Spinal cord injury and substance use: a systematic review

Lesión medular y uso de sustancias: una revisión sistemática

P. Lusilla-Palacios*, Carmina Castellano-Tejedor**

*Department of Psychiatry, Hospital Universitari Vall d'Hebron, CIBERSAM, Universitat Autònoma de Barcelona, Passeig de la Vall d'Hebron 119-129, P.O. box 08035, Barcelona (Barcelona), Spain
**Institut de Recerca Vall d'Hebron de Barcelona, Passeig de la Vall d'Hebron 119-129, P.O. box 08035, Barcelona (Barcelona), Spain

Abstract

The objective of this study was to review recent findings about the prevalence of substance use (SU) and substance use disorders (SUD), and to discuss the related impact on health in spinal cord injury (SCI) population. For this purpose, computer-aided searches of MEDLINE (PubMed) and the Cochrane Library were conducted. From an initial pool of 59 articles, 52 met the inclusion criteria. Most of the studies referred to alcohol and tobacco and only a few studies reported on other substances. Study designs were mainly cross-sectional and descriptive, with scarce intervention and longitudinal studies. Although a high prevalence of post-injury SU has been documented among SCI patients, limited research exists on pre-injury SU and on longitudinal studies. Moreover, when exploring SUD, it has not been systematically studied in accordance with CIE or DSM criteria. Alcohol appears to be the most consumed substance among this population. Additionally, those patients with SU have shown poorer outcomes in different health indicators. Therefore, more insight is required to increase scientific knowledge in this field and to recommend tailored preventive interventions and research priorities in relation to this population.

Key Words: Spinal cord injury, substance use, substance use disorders, addictive behaviours, health outcomes.

Abbreviations: SCI: Spinal Cord Injury(ies); SU: Substance Use; SUD: Substance Use Disorder(s).

Resumen

El objetivo de este estudio fue el de revisar los hallazgos recientes sobre la prevalencia de uso de sustancias (US) y trastornos por uso de sustancias (TUS) y discutir su impacto en la salud en población con lesiones medulares (LM). Para este propósito, se realizaron búsquedas asistidas por ordenador en MEDLINE (PubMed) y en la Biblioteca Cochrane. A partir de un conjunto inicial de 59 artículos, 52 cumplieron los criterios de inclusión. La mayoría de trabajos se centraban en el consumo de alcohol y tabaco, y sólo unos pocos informaron acerca del uso de otras sustancias. El tipo de diseño de investigación fue mayoritariamente transversal y descriptivo, siendo escasos los estudios de intervención y longitudinales. A pesar de la alta prevalencia de US documentada en pacientes con LM, apenas existen trabajos sobre el consumo previo a la LM y de diseño longitudinal. Además, cuando se ha evaluado el TUS, éste no se ha estudiado de forma sistemática siguiendo criterios diagnósticos CIE o DSM. El alcohol ha resultado ser la sustancia más consumida entre esta población. Además, los pacientes con US han mostrado peores puntuaciones en distintos indicadores de salud. Por ello, se necesita más investigación para seguir avanzando en este ámbito de estudio, así como para poder diseñar intervenciones preventivas más efectivas adaptadas a las necesidades específicas de esta población, y para sugerir prioridades de investigación.

Palabras clave: Lesión medular, uso de sustancias, trastorno por uso de sustancias, comportamiento adictivo, salud.

Abreviaturas: LM: Lesión Medular(es); TUS: Trastorno por Uso de Sustancias; US: Uso de Sustancias.

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Send correspondence to:
Carmina Castellano-Tejedor, University Hospital Vall d'Hebron, Passeig de la Vall d'Hebron 119-129, P.O. 08035, Barcelona, Spain.
E-mail: ccastellano@vhebron.net

The impact of a Spinal Cord Injury (onwards SCI) after a major trauma can lead to negative emotional responses (i.e. depression, anxiety), disengagement-type coping (i.e. injury-related factors denial, avoidance) and altered psychosocial functioning (i.e. family roles, identity); (Antonak & Livneh, 1991; Hammell, 1992; Vash & Crewe, 2004; Wright, 1960). Sometimes, post-injury psychological distress could be so intense and unbearable that patients might seek relief in substance consumption (Smedema & Ebener, 2010; Treischmann, 1988). On the one hand, people with pre-injury substance use (onwards SU) could exacerbate their consumption and increase their odds for developing a substance use disorder (SUD) or, in the best case scenario, they can decide to give up or reduce their SU behaviours (Bombardier, Stroud, Esselman & Rimmele, 2004; Burns & Ditunno, 2001; Krause, 2004; Saunders & Krause, 2011; Smedema & Ebener, 2010).

Scientific research agrees to point out that SU and especially SUDs have a negative impact on a person's vocation, academic performance, family and social life, as well as on physical and psychological health status; if SUDs occur in population with severe chronic health conditions, such a SCI, disability and negative consequences increase considerably (Burns & Ditunno, 2001; de Groot, Post, Snoek, Schuitemaker, van der Woude, 2013; Hammell, 1992; Smedema & Ebener, 2010; Vash & Crewe, 2004).

To date, existing research on SU and SCI is mainly descriptive and designed as cross-sectional (Smedema & Ebener, 2010; Wegener, Adams & Rohe, 2012). To our knowledge, only one literature review on this topic exists, but it dates from 2010 and it is not exclusively focused on SCI population (Smedema & Ebener, 2010).

Given the potential risks that SU and SUDs could entail in SCI patients mid-long term adjustment and health status (Smedema & Ebener, 2010; Wegener et al., 2012; Wright, 1960), it is important to acknowledge the magnitude of the problem and to consider it as a key element in rehabilitation programs (Bozzacco, 1990; Krause, 1992; Smedema & Ebener, 2010; Wegener et al., 2012). Only by doing this, it will be feasible to design accurate screenings and assessments that allow diagnosing and to plan specific interventions to address such issues (Hammell, 1992; Treischmann, 1988; Wright, 1960).

