were used to elicit cigarette smoking behavior: a) "On average, do you smoke daily now?" and b) "How long have you smoked?". Questions used for drinking and use of hypnotics were: "Did you drink at least once per month over the past 6 months?" and "During the past month, did you take sleeping pills (prescribed or 'over the counter') at least once per week?", respectively. Currently, smoking was defined as having smoked for at least half a year and now smoked at least one cigarette per day.[41] Currently drinking referred to

drinking monthly during the past 6 months.[42] Current use of hypnotics was defined as the use of any hypnotics at least once a week during the past month. Although the use of sedative hypnotics is generally the result of nightmares and nightmares-associated insomnia, there is also evidence that the use of some hypnotics (ie, temazepam and triazolam) would cause nightmares.[43,44] We therefore considered the use of hypnotics as a candidate correlate of nightmares in this study.

HBV infection status was denoted by the test results of HBV surface antigen (HBsAg) and HBV core antibody (HBcAb). HCV infection status was denoted by the test result of HCV antibody (HCAb). The 5-point Verbal Rating Scale was used to measure pain intensity: "Overall, how intense is your pain now?," which was rated on a 5-point scale from 1=none to 5=very severe. Respondents who answered "moderate," "severe," and "very severe" were categorized as having clinically significant pain.[26]

Depressive and anxiety symptoms were evaluated with the validated Chinese Zung's Self-rating Depression Scale (SDS) and Zung's Self-rating Anxiety Scale (SAS), respectively.[45] Both scales have 20 items and responses to all items are scored from 1=a little of the time to 4=most of the time. In China, total crude scores of ≥40 on SDS and ≥43 on SAS are used to denote clinically significant depression and anxiety, respectively.[25,46]

In this study, insomnia during the prior month included three basic forms: DIS ("How often have you had difficulties in getting to sleep?"), DMS ("How often have you had difficulties in maintaining sleep and waked up in the middle of night?"), and EMA ("How often have you waked up in the early morning and had difficulties in falling sleep again?").[5,47] The presence of insomnia was defined by an "often" response to any of the three questions.

In accordance with previous studies, we used one single question to assess nightmares: "How often have you had nightmares during the past month?" with a particular definition of nightmares given: "Here 'nightmares' refer to intense, emotionally negative mental experiences that often occur during late-night sleep and lead to abrupt awakenings".[5,7,48,49] Frequency of nightmares was rated on a 4-point scale (1=none, 2=less than once a week, 3=once or twice a week, 4=three or more times a week). FNs refer to reporting nightmares at least once a week.[5,7,48,49] As one of our quality control measures, six trained psychiatrists were required to immediately check the completeness of all answers in the

questionnaires before collecting patients' questionnaires. Patients who endorsed nightmares in their questionnaires were further interviewed face-to-face by these psychiatrists to ascertain the presence of nightmares and exclude the false-positive cases with bad dreams, sleep terrors, sleep walking, and nocturnal panic attack.

The validated Chinese Sheehan Disability Scale (ShDS) was used to assess the severity of functional impairment of MMT patients.[50,51] The ShDS has three items, which assess functional impairments associated with work/school, social life and leisure activities, and family life and home responsibilities. Each item is rated on an ordered metric scale from 0 (not at all) to 10 (very severely). The total score of ShDS ranges from 0 (unimpaired) to 30 (highly impaired), with a higher total score representing a greater functional impairment.

Statistical analysis

Prevalence rates of FNs in the whole patient sample and different patient cohorts were calculated and the chi-squared test was used to compare rates between groups. Multivariable logistic regression model with backward stepwise selection that entered significant variables in the chi-squared test as independent variables and nightmares as the dependent variable was used to identify factors significantly and independently associated with nightmares. OR and 95% CIs were used to quantify the associations between factors and nightmares. Independent samples Mann–Whitney U test was used to compare ShDS scores of patients with and without nightmares. Multiple linear regression models were used to examine the strength of association between nightmares and ShDS score, controlling for socio-demographic variables, drug use characteristics, physical health, mental health, and insomnia. The statistical significance level was set $P<0.05$ (two-sided). SPSS software version 15.0 package was used for all analyses (SPSS Inc., Chicago, IL, USA).

