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REVIEW

Etiology of spinal cord injuries in Sub-Saharan Africa

N Draulans, C Kiekens, E Roels and K Peers

Study design: Review.
Objectives: The aim is to highlight the epidemiology of spinal cord injuries (SCIs) in Sub-Saharan Africa in order to improve prevention strategies.
Setting: University Hospitals Leuven, Belgium.
Methods: Pubmed was searched over August and September 2010. A combination of the following MeSH-terms was used: 'Africa South of the Sahara', 'Spinal Cord Diseases', 'Paraplegia' and 'Spinal Cord Injuries'. Limits were set on articles published as from 1990. The World Health Organization database was also consulted.
Results: We obtained 243 hits of which 13 articles were relevant to the case. These papers covered seven countries: Ethiopia, Ghana, Nigeria, Senegal, Sierra Leone, South Africa and Zimbabwe. In traumatic SCIs, motor vehicle accidents are the most frequent cause of injury followed by falling from a height and thirdly violence, being the most important cause of SCI in South Africa. In the Plateau State of Nigeria, collapsing tunnels in illegal mining are the most prevalent cause. For the non-traumatic SCIs, tuberculosis appeared to be the most important cause, followed by malignant illnesses. Human immunodeficiency virus (HIV) serology tests were only available in the article concerning Ethiopia. Relatively more men were involved in traumatic SCIs and the average age was higher in the non-traumatic than in the traumatic group.
Conclusion: Although literature on the subject is scarce, prevention should focus on road-safety, tuberculosis and HIV. Standardized registration of SCI is needed for prevention and further research. The use of the current International SCI core data set should be encouraged worldwide as a uniform classification method.
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Keywords: etiology; spinal cord injury; paraplegia; Africa South of the Sahara

INTRODUCTION

Spinal cord injury (SCI) is a condition with a devastating impact on the physical, mental and social life of often young persons. It also represents a considerable financial cost to society and family. Epidemiological and etiological knowledge about SCI is essential for designing and focusing prevention campaigns. Especially in the Sub-Saharan countries, this knowledge is warranted as on average less means and financial resources are available, not only for preventative strategies but also for treatment and rehabilitation.

SCI is most often referred to as traumatic or non-traumatic. In worldwide reviews, traumatic SCI annual incidence rates yield values from 12.1 to 57.8 cases per million with motor vehicle accidents (MVAs), falls, violence and sports being the leading causes.[1–4]

Compared with traumatic SCI very little is known on the incidence and etiology of non-traumatic SCI, presumably in part because of the often progressive onset of the lesion.

Data on Sub-Saharan Africa (SSA) are seldom mentioned in these worldwide reviews. Only Ackery *et al.*[2] and Cripps *et al.*[4] mentioned articles concerning the etiology of traumatic SCI in SSA, but they did not discuss the non-traumatic causes. Therefore, a search purely focused on SSA seemed necessary to try to close this gap in literature. The collection of these data may help to highlight the main bottlenecks and to focus on prevention of SCI in SSA, using the limited means as efficiently as possible.

METHODS

Search strategy

Literature was browsed in the period of August and September 2010, using PubMed and a combination of the following MeSH terms: 'Africa South of the Sahara', 'Spinal Cord Diseases', 'Paraplegia' and 'Spinal Cord Injuries'. 'Africa South of the Sahara' was combined with each of the other MeSH terms. Articles with as a main subject polio (NOT 'Poliomyelitis' (Majr)) were discarded as this illness is not causing a spinal cord lesion as such. For each MeSH-term several subheadings were selected. No language restrictions were necessary as all the articles found were in English or French. The search function was limited to 'articles published as from the year 1990' and 'humans'. This list subsequently was searched through looking for relevant articles and the literature survey was completed making use of a list of related articles on PubMed and the reference lists of each relevant article.

Inclusion criteria

The papers were selected as relevant on basis of the following criteria: presence of data on incidence or etiology of traumatic or non-traumatic SCI in a Sub-Saharan country. As no articles reported incidence rates at population level in a Sub-Saharan country, articles based on hospital admissions were included additionally.

Exclusion criteria

Articles of which the full text could not be obtained and case reports were excluded. As for content, articles focusing only on cervical lesions or penetrating trauma or pediatric population were excluded as these articles did not give an overview of the etiology of SCI in general.