Therefore, this paper is aimed to systematically review scientific literature on SU and SUDs in SCI patients (considering pre- and/or post-injury period) and to discuss their impact on different general health indicators. It is expected that this knowledge will serve to encourage further research in this field and to recommend clinical priorities with this population.

Methods

Search strategy

The primary data source for this review was the electronic database MEDLINE (PubMed). The Cochrane library was also accessed and searched via the Health Information Resources website, www.library.nhs.uk/default.aspx (formerly the National Library for Health). Reference lists of reviewed articles were also searched to identify potentially relevant missing studies. The search terms (in English only) were *spinal cord injury* in combination with: *substance use, substance use disorder, substance dependence, substance disorder, addiction, alcohol, tobacco, cocaine, stimulants, opioids/opiates, marihuana/marijuana,* and *cannabis/cannabinoid.* Duplicated results were removed. Hyphens and abbreviations were not used in case they limited the search. The remaining citations were displayed and examined in depth. The PRISMA guidelines were followed to conduct this systematic review.

Inclusion and exclusion criteria

Eligibility criteria were made by a single author (CC), with consensus from the other author (PL) on the basis of information found in the article's title, abstract, key words or full text if necessary. Studies were included in the review if they met the following criteria: (1) any study with humans attempting to evaluate substance abuse (such as: alcohol, tobacco and/or other drugs) in SCI before, during or after the rehabilitation. Studies with SCI samples plus other samples were also included. Studies were excluded if they were in any other language than English or else if substance use was referred to only in the introduction or the discussion of the article. That is, neither its assessment was an objective of the study nor specific measures for it were taken. Studies on prescribed drugs such as medication with psychotropic effects (e.g. to treat neuropathic pain) were not included in this review. Commentaries, proceedings and letter to the editor were also excluded. No publication date limits were set (search updated until May 2014).

Data extraction

Data extraction was conducted in three stages. At stage 1, one reviewer conducted the preliminary search and selection of studies applying inclusion criteria. At stage 2, two reviewers performed data extraction independently. At stage 3, synthesis of literature was put in common and discussed. Data from eligible articles were summarized into a form with the following column headings: author(s), year of publication, study design, sample, assessment tool(s) and measures for substance use, other measures, target substances, assessment period (pre/post injury), prevalence of substance use (when specified in the article) and main findings. This procedure was performed by both authors independently (CC & PL), with disagreements being resolved through discussion.

Results

Search results

The literature search of MEDLINE resulted in 224 potentially relevant articles related to the review topics. Excluded on duplicate, title and abstract were 165 articles, leaving 59 relevant articles. These retrieved articles were evaluated in depth according to the inclusion criteria. Fifty-two out of 59 previously selected articles met inclusion criteria. Cochrane database retrieved only 2 relevant articles already included in the MEDLINE search. As a result, 52 studies were finally reviewed.

General findings

A summary of reviewed articles is displayed in Tables 1 & 2.

Our review highlights that SU/SUDs are very common among SCI patients. Most of the studies have indicated higher rates of SU compared to general population. However, there are also several studies that do not compare prevalence found to general population or other clinical samples, which is clearly a limitation to yield conclusions. Additionally, prevalence of SU/SUDs varies widely across studies. Therefore, our results point out the need to improve research methodologies when addressing these questions.

As some theoretical studies have indicated (Smedema & Ebener, 2010), we have found that the most studied substances have been alcohol (n = 45, 86.5% of included articles) and tobacco (n = 15, 28.8% of included articles) being stimulants or sedative drugs less explored (Heinemann, Doll, Armstrong, Schnoll & Yarkony, 1991; McKinley et al., 1999). In this sense, studies on cannabis use/abuse (n = 6, 11.5% of included articles; Heinemann et al., 1988; 1991; Hwang et al., 2012; Stroud et al., 2011; Turner, Bombardier & Rimmele, 2003; Young, Rintala, Rossi, Hart & Fuhrer, 1995) and illicit drugs (n = 6, 11.5% of included articles; Heinemann et al., 1991; Kolakowsky-Hayner et al., 1999; 2002; McKinley et al., 1999; Rish, Dilustro, Salazar, Schwab & Brown, 1997; Turner et al., 2003) are scant.

With regard to alcohol, although consumption patterns have been found to be similar to general population in terms of gender and age (higher consumption in young males); (Banerjea et al., 2009; Saunders & Krause, 2011; Krause et al., 2009), rates of "risk consumption" are higher in SCI population (Tate et al., 2004; Turner et al., 2003). More than 50% injured patients show alcohol consumption patterns ranging from moderate-to-heavy drinking according to screening procedures and, in some studies, DSM or CIE criteria (Heinemann et al., 1991). Even though evidences are still scarce and not conclusive enough, risk consumption seems to be associated with family history of alcoholism and pre-injury "at risk" alcohol consumption (Schandler et al., 1995; Tate, 1993).

Overall, results seem to indicate higher rates of SU (especially, alcohol) prior to the injury and an exacerbation of this behaviour after the injury (de Groot et al., 2013; Wegener et al., 2012). In this sense, some studies have identified high rates of positive blood alcohol concentration at the time of the injury, and have associated these outcomes to the onset of the SCI (Forchheimer et al., 2005; Levy et al., 2004). Interestingly, there is also one study (Stroud et al., 2011) that points out that up to 71% of the sample described the onset of the injury as a "teachable moment" for quitting. However, it is a cross-sectional design and no further evidences are provided regarding final rates of alcohol consumption abandonment and specific motivations.