Results

The mean age of the 603 MMT HDPs was 38.1 years (SD=7.0, range=21–59) and 69.8% were males. The prevalence of HBsAg, HBcAb, and HCAb was 22.7%, 20.6%, and 78.1%, respectively. Detailed socio-demographic and drug use characteristics of the patient sample are shown in Table 1.

In total, 156 MMT clients endorsed FNs. Prevalence of FNs was 25.9% in the whole sample of Chinese HDPs receiving MMT, with 23.8% in men and 30.4% in women.

Although higher rates of nightmares in women than men were observed, their difference did not reach statistically significant level ($P=0.122$). Results from Chi-squared tests (Table 1) show that patients having nightmares were more likely to have an educational attainment of senior high school and above ($P=0.001$), be unemployed ($P=0.009$), have a history of re-education through forced labor ($P=0.015$), inject heroin before MMT ($P<0.001$), take a high dose of methadone (>70 mg/day) ($P<0.001$), be non-smokers ($P<0.001$), take hypnotics ($P<0.001$), have a positive HBsAg test result ($P<0.001$), have a positive HBcAb test result ($P<0.001$), have a positive HCAb test result ($P=0.002$), feel pain ($P<0.001$), be depressed ($P<0.001$), be anxious ($P<0.001$), and have insomnia ($P<0.001$).

Multivariable logistic regression analysis (Table 2) shows that an educational attainment of senior high school and above (OR=2.73, $P<0.001$), unemployment (OR=3.16, $P<0.001$), a history of re-education through forced labor (OR=3.14, $P<0.001$), injecting heroin before MMT (OR=3.62, $P=0.002$), a high dose of methadone (>70 mg/day) (OR=2.03, $P=0.006$), use of hypnotics (OR=1.91, $P=0.044$), the presence of HBcAb (OR=4.63, $P<0.001$), pain (OR=3.20, $P<0.001$), anxiety (OR=2.06, $P=0.039$), and insomnia (OR=5.75, $P<0.001$) were significantly associated with nightmares among MMT HDPs.

Total ShDS scores were significantly higher in clients with nightmares than those without nightmares ([median, interquartile]: [9, 13] vs [6, 14], z=3.887, $P<0.001$). After controlling for potential confounders (including socio-demographic variables, drug use characteristics, physical health, mental health, and insomnia), results from multiple linear regression analysis (Table 3) reveal that nightmares were still significantly associated with a higher ShDS score (β=2.718, $P=0.006$).

Discussion

To the best of our knowledge, this is the first study examining the clinical characteristics of nightmares in Chinese MMT HDPs, as well as their association with functional impairment. Main findings of this study are: a) an overall prevalence of 25.9% of FNs in Chinese MMT patients, without significant gender difference; b) significant correlates of nightmares of Chinese MMT HDPs: an educational attainment of senior high school and above, unemployment, a history of re-education through forced labor, injecting heroin before MMT, a high dose of methadone (>70 mg/day), use of hypnotics, the presence of HBcAb, pain, anxiety, and insomnia; and c) a significant

Table 1 Characteristics of the sample of Chinese methadone-maintained heroin-dependent patients, and prevalence rates of frequent nightmares according to variables