Department of Physical Medicine and Rehabilitation, University Hospitals Leuven, Pellenberg, Belgium
Correspondence: Dr C Kiekens, Department of Physical Medicine and Rehabilitation, University Hospitals Leuven, UZ Leuven campus Pellenberg, Weligerveld 1, 3212 Pellenberg, Belgium.
E-mail: carlotte.kiekens@uzleuven.be
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Furthermore, the World Health Organization (WHO) data base has been consulted concerning the evolution of prevalence of tuberculosis. The web was also explored for any relevant article or association that could offer more information on the subject.

RESULTS

Browsing literature yielded 243 articles, each of them referring to related articles of which in the end only 13 appeared to be both relevant and available. A flowchart for the selection of articles included in this review is provided in Figure 1 and Table 1 shows an overview of the retained articles. The selected articles report mainly in a retrospective way, numbers and etiologies of either traumatic or non-traumatic spinal cord lesions. In each case, the population consists of patients registered at a specific hospital during a specific period of time meaning these are referral-based and not population-based studies.

As all studies clearly distinguish traumatic and non-traumatic spinal cord lesions, Figure 2 shows the etiologies of traumatic SCI and Figure 3 of the non-traumatic SCI.

In most of the retrieved articles, additional information on the epidemiology of SCIs was available and it was summarized in Table 2 by the investigator, giving the percentage of paraplegia and tetraplegia, sex distribution, age and percentage of complete and incomplete lesions often using the Frankel-scale.

Etiology of traumatic SCIs

Nine articles on traumatic SCIs concerning five Sub-Saharan countries (Nigeria, Senegal, Sierra Leone, South Africa and Zimbabwe) were included.

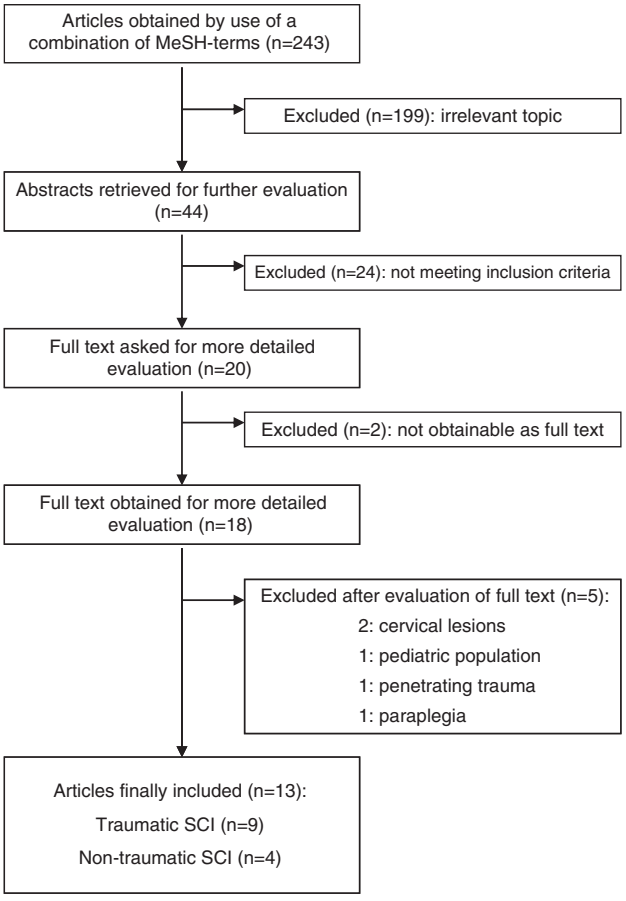

Figure 1 Flow diagram of the systematic literature review.

Our search produced four Nigerian articles. Igun *et al*.[5] described the epidemiology of 68 traumatic spinal injuries, of which 56 had a spinal cord lesion. Vehicular accidents (49%) were the main cause and collapsed tunnels (cave-in injuries in illegal mining) were second in line (26%). Other important causes were falls from a height (19%) and gunshot wounds (6%). In all, 77% of the patients with a spinal cord lesion had a complete lesion (=Frankel A). The hospital mortality after 30 days was 26%, among which patients suffering tetraplegia doubled in number those suffering paraplegia.

Solagberu[6] analyzed retrospectively the data of 39 patients with traumatic SCI. In total, 67% were due to traffic accidents and 23% due to falling from a tree. In 46%, there was a cervical lesion. In all, 69% of the patients sustained a complete lesion. Out of 10 persons not surviving the SCI, 9 had been transferred to various centers before being admitted to this hospital.