Tobacco is the second most consumed substance by this clinical population (Weaver et al., 2011). As in the case of alcohol, the prevalence/percentage of tobacco consumption varies greatly depending on the study (Levy et al., 2004; Weaver et al., 2001). Also noteworthy is that many studies do not provide specific rates of tobacco use/consumption and compare these values to general population. Additionally, in some studies cannabis smoking and tobacco smoking are not clearly differentiated and we cannot conclude if indicated prevalence is explained by tobacco, cannabis, or else a combination of both substances. Overall, where it is specified, prevalence ranges between 19-40% of the injured patients. Although being non-constant, tobacco use is frequently related to harmful alcohol consumption in this population. Logically, this negatively impacts on the health of individuals and increases their likelihood of suffering from other medical complications, as some studies have demonstrated (De Groot et al., 2013; Hwang et al., 2012; Krause & Saunders, 2009).

Regarding consumption of illegal substances, this has been studied by only few authors and less systematically. In this sense, results are based on screening procedures in the acute moment at hospital admission and no follow-up assessments are scheduled. Thus, very few studies have been carried out using procedures to collect such measures pre/post injury in a longitudinal design. Consequently, the prevalence found may reflect occasional rather than regular illegal substances consumption. As it can be observed in our study (see Table 2), only seven studies assessed SU/SUD based on clear diagnostic criteria.

With the exception of cannabis, the prevalence of illegal drugs consumption varies widely between 8 and 70% of patients. Cocaine and psycho-stimulants prevalence ranges from 0 to 14.4% and opiate use is around 4%. These percentages are clearly lower to those related to alcohol and tobacco. It is important to highlight that this prevalence may not be entirely accurate because several works included the consumption of substances as varied as sedatives, narcotic analgesics and barbiturates under the heading "psychotropic substances".

Measures to explore the possible relationship between SU/SUDs and health outcomes are many and varied. Consequently, comparison between studies is difficult and no conclusive results can be yielded. However, evidences seem to suggest poorer health-related outcomes (both physical and psychological) among those patients considered as risk substance consumers (Tate, 2004). In this sense, it has been indicated that moderate to severe SU has been related to higher risk of life-time substance-related problems and impaired health (Stroud et al., 2011). There are few studies addressing one substance at a time (n = 16, 30.8% of included articles, see Tables 1 and 2 for more details). Most of them evaluate a broad range of substances. Consequently, the individual effects of each of them on the health of the injured patients are not always specifically described (Banerjea et al., 2009; Smedema & Ebener, 2010; Tate et al., 2004). Moreover, prevalence of SUs has not always been provided (Bozzacco, 1990; Krause, 1992; Njoki, Frantz & Mpofu, 2007; Perez & Pilsecker, 1994; Sweeney & Foote, 1982).

Finally, it is worthwhile mentioning that most of the studies were descriptive and designed as cross-sectional (see Tables 1 & 2). In addition to this, assessment period of SU/SUD (and specific timing pre/post injury) varies widely among studies. While some studies assess and report data regarding both pre- and post injury period time, the majority of them are focused on a single period, either pre or post-injury. Moreover, there are only a few empirical studies assessing SUD following DSM or CIE criteria (See Table 2); (Banerjea et al., 2009; Findley et al., 2011; Heinemann et al., 1991; Tate et al., 2004; Turner et al., 2003). The majority of the included articles in this review only provide a concise description of SU patterns and/or prevalence in relation to diverse health outcomes employing screening tools (see Table 1); (Davies & McColl, 2002; Furlan & Fehlings, 2013; Hwang et al., 2012; Krause, 1992; 2004; Krause, Coker, Charliflue & Whiteneck, 2000; Tate et al., 2004). As a consequence, the exact prevalence of SUD among SCI population remains unclear. Additionally, it is noteworthy mentioning that the DSM and CIE criteria have changed in the updated versions and no studies have used these new criteria. Similarly, only two studies have reported prevalence of dual diagnosis according to DSM criteria (co-existence of both SUD and mental disorders); (Banerjea et al., 2009; Findley et al., 2011).

In brief, as previous theoretical reviews have stressed, all these characteristics make it difficult to examine thoroughly long-term relationships between SU/SUDs and health outcomes (Smedema & Ebener, 2010; Wegener et al., 2012).

Table 1
Articles on SU in SCI population

	Author(s)	Year	Study design	Sample	Assessment tool(s) for SU	Other measures	Target substance(s)	Main findings
Pre-SCI	Saunders & Krause	2011	Cross-sectional survey	N=1435	- BRFSS	- ZKPQ - Annual household & education	Alcohol	Moderate (29.4% of the sample) and heavy drinking (19.3% of the sample) was related to gender (male), age (younger), higher income and education, impulsivity and sensation seeking traits and less severe SCI.
	Krause et al	2009	Cross-sectional survey	N=1388	- BRFSS - CAGE - SCIHS	None	Alcohol, tobacco, psychotropic prescribed medication	Severe SCI exhibits less alcohol/tobacco use but more psychotropic prescription medications. More alcohol/tobacco use in younger.
	Garrison et al	2004	Cross-sectional survey	N=448	- Self-report	None	Alcohol	Participants with cervical SCI had increased relative odds (2.06) of having used alcohol at injury compared with participants without cervical SCI; 12% of them used alcohol at the time of the injury.
	Kolakowsky-Hayner et al	1999	Case-control	N=26 SCI, matched with N=26 TBI	- GHHQ	None	Alcohol and other illicit drugs (cocaine, heroin, marijuana, speed)	96% SCI patients reported pre-injury alcohol use and 57% were heavy drinkers. The rate of pre-injury heavy drinking for both groups was alarmingly high.
Post-SCI	De Groot et al	2013	Prospective cohort	N=130	- Health behavior scale (2 items on SU)	- Blood lipid levels - BMI - PASIPD	Alcohol, tobacco	More than 70% of the sample drinks alcohol regularly and more than 40% smokes. Lifestyle factors are related to cardiovascular risks.
	Furlan & Fehlings	2013	RCT-prospective cohort	N=499	- BAC	- NASCIS pain score - FIM - Mortality (1 year post injury)	Alcohol	9.4% illegal BAC 94.4% survival at year 1 post injury No relationship between BAC and FIM/mortality
	Hwang et al	2012	Cross-sectional survey	N=215	- Medical chart review for frequency of use and type of substance	- FIM - SF-12 - SWLS - PHQ-9 - CHART	Alcohol, cocaine, marijuana, tobacco, other illicit drugs (not specified)	Rates of regular use: 55.4% alcohol, 27.9% tobacco, 10.7% marijuana, 0% cocaine/other drugs. Depression was related to tobacco use, alcohol and independent living. Regular use of alcohol was not associated with chronic medical conditions.
	Krause & Saunders	2009	Cross-sectional survey	N=1386	- BRFSS - CAGE - SCIHS	None	Alcohol, tobacco, psychotropic prescribed medication	Use of prescribed medication (OR 2.58) and smoking behaviour (1.43) more predicts hospitalizations.
	Krause et al	2009	Prospective cohort	N=1386	- CAGE - SCIHS - Self-rated questionnaire	None	Alcohol, tobacco, psychotropic prescribed medication	Smoking, binge drinking, use of prescribed medication and hours in bed were the best set of behavioural predictors of mortality.
	Forchheimer et al	2005	Cross-sectional survey	N=119	- BAC	None	Alcohol	42% had a (+) BAC at the time of their injury; among (+) BAC, 87% had BACs >.08 (+) BAC related to severe SCI impairments (60% tetraplegia)