Variables		n	Nightmares			
			Number	%	χ2	P
Gender	Male	412	98	23.8		
	Female	191	58	30.4	2.397	0.122
Age (years)[a]	≤39	327	83	25.4		
	≥40	276	73	26.4	0.143	0.705
Education	Junior high school and below	373	78	20.9		
	Senior high school and above	230	78	33.9	11.603	0.001
Marital status[b]	Married	295	69	23.4		
	Non-married	308	87	28.2	2.081	0.149
Employment	Yes	317	67	21.1		
	No	286	89	31.1	6.79	0.009
Self-rated economic status	Good	149	35	23.5		
	Fair	314	83	26.4		
	Poor	140	38	27.1	0.884	0.643
History of re-education through forced labor[c]	Yes	286	87	30.4		
	No	317	69	21.8	5.87	0.015
Route of past heroin administration	Smoking	96	12	12.5		
	Injecting	507	144	28.4	12.851	<0.001
Duration of heroin use (years)[a]	≤10	373	90	24.1		
	>10	230	63	27.4	0.802	0.37
Duration of MMT (months)[a]	≤24	240	68	28.3		
	>24	363	65	17.9	1.671	0.196
Methadone dose (md/day)[a]	≤70	273	51	18.7		
	>70	330	108	32.7	14.893	<0.001
Current drinking	No	507	133	26.2		
	Yes	96	23	24	0.218	0.641
Current smoking	No	51	24	47.1		
	Yes	552	132	23.9	13.042	<0.001
Currently taking hypnotics	No	504	111	22		
	Yes	99	45	45.5	17.035	<0.001
Hepatitis B virus surface antigen	Positive	137	61	44.5		
	Negative	466	95	20.4	32.169	<0.001
Hepatitis B virus core antibody	Positive	124	62	50		
	Negative	479	94	19.6	47.391	<0.001

(*Continued*)

Table 1 (Continued).

Variables		n	Nightmares			
			Number	%	χ2	P
Hepatitis C virus antibody	Positive	471	139	29.5		
	Negative	132	17	12.9	9.493	0.002
Pain	No	280	49	17.5		
	Yes	323	107	33.1	18.006	<0.001
Depressive symptoms	No	399	81	20.3		
	Yes	204	75	36.8	15.102	<0.001
Anxiety symptom	No	384	76	19.8		
	Yes	219	80	36.5	16.188	<0.001
Insomnia	No	230	31	13.5		
	Yes	373	125	33.5	28.197	<0.001

Notes: [a]Continuous variables were dichotomized at the median. [b]"Non-married" includes never-married, remarried, cohabitating, separated/divorced, and widowed. [c]An old model of heroin detoxification in China, which was officially abolished in 2013. It refers to administrative detentions for persons with heroin addiction who relapse or inject heroin after compulsory detoxification.

Table 2 Results of multiple logistic regression analysis on factors significantly associated with frequent nightmares in Chinese methadone-maintained heroin-dependent patients

Variables	Risk level	Reference level	Coefficient	Standard error	Wald χ2	P	OR (95%CI)
Education	Senior high school and above	Junior high school and below	1.005	0.262	14.729	<0.001	2.73(1.64,4.56)
Employment	No	Yes	1.151	0.269	18.287	<0.001	3.16(1.87,5.36)
History of re-education through forced labor	Yes	No	1.144	0.266	18.452	<0.001	3.14(1.86,5.29)
Route of past heroin administration	Injecting	Smoking	1.286	0.422	9.271	0.002	3.62(1.20,8.26)
Methadone dose (md/day)	>70	≤70	0.707	0.256	7.625	0.006	2.03(1.23,3.35)
Hypnotic use	Yes	No	0.647	0.322	4.046	0.044	1.91(1.02,3.59)
Hepatitis B virus core antibody	Positive	Negative	1.53	0.419	13.35	<0.001	4.63(2.03,10.53)
Pain	Yes	No	1.162	0.309	14.143	<0.001	3.20(1.74,5.86)
Anxiety symptom	Yes	No	0.637	0.302	4.449	0.039	2.06(1.04,4.48)
Insomnia	Yes	No	1.748	0.318	30.21	<0.001	5.75(3.08,10.72)

positive association between nightmares and a greater degree of functional impairment in Chinese MMT HDPs, net of potential confounding effects of socio-demographic variables, drug use characteristics, physical health, mental health, and insomnia.