Olasode *et al*.[7] systematically collected data of 71 patients. In all, 63 cases (89%) were due to traffic accidents, 2 cases were caused by falling from palm trees (3%) and 3 cases (4%) were due to violence (strangulation, gunshot).

Obalum *et al*.[8] analyzed retrospectively the data of 468 patients with traumatic SCI. In all, 77% were due to road traffic accidents, 11% were related to violence and 9% were related to falls. At presentation 92% of the patients had an AIS grade A. At discharge, AIS grade A represented 49% of the patients and 18% had died in the meanwhile.

An article from Senegal, Seye *et al*.[9] reported on 496 traumatic spinal injuries treated at the University Hospital of Dakar. Falling from great height was the most frequent cause (49%) followed by traffic accidents with 44%. Sport accidents represented 6% of the traumata.

As for Sierra Leone, Gosselin and Coppotelli[10] described the epidemiology of 24 patients who were admitted with traumatic SCI. Twelve patients sustained a road traffic accident (50%) while in 10 patients the cause of the SCI was a fall (41%). A total of 21 patients had a complete lesion at admission versus only 3 patients with an incomplete lesion.

Levy *et al*.[11] from Zimbabwe, described the etiology of 136 SCI cases and reported a high incidence of traffic accidents (56%). Less important causes were falling from trees (11%), and violence (15% including gunshot and stab wounds).

Another two selected articles dealt with South-African SCI. Hart and Williams[13] reviewed the files of 616 SCI patients and reported that traumatic SCI represented 89% of the total number of SCI in that period. Violence (56%) was by far the most frequent cause, followed by MVAs (25%) and falls from heights (2.5%). Velmahos *et al*.[12] collected data in two hospitals of which one was also used by Hart and Williams.[13] He reported on 551 SCI patients and violence was mentioned to be the most common cause (gunshot wounds 35%, stab wounds 26%, followed by traffic accidents 30%).

Etiology of non-traumatic SCIs

Only four papers on non-traumatic SCI etiology were found, originating from four different countries as mentioned in Table 1. Table 3 shows the different diagnostic methods that were available in the hospitals.

A study in Ethiopia from Zenebe[14] stated tuberculous spondylitis was the main cause of non-traumatic SCI (27%), followed by human immunodeficiency virus (HIV)-1-associated myelopathy (17%). Other important causes were metastatic cord compression (15%), tropical spastic paraparesis (14%), cervical spondylosis (9%) and primary cord tumors (9%).

Nyame[15] in Ghana collected prospectively data from 64 patients suffering from non-traumatic paraplegia treated at the Korle Bu

Table 1 Literature survey

Country	*Authors*	*Study*	*Setting*	*Number of patients*
Traumatic				
Nigeria	Igun *et al.*[5]	1984–1997	Retrospective. Hospital setting	68
Nigeria	Solagberu[6]	1995–1999	Retrospective. Hospital setting	39
Nigeria	Olasode *et al.*[7]	18 months	Prospective. Hospital setting	71
Nigeria	Obalum *et al.*[8]	1992–2006	Retrospective. Hospital setting	468
Senegal	Seye *et al.*[9]	1980–1988	Retrospective. Hospital setting	496
Sierra Leone	Gosselin and Coppotelli[10]	2000–2004	Retrospective. Hospital setting	24
Zimbabwe	Levy *et al.*[11]	1988–1994	Retrospective. Hospital setting	136
South Africa	Velmahos *et al.*[12]	1988–1992	Retrospective. Hospital setting	551
South Africa	Hart and Williams[13]	1988–1993	Retrospective. Hospital setting	616
Non-traumatic				
Ethiopia	Zenebe[14]	1990–1993	Retrospective. Hospital setting	130
Ghana	Nyame[15]	1991–1994	Prospective. Hospital setting	64
Nigeria	Ogunniyi *et al.*[16]	1988–1993	Retrospective. Hospital—setting	104
Zimbabwe	Parry *et al.*[17]	1989–1994	Retrospective. Hospital setting	159

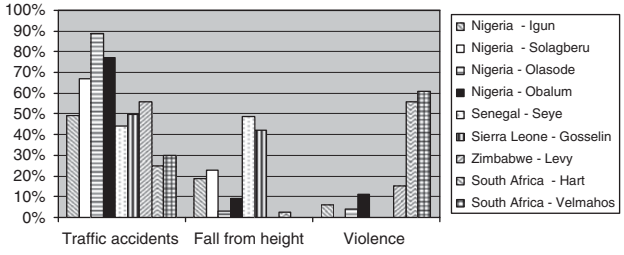

Figure 2 Causes of traumatic SCI in SSA.