	Author(s)	Year	Study design	Sample	Assessment tool(s) for SU	Other measures	Target substance(s)	Main findings
Post-SCI	Krause	2004	Cross-sectional survey	N=13280	- BRFSS - CAGE - Ad hoc brief index of prescribed medication usage	- General health survey - ZKPQ - Multidimensional Health Locus of Control Scale	Alcohol, psychotropic prescribed medication	Heavy drinking and prescription medication use for pain, spasticity, depression, and sleep were associated with a greater likelihood of subsequent injuries, and certain personality traits (sensation seekers)
	Rothstein et al	1992	Cross-sectional survey	N=153	- Urine toxicology screening	None	Amphetamines, barbiturates, BZD, cocaine, methadone, opiates	29% of the sample used BZD, ≤ 13% other illicit substances and use of barbiturates was not found.
	Cushman et al	1991	Cross-sectional survey (with matched control group)	N=60 (n_1=30, n_2=30)	- Alcohol use: police and medical report	- Medical records - Scene investigation from police accident report: Mortality, rollover crashes, human factors, night-time accidents, weather or road conditions	Alcohol	SCI patients were not different from controls in terms of mortality, number of rollover crashes, alcohol use or other conditions referred in the police accident report. However, none of the SCI drivers had used restraints compared to the control group.
	Heinemann et al	1988	Cross-sectional survey	N=88	- Serum ethanol - Urine toxicology screening - Self-report	None	Alcohol, BZD cannabinoids, cocaine, opiates	35% urine tests (+) for substances: 40% serum ethanol, 14% cocaine, 8% cannabinoids, 5% BZD and 4% opiates. Self-report of intoxication and urine analyses were discordant in 34% of the cases.
Pre/post-SCI	Stroud et al	2011	Cross-sectional survey	N=118	- Urine toxicology screening & BAC - Self-report consume Brief Drinker Profile - Readiness to change questionnaire - SMAST	- Ad-hoc questionnaire for attributions about cause of injury	Amphetamines, BZD, cocaine, marijuana, opiates	Alcohol caused the injury in 50% of at-risk drinkers. 51% "at risk" drinkers with 38% reporting life-time alcohol-related problems. 71% were willing to change alcohol use (SCI as a "teachable moment" for quitting) 33% illicit drugs (28% marijuana, 9% amphetamines and 6% cocaine)
	Weaver et al	2011	Cross-sectional survey (multisite)	N=1210	- Self-reported measures (lifespan tobacco use) - Semi-structured interview for key informants about tobacco	None	Tobacco	22% current smokers, 57% past smokers & 27% never smoked. Current smokers reported more respiratory illnesses, alcohol use, overweight, pain and depression than past or never smokers. Smokers received referral to counseling and 23% prescription for medication/nicotine replacement. Key informants identify the following barriers: difficulty of providing follow-up, patients' unwillingness to give up tobacco

	Author(s)	Year	Study design	Sample	Assessment tool(s) for SU	Other measures	Target substance(s)	Main findings
Pre/post-SCI	Krause	2010	Longitudinal	N=1386	- BRFSS - Ad hoc brief index of prescribed medication use	- ZKPQ	Alcohol, prescribed medication	Binge drinking, psychotropic medication use & some personality characteristics (sensation seekers, impulsivity) were related to injury-related hospitalizations.
	Hitzig et al	2008	Cross-sectional survey	N=781	- A.T. Jousse LTF questionnaire: drug addiction	- A.T. Jousse LTF questionnaire: impairment, health status, self-reported secondary health complications	Substance use/abuse (not specified)	Drug addiction [OR=0.966 (95% CI, 0.935– 0.997, p<0.05)] decreased per year with age.
	Njoki et al	2007	Cross-sectional survey	N=10	- Ad hoc interview: alcohol, tobacco and other drugs	- Ad hoc interview: physical activity & lifestyle	Alcohol, tobacco, other substances (not specified)	The focus group participants were involved in diverse health risk behaviors.
	Bombardier et al	2004	Cross-sectional cohort	N=76	- SMAST	- FIM - Length of stay	Alcohol	39% had a history of problem drinking related to lower years of education, tetraplegia and longer length of stay, with lower functional recovery.
	Levy et al	2004	Cross-sectional survey	N=11376 (SCI=967)	- Retrospective data from a statewide, population-based injury surveillance system	None	Alcohol, tobacco, other drugs	Alcohol involved in 34% of SCIs Large differences also existed in victim alcohol involvement between fatal and nonfatal cases of intentional SCIs (0% vs. 48%) Those who imbibed were 3 times as likely to suffer SCI. These excess risks persisted for all age groups between 15-64 years, with the excess risk especially high for drinkers aged 15 to 20. In contrast, people aged >65 did not appear to be at excess risk on days that they imbibed.
	Seltz et al	2004	Case-control	N=14 (n_1=7 SCI, n_2=7, no-SCI; monozygotic twins	- AUDIT	- SCID-P	Alcohol	No significant differences between SCI and non-SCI co-twins' SU patterns, suggesting that drinking patterns might not be significantly affected by SCI and substance misuse might precede the injury.
	Kolakowsky-Hayner et al	2002	Case-control	N=30 SCI & matched TBI group	- Medical history about quantity& frequency of alcohol intake	- GHQ	Alcohol, other illicit drugs	41% SCI & 43% TBI patients were moderate or heavy drinkers. Illicit drugs' use was higher among post-injury SCI patients.
	Davies & McColl	2002	Cross-sectional survey	N=97	- Sections of the LCHRA	- LSH-QCPIC - ATS-DLD	Alcohol, tobacco	The interaction between cigarettes smoked per day and excessive alcohol consumption was related to respiratory morbidity. Urinary tract morbidity was (+) related to smoking and (-) related to alcohol consumption.
	Krause et al	2000	Cross-sectional survey	N=97	- Ad hoc semi-structured interview including items from the BRFSS	- RSS - OAHMQ - CHART - Pressure ulcers	Alcohol, tobacco	49% consume alcohol on a regular basis and it was significantly related to greater risk for post-SCI injuries.