In the general populations of Western countries, FNs are more common in children (20%) than adults (2–6%), and in women than men.[2,3,52] In the Chinese general population, the prevalence of FNs in children and adults is 5.2% and 5.1%, respectively.[5,6] Compared to these estimates of general population, we found a higher prevalence of FNs in Chinese MMT HDPs (25.9%); this finding is in line with the assertion that nightmares are more frequent among psychiatric populations.[3] Because nightmares are often viewed as a sign of psychopathology, the high prevalence of FNs in MMT patients is expected.[3] Moreover, in addition to the aforementioned high levels of depression and anxiety, and withdrawal from psychoactive drugs, we speculate that a high level of stress also explains the high prevalence of nightmares in MMT patients, because this patient population often experiences stressful events and nightmares tend to occur during periods of

Table 3 Results of multiple linear regression analysis on the relationship between frequent nightmares and functional impairment, as measured by Sheehan Disability Scale

Control variables	Coefficient	Standard error	t	P
Model 1: only one predictor, nightmares	3.153	0.790	3.99	<0.001
Model 2: controlling for socio-demographic variables	2.946	0.863	3.414	<0.001
Model 3: controlling for socio-demographic and drug use related variables	2.747	1.063	2.583	0.009
Model 4: controlling for socio-demographic variables, drug use characteristics, and physical health	2.837	1.026	2.765	0.006
Model 5: controlling for socio-demographic variables, drug use characteristics, physical health, and mental health	2.528	0.971	2.604	0.009
Model 6: controlling for socio-demographic variables, drug use characteristics, physical health, mental health, and insomnia	2.718	0.978	2.778	0.006

stress.[3,53] Because socialization processes differ between genders, nightmares are more common in females than males.[54] Nevertheless, we failed to replicate such gender difference in MMT patients. Given the relatively large gap in the prevalence of nightmares between males and females (6.6%), the primary reason for this inconsistency should be the relatively small sample size of MMT patients, which is not large enough to detect this difference. Other strong risk factors of nightmares such as insomnia might also influence or mask the effect of gender on the occurrence of nightmares.

Previous studies have reported the significant link between nightmares and lower socioeconomic status such as low family income.[5,6] Both education and employment status are important indicators of socioeconomic status, but we found opposite associations between the two indicators and nightmares.[55] Strictly speaking, the presence of nightmares may partly depend on an individual's ability to remember a dream upon awakening, because some persons may simply forget their dreams, even if they have experienced nightmares during sleep. Considering the positive association between education and cognitive reserve, and impaired memory resulted from heroin use, higher prevalence of nightmares in patients with an educational attainment of senior high school (vs junior high school and below) might be due to their less severe memory impairment.[56,57]

Re-education through forced labor was a problematic treatment approach for heroin detoxification in China, which contained some compulsory measures, including restricting the freedom of heroin users and "re-educating" them through penal labor without judicial review. Due to some reasons, this treatment would become a stressor for Chinese HDPs, possibly resulting in elevated risk of nightmares.

Most dreams (including nightmares) occur during the REM stage of sleep. Evidence from polysomnography studies has shown that REM rebound, the lengthening and increasing frequency and depth of REM, plays an important role in the occurrence of dreaminess and nightmares.[58,59] Because of the suppression effect of opioid administration on REM sleep, REM rebound happens after heroin withdrawal, as a result of a compensatory increase in REM sleep.[60] Since injecting heroin is indicative of more severe heroin dependence, patients who injected heroin would have more severe REM rebound after withdrawal, resulting in an increased risk of nightmares.[61] The positive association between hypnotics use and nightmares seems not consistent with the fact that many hypnotics are REM sleep-suppressant medications. We speculate that MMT patients may use hypnotics irregularly or at an insufficient dose; therefore, they also frequently suffer from REM rebound resulted from hypnotics withdrawal. The other alternative explanation is that nightmares, as a side effect, can be caused by some hypnotics.[41,42] The relationship between a high dose of methadone and nightmares is difficult to explain, because the use of methadone and other opioids is generally associated with REM sleep suppression.[23] Nevertheless, some researchers also speculate that the REM sleep suppression would result in an increased intensity of the REM episodes, which in turn increases the likelihood of nightmares.[43]

One previous study has reported more worries about contamination and illnesses related to HBV infection in HBV carriers, which may be reflected by the content of dreams of patients and result in a higher likelihood of nightmares.[62] This may explain the association between nightmares and the presence of HBcAb. Because persons

suffering from pain are more likely to have dreams containing pain, the pain-nightmares relationship might be attributed to the painful experience in dreams.[63]

Consistent with findings from a study based on the Finnish general adult population, insomnia was found to be the strongest correlate of nightmares among MMT patients (OR=5.75).[4] This may be due to the reciprocal relationship between the two, for example, nightmares can disrupt the continuity of sleep, leading to DMS, whereas insomnia can cause sleep deprivation, resulting in REM rebound and nightmares.

Indeed, it is not surprising to find the significant contribution of FNs on functional impairment of MMT patients, because their associated psychopathology may mediate the effect of FNs on functional impairment. Nevertheless, we further found the nightmares-functioning association was independent of a variety of covariates, including psychopathology and insomnia, suggesting that nightmares may also independently influence the function of MMT patients.

This study has some limitations. First, stress plays an important role in the etiology of nightmares but we did not measure stressful life events and level of stress of MMT patients. Second, we did not assess the type of nightmares and collect data on the nightmare content. Third, although REM rebound involves in the occurrence of nightmares, we did not use polysomnography to evaluate the sleep architecture due to our limited research budget. Further studies using polysomnography and collecting data on past traumatic events, and type and content of nightmares would deepen our understanding on nightmares of MMT patients. Fourth, since this is a self-report survey, the prevalence of FNs might be underestimated due to recall bias. Fifth, no age- and gender-matched healthy controls were recruited for this study. Prevalence rates of FNs reported in the general population-based studies were used as the comparison references. Results from such comparison might be problematic due to problematic comparability between MMT HDPs and the populations studied in the literature.

Conclusion

Nightmares are a treatable sleep condition. There is convincing evidence that nightmares can be effectively treated with pharmacological and psychological treatments such as prazosin and Image Rehearsal Therapy (IRT).[36] Given the high prevalence of nightmares and their associations with many negative health outcomes, including functional impairment as revealed in this study, nightmares should be a therapeutic target for improving the health and functioning of patients in China's MMT clinics. Nevertheless, nightmares are often underreported by methadone-maintained patients or ignored by health care providers in China's MMT settings. Specialized educational and training programs in sleep medicine are warranted to strengthen health care providers' ability to recognize, diagnose, and manage nightmares and other sleep problems in MMT clinics. Sleep health education should also be provided to MMT patients to increase their sleep health literacy.

The great number of correlates of nightmares identified in this study also suggest the complexity of nightmares in methadone-maintained HDPs, particularly nightmares' associations with a high dose of methadone and use of hypnotics. Considering HDPs' susceptibility to polydrug abuse and the possible interplay among medications, which might complicate the treatment, psychological treatments such as IRT should be considered as the first choice for treating nightmares. Moreover, nightmares of MMT patients are also significantly associated with HBV infection, pain, anxiety, and insomnia, making it necessary to provide appropriate and timely treatments for co-occurring infectious diseases, pain, mental health problems, and other sleep problems in Chinese MMT patients.

Author contributions

All authors contributed to data analysis, drafting or revising the article, gave final approval of the version to be published, and agree to be accountable for all aspects of the work.

Disclosure

The authors report no conflicts of interest in this work.

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