	Author(s)	Year	Study design	Sample	Assessment tool(s) for SU	Other measures	Target substance(s)	Main findings
Pre/post-SCI	McKinley et al	1999	Longitudinal	N=87	- Urine toxicology screening & BAC	- FIM - Length of stay	Alcohol, cocaine, BZD, opiates, amphetamines, phencyclidine, barbiturates	53% (+) admission toxicology screens with 37% (+) for alcohol and 30% (+) illicit drug screens. No differences between (+) and (-) screens for toxics at admission in rehabilitation outcomes.
	Bombardier & Rimmele	1998	Cross-sectional survey	N=58	- SMAST - RTC - Ph Scale from Brief Drinkers Profile	None	Alcohol	35% "alcoholic" range in the SMAST and 50% at risk (21% pre-contemplation, 45% contemplation, 10% action) Multivariate analyses indicated that a positive history of alcoholism and higher daily consumption were associated with greater readiness to change.
	Wineman et al	1999	Cross-sectional survey	N=78	- Ad hoc records for SU	- Medical records: injury-related variables, comorbid health conditions, healthcare utilization (last 5 years)	Substance use (not specified)	Results indicated that high users, compared to non-users and low-users, had a higher SU rate, a higher unemployment rate at the time of the most recent health care visit, and more violent causes of their SCI.
	Krause et al	1999	Cross-sectional survey	N=76	- BRFSS	None	Alcohol, tobacco	28% American Indians smoke regularly and 43% reported to drank in the last month. Among them, 60% drank heavily. However, health screens were better or comparable to GP.
	Rish et al	1997	Cross-sectional survey	N=230	- Medical records (including cause of death if appropriate)	- Medical records regarding SU: alcohol, drugs (illicit & prescribed)	Alcohol and other drugs (illicit & prescribed)	Psychosocial maladjustment and substance abuse were prevalent and created heavy health care demand. Psychiatric problems and substance abuse were strong determinants for morbidity and mortality.
	Schandler et al	1996	Cross-sectional survey	N=90	- Family history of alcoholism (CAST & The Family Tree) - SMAST	- WOC Questionnaire	Alcohol	Compared to subjects with no family alcoholism history, those with antecedents reported significantly higher use of constructive coping, but their use of alcohol and anti-social behaviors indicated that they were less effective in actual coping
	Schandler et al	1995	Cross-sectional survey	N=100	- Ad hoc interview and questionnaire about past and present use of alcohol - SMAST - CAST	None	Alcohol	The incidence of SCI patients with family history of alcoholism was over 4 times than found in GP. Possible relationship between predisposition to alcoholism and accidents/SCI.

	Author(s)	Year	Study design	Sample	Assessment tool(s) for SU	Other measures	Target substance(s)	Main findings
Pre/post-SCI	Young et al	1995	Cross-sectional survey	N=123	- Ad hoc interview and questionnaire about past and present use SU - SMAST	- Health ratings - FIM - CHART - CES-D - LSIA - PSS-10 - Social Support scale - Health maintenance behaviors	Alcohol, marijuana	Prevalence of alcohol use was lower than GP (40-60% women and men with SCI vs. 59%-79% women and men from GP). However, alcohol abuse was higher (13%-23% women and men with SCI vs. 5%-16% women and men GP). Marihuana use was also lower than GP (16% vs. 12%). However, more SCI-women used marihuana (15%) compared to women from the GP (12%). The reverse was true for men (16% SCI vs. 24% GP)
	Perez & Pilsecker	1994	Longitudinal / intervention study	N=10	- Program for substance abusers SCI patients	Not applicable	Several substances (not stated)	Group psychotherapy for SCI substance abusers has demonstrated the usefulness as a part of a comprehensive therapeutic package. The importance of denial, physical associated problems and kindness norm and challenging among this population is discussed.
	Tate	1993	Cross-sectional survey	No stated	- CAGE - Alcohol history	- Injury-related variables	Alcohol	Age did not correlate significantly with patient's CAGE scores; however, SCI subjects with higher mean' scores (CAGE) had higher incidence of medical complications. CAGE scores were significantly correlated with previous history of alcohol and drug abuse, and with the average weekly number of drinks pre-injury.
	Krause	1992	Review	Not applicable	Not applicable	Not applicable	Several substances (not specified)	Research is paying more attention to substance use/ abuse and its impact on SCI patients' rehabilitation. Alcohol is the most consumed substance (pre/ post-injury) and could have detrimental effects on rehabilitation. However, fewer patients receive specific treatment for it and abuse of substances as well as drug prescriptions continues to be a source of problems.
	Radwanski	1992	Cross-sectional survey	N=16	- DUI - Self-medication practices - Drug Use for Chronic Pain Management Survey	- VAS for pain - MCPQ - Chronic Pain Modifier Questionnaire	Alcohol	45% experienced chronic pain and reported that SUD relieved pain (from 50-100%). Over-the-counter, prescription, illicit drugs or alcohol are the most agents employed in self-medication.
	Kiwerski & Krasuski	1992	Cross-sectional survey	N=1193	- State at the time of the injury (sober vs. under the influence of alcohol)	- Ad hoc medical and demographic records	Alcohol	Functional results were better in the sober group. Intoxication also affects the general state of health and the course of recovery in the early post-traumatic period.
	Sliwa et al	1992	Case study	N=1	- Ad hoc records related to alcohol use	Ad hoc records for risk factors	Alcohol	Risk factors for the second SCI: wheelchair use, previous spinal fusion, alcohol use and sensation-seeking behaviour.

	Author(s)	Year	Study design	Sample	Assessment tool(s) for SU	Other measures	Target substance(s)	Main findings
Pre/post-SCI	Charlifue & Gerhart	1991	Cross-sectional survey (with matched control group)	N=5200	- Ad hoc records related to alcohol abuse	- Medical records related to physical & psychological health status	Alcohol	Alcohol abuse was identified as an important risk factor (among others) related to higher probability to commit suicide.
	Bozzacco	1990	Theoretical	Not applicable	Not applicable	Not applicable	Alcohol and other substances (not specified)	Pre/post-injury reported SU is varied and probably underreported. In the absence of severe physiological symptoms, the SUD disorder is not made due to the stigma of disability.
	Heinemann et al	1988	Cross-sectional survey	N=103	- Drinking histories: prevalence of alcohol abuse, consequences of alcohol use - SMAST	None	Alcohol	A significant number of individuals with recent SCI have heavy drinking histories and experience behavioural problems resulting from alcohol use. Enjoyment was cited by 92% of the sample as a reason for drinking.
	Meyers et al	1985	Cross-sectional survey	N=96	- Ad hoc records for substance use	- Medical, injury-related variables	Alcohol, cannabis and tobacco	There were no significant relationships between either numbers of hospitalizations or total days hospitalized and SU (alcohol, cannabis or tobacco) as well as other medical or demographical variables.
	Frisbie & Tun	1984	Cross-sectional survey	N=137	- The course of alcohol consumption and causes of remission	None	Alcohol	A high percentage had high pre-injury alcohol consumption. Reasons given for remissions were general health considerations and possible complications, compounding of the disabilities and loss of taste for liquor.
	Sweeney & Foote	1982	Longitudinal / intervention study	N=36	- Program for drug and alcohol dependent SCI patients.	- Ad hoc 26-item questionnaire to assess achievements in environmental adaptation.	Alcohol, other substances (not specified)	The Drug Dependence Treatment Program was proved useful to reduce alcohol and drugs use among SCI patients.

Note. ATS-DLD: American Thoracic Society-Division of Lung Diseases; BAC: blood alcohol concentration; BMI; Body Mass Index; BRFSS: The Behavioral Risk Factor Surveillance System; BZD: Benzodiazepines; CAGE: Screening for alcohol; CAST: The Children of Alcoholics Screening Test; CES-D: The Center for Epidemiologic Studies Depression Scale; CHART: Craig Handicap Assessment and Recording Technique; DUI: The Drug Use Inventory; FIM: Functional Independence Measure; GHHQ: The General Health History Questionnaire; GP: General Population; LCHRA: Lyndhurst Computerized Health Risk Assessment; LSH-QCPIC: London school of Hygiene Questionnaire on Chest Pain and Intermittent Claudicating; LSIA: Life Satisfaction Index-A; MCPQ: McGill Comprehensive Pain Questionnaire; NASCIS; National Acute Spinal Cord Injury Study; OAHMQ; The Older Adult Health and Mood Questionnaire; PASIPD; The Physical Activity Scale for Individuals with Physical Disabilities; PHQ-9; Patient Health Questionnaire-9 items; PSS-10: Perceived Stress Scale-10 items; RSS; The Reciprocal Social Support Scale; RTC: Readiness to change questionnaire; SCI: Spinal Cord Injury; SCIHS: The Spinal Cord Injury Health Survey; SF-12; Short-Form Health Survey-12 items; SMAST: The Short Michigan Alcoholism Screening; SU: Substance Use; SWLS; The Satisfaction with Life Scale; TBI: Traumatic brain injury; WOC: Ways of Coping Questionnaire.

Table 2
Articles on SUD in SCI population

	Author(s)	Year	Study design	Sample	Assessment tool(s) for SU	Other measures	Target substance(s)	Main findings
Post-SCI	Findley et al	2011	Longitudinal	N=8344	- ICD-9 criteria	- ICD-9 criteria for mental illness	Alcohol, tobacco, other drugs (not specified)	62% no mental illness or SUD, 26% only mental illness, 12% alcohol and/or drug use, 8% mental illness and SUD. Tobacco use was the most prevalent abused substance 19%. Patients with SUD had significantly higher rates of mortality (OR 1.30) and 8% of the sample had dual diagnosis.
	Banerjea et al	2009	Longitudinal	N=8338	- ICD-9 criteria	- ICD-9 criteria for mental illness - Medical Chart	Alcohol, tobacco, other drugs (not specified)	26% SUD (19% tobacco, 9% alcohol, 8% other drugs) & 14% dual diagnosis SUD more common in male, younger, shorter time of SCI duration and those diagnosed with depression, anxiety and/or PTSD.
Pre/post-SCI	Wegener et al	2012	Theoretical article/Book chapter	Not applicable	Not applicable	Not applicable	Alcohol and other drugs (illicit and prescribed)	An overview of core clinical issues (emotional responses, substance use, pain, cognitive deficits, sexuality and vocational rehabilitation) providing guidance on incorporation of rehabilitation psychology into SCI rehabilitation. SUD are identified as risk pre/post-injury factors.
	Smedema & Ebener	2010	Literature review	Not applicable	Not applicable	Not applicable	Alcohol, tobacco and other illicit drugs	Pre-injury substance abuse appears unrelated to acceptance of disability in persons with SCI. Recent substance abuse tends to have a detrimental effect on psychosocial outcomes across all disability groups.
	Tate et al	2004	Cross-sectional survey	N=3041	- DSM-IV criteria for alcohol - Recommended questions (5 items) by the National Institute on Alcohol Abuse and Alcoholism - CAGE - Self-reported (prescribed medication)	- Ad hoc questionnaire for pain - CHART - SWLS - SF-36	Alcohol, psychotropic prescribed medication	60% consume alcohol regularly, among them, 15% at risk consumers. 11% use illegal drugs or prescribed medication for non-medical reasons (73.3% marijuana, 14.4% crack or cocaine and 12.3% others) At-risk drinkers and substance users tended to be younger, single, male, less educated and paraplegic CAGE (+) and substance users reported more pain, more pressure ulcers and lower life satisfaction.

	Author(s)	Year	Study design	Sample	Assessment tool(s) for SU	Other measures	Target substance(s)	Main findings
Pre/post-SCI	Turner et al	2003	Cross-sectional cohort	N=218	- DSM-IV criteria for alcohol - SMAST - PDS - Total drinks/week - Total illicit drugs used 3 months prior injury admission toxicology - The readiness to change questionnaire - Treatment intention questionnaire	None	Alcohol, cocaine, heroin, LSD, methadone, marijuana, speed, heroin, other illicit drugs	Four typologies: (I) 17.9% abuse alcohol; (II) 21.1% alcohol dependence; (III) 14.7% in partial remission or relapse & (IV) 46.3% no alcohol problems Group I (high-use, high-consequences) was more likely to report an alcohol-related injury. Groups high in alcohol use-related consequences, type I and type III, were more likely to express a desire to participate in alcohol treatment
	Heinemann et al	1991	Longitudinal	N=86	- Ad hoc semi-structured interview based on DSM criteria	- Ad hoc semi-structured interview for perceived need of treatment for SUD	Alcohol, analgesics, barbiturates, BZD, cocaine, codeine, marijuana, narcotic, stimulants	52% SUD post-injury with 16% reporting need for treatment. Only 7% received treatment for SUD. 69% consumed alcohol pre-injury and 71% post. First 6 months post-injury more risky for SUD.

Discussion

People with acute injuries such as SCI are at disproportionately greater risk for SU and/or SUDs than the general population (Kolakowsky-Hayner et al., 1999; Schandler et al., 1996; Schandler, Cohen, Vulpe & Frank, 1995; Smedema & Ebener, 2010; Wegener et al., 2012). Additionally, as some research has pointed out, SU could be also a major contributor to SCI (Bombardier et al., 2004; Forchheimer et al., 2005; Garrison et al., 2004; Heinemann et al., 1988; Kolakowsky-Hayner et al., 1999; Krause et al., 2000; Krause, 2004; Levy et al., 2004; McKinley et al., 1999; Tate et al., 2004). Therefore, this is a topic of great interest for health providers and scientists due to its potential relationship with patients' mental health, collaboration during rehabilitation process and subsequent functioning, as well as lifestyle choices when discharge (Bombardier & Rimmele, 1998; Frisbie & Tun, 1984; Njoki, Frantz & Mpofu, 2007; Post & van Leeuwen, 2012; Stroud et al., 2011).

Our review highlights that the most prevalent substances consumed by SCI population are alcohol, tobacco and sedative drugs (with and without prescription); as well as the fact that these results are very commonly linked to significantly poorer outcomes regarding health (e.g. higher rates of secondary falls or medical complications) and mental health (e.g. higher rates of mood disorders) (Post & van Leeuwen, 2012; Smedema & Ebener, 2010; Wegener et al., 2012). In this sense, the prevalence of mental disorders and illicit drugs use/abuse remains unknown; although it may be a cause of concern among health providers and it usually adds an increased difficulty in dealing with these patients (Smedema & Ebener, 2010).

Additionally, we have found that most of the research done in this field has been designed as cross-sectional and little research has been done on longitudinal or intervention studies to prevent or treat SU and SUDs (Bombardier et al., 2004; Levy et al., 2004; Perez & Pilsecker, 1994; Smedema & Ebener, 2010; Sweeney & Foote, 1982; Wegener et al., 2012).

In general, methodologies and measured variables differ widely among studies. Most of the literature focused on assessing alcohol intake or screen blood alcohol concentration (Furlan & Fehlings, 2013; McKinley et al., 1999; Rothstein et al., 1992; Stroud et al., 2011; Turner et al., 2003). There are several studies that assessed tobacco and other additional legal substances (e.g. prescribed medication). However, there are only few studies on illegal substances. Moreover, assessment periods are very divergent; some authors have only measured pre-injury substance abuse, others have only measured recent substance abuse and some studies were focused on assessing pre- and recent substance abuse. Besides, SU was measured and diagnosed in many different ways in every study. Most of the studies used screening tools and did not check DSM or CIE criteria for SUD (Banerjea et al., 2009; Findley et al., 2011; Smedema & Ebener, 2010; Tate, Forchheimer, Krause, Meade & Bombardier, 2004). In this sense, it is worthwhile mentioning that any of the included articles based their outcomes on the updated criteria of DSM-IV-TR or CIE-10 for substance use disorders. Moreover, among those studies using DSM-IV criteria, it is not stated whether they have employed the substance use disorders section of the Structured Clinical Interview for the DSM (SCID), which is very useful to diagnostic interviews/assessments. Taking all this into account, a recommendation for future research is to use the updated version of the DSM, the DSM-5 (American Psychiatric Association, 2013).

This variability among studies regarding the operativization of main variables of substance use/abuse vs. disorder makes comparisons difficult and hampers to yield conclusions regarding the precise prevalence of SU and SUD among this population, as well as its potential relationship with physical and mental health.

In spite of the aforementioned, some important trends can be identified. First, a high use of substances such as alcohol, tobacco and/or marijuana has been described among injured patients. It has been hypothesized that substance abuse could be used as a coping resource to decrease distress and facilitate disengagement of the injury or its consequences (Bracken & Shepard, 1980; Krause, McArdle, Pickelsimer & Reed, 2009; Post & van Leeuwen, 2012). Nevertheless, it is well known that substance abuse and dependence imposes a great risk on the health status of SCI patients because of existing medical complications and medication prescriptions (Hitzig et al., 2008; Krause et al., 1999; 2000; 2009; Smedema & Ebener, 2010; Wegener et al., 2012). Thus, it must be properly addressed with rehabilitative therapies by a multidisciplinary professional team (Antonak & Livneh, 1991; Hammell, 1992; Vash & Crewe, 2004; Wegener et al., 2012; Wright, 1960). As the study of Stroud et al. (Styroud et al. 2011) has demonstrated, the onset of the injury could be a very appropriate moment to start this type of psychoeducative interventions. Addictive behaviours among this population add a special difficulty and an additional cost to their treatment, implying recurrent hospitalizations and higher follow-up and medical appointments after the injury (Levy et al., 2004; Krause, 2004; 2010; Schandler et al., 1995). Therefore, it is crucial to screen for these patterns and to intervene by psycho-education, group therapies or appropriate psychological interventions to reduce comorbidity and facilitate post-injury adjustment (Antonak & Livneh, 1991; Hammell, 1992; Smedema & Ebener, 2010; Perez & Pilsecker, 1994; Vash & Crewe, 2004; Wegener et al., 2012; Wright, 1960). Follow-up assessments after discharge from the rehabilitation programme are equally important to prevent the recurrence of dependency problems (Antonak & Livneh, 1991; Hammell, 1992; Smedema & Ebener, 2010; Perez & Pilsecker, 1994; Vash & Crewe, 2004; Wegener et al., 2012; Wright, 1960). In addition to this, efforts to try to involve the family of the injured when possible could add an important value to preventive and rehabilitative practices

and ensure higher rates of success (Hammell, 1992; Smedema & Ebener, 2010; Vash & Crewe, 2004; Wegener et al., 2012; Wright, 1960).

Secondly, the link between the use of illicit substances or even alcohol and occurrence of SCIs has often been reported in scientific literature. In most cases, alcohol abuse post-injury is a continuation of an earlier pattern of problem drinking or other substance abuse (Forchheimer et al., 2005; Frisbie & Tun, 1984; Kolakowsky-Hayner et al., 1999; McKinley et al., 1999; Schandler et al., 1996; Smedema & Ebener, 2010; Stroud et al., 2011; Wegener et al., 2012). Therefore, pre-injury substance abuse seems to be an important predictor of post-injury substance abuse. However determining the extent of these substance abuse patterns on injured patients' mental health and final adjustment is a field that deserves further exploration since most of the studies are not designed as longitudinal and pre/post injury period has not been properly studied for SU/SUDs (Smedema & Ebener, 2010; Wegener et al., 2012).

Conclusion

Scientific literature has pointed out that many people with physical disabilities or chronic health conditions have a hidden additional disability very often, which is substance use or abuse (SUD) involving alcohol and/or other psychotropic drugs. Patterns of SU behaviour vary according to the use before disability, following the onset of disability, or both before and following the onset of disability.

Even though some studies suggest that many people living with SCI manage the consequences of their disability without significant levels of psychopathology, there are evidences pointing out to a high risk of psychopathology and SU/SUD among these patients several years after the injury. Thus, SU is a very common health issue experienced by people sustaining a SCI. For that reason, health providers should pay special attention to unhealthy lifestyles and mood disturbances at both, short term and mid-term follow-up appointments since a high risk of maladjustment and SU among this population has been described.

To our knowledge, this is the first systematic review on this topic. One analysis of the literature exists but it dates from 2010. Besides it is not systematic and it is not exclusively focused on SCI population (Smedema & Ebener, 2010). Therefore, this review adds to the knowledge and it is expected to serve as a starting point to design future research in this field, overcoming current limitations. In this sense, our results have highlighted the need for more longitudinal studies assessing pre- and post-injury patterns of SU, as well as studies assessing the effectiveness of interventions aimed to address such issues among SCI patients. Ideally, such approach will be led by multidisciplinary teams that include SU as pathology and as a central issue in the rehabilitative program rather than as a secondary problem.

Limitations of this review

The main limitation of this review was that only articles written in English were included, excluding therefore several suitable studies written in other languages. There are also some issues that must be taken into consideration when reading our results. Most of the studies were designed with male sample populations and a specific differentiation of paraplegic and patients with tetraplegia was not established. Thus, generalization of results must be cautious. Additionally, not all the studies control the possible confounding effect of prescribed drugs on SU behaviours (such as opiates or other sedatives for neuropathic pain) and some authors have pointed out that a high risk for SUD exists among patients who are already on treatment with such substances.

Recommendations for further studies

The information provided in this study will give a clearer picture on SU among SCI patients. Besides it will enable clinicians to acknowledge potential risks in this sense and to better target individuals at risk for SU and/or SUD. Future research should be undertaken using longitudinal designs to include long-term outcomes, as well as the nature of the risk for secondary health complication in relation to specific substances. Moreover, specific SU/SUD diagnosis for both illicit and legal drugs (and not only screenings) should be carried out to allow comparisons across studies. Only by doing this, it will be possible to advance in the field of follow-up studies after interventions on SU/SUD.

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Conflicts of interest

Nothing to declare.

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