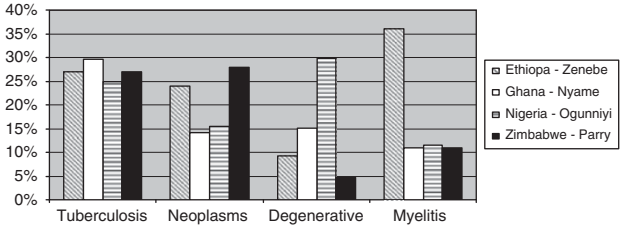

Figure 3 Causes of non-traumatic SCI in SSA.

Teaching Hospital. The most common cause appeared to be tuberculosis (30%), followed by neoplastic lesions (14%) and degenerative diseases such as cervical spondylosis with myelopathy (13%) and motor neuron diseases (6%). Transverse myelitis and the Guillan–Barré syndrome (however, a Guillain–Barré syndrome is not a SCI) were mentioned additionally, each of them representing 11%. We must mention, however, that motor neuron disease and Guillain–Barré syndrome cannot be considered as an SCI.

Ogunniyi *et al.*[16] collected and retrospectively analyzed data from 104 patients registered at the University College Hospital in Niger from 1988 to 1993. Spondylotic myelopathy appeared to be the main cause (29.8%), tuberculous myelopathy was the second most important cause (25%), followed by neoplasms (15%) and transverse myelitis (12%).

Parry *et al.*[17] examined the etiology of 159 non-traumatic SCI in the population of Zimbabwe. The most frequent cause of non-traumatic SCI was neoplasm (28%), one-third of them being metastatic. Tuberculosis represented 27% of the causes. Of these 43 patients, 4 patients died, 27 regained mobility (walk unassisted or with mechanical aids) and 11 remained paraplegic. One patient was lost to follow-up. The investigators mentioned that the part represented by tuberculosis could be falsely low in this study, as it concerns a tertiary center and these patients can often be treated in the local hospital. Transverse myelopathy of unknown origin and Guillain–Barré (not a SCI) represented 11% and 6% of the causes, respectively.

One year after discharge from hospital, 48% of the patients were still alive, meanwhile the death of 18% had been confirmed. In all, 44% was lost to follow-up. The investigators warn for the expected increase in HIV-related myelopathy.

DISCUSSION

To our knowledge, this review is the first attempt to make a survey of the etiology of SCIs focused on SSA over the last 20 years. In spite of many obvious obstacles, such as scarcity and age of data, incomplete data and absence of a uniform classification system, the following items may be worthwhile considering.

Incidence and prevalence

In spite of a thorough literature search no trustworthy data could be found concerning incidence and prevalence of spinal cord lesions in SSA. The studies reported always took place in a hospital context and none of them provided a survey of all admissions over the country. Correct data can only be obtained when the admission data of the country at large are at disposal and at the same time, the number of patients who never reached the hospital, can be estimated.

The most recent worldwide survey on the incidence of SCI shows clearly that even in Western countries systematic collection of these data is a problem. Van den Berg *et al.*[1] states that values of annual incidence rates range from 12.1 to 57.8 cases per million population, respectively, in the Netherlands and Portugal.

Etiology of traumatic SCIs

When performing a critical appraisal of the studies found, we conclude that although the information seems important, it is not clear whether it is valid. As mentioned before, all studies are referral

Table 2 Epidemiological data

Country	*Authors*	*Tetra-/paraplegia*	*Male/female ratio*	*Average age (in years)*	*C/IC*
Traumatic					
Nigeria	Igun *et al.*[5]	—	2/0	Not mentioned	77–33%
Nigeria	Solagberu[6]	46–54%	12/0	37	69–31%
Nigeria	Olasode *et al.*[7]	—	10/0	30	—
Nigeria	Obalum *et al.*[8]	30–70%	2/4	Majority 30–40	49–51%
Senegal	Seye *et al.*[9]	46–54%	4/9	36	—
Sierra Leone	Gosselin and Coppotelli[10]	—	12/0	30	88–12%
Zimbabwe	Levy *et al.*[11]	—	8/1	Majority 20–40	—
South Africa	Hart *et al.*[13]	26–74%	3/5	28	66–34%
South Africa	Velmahos *et al.*[12]	25–75%	4/0	Majority 20–30	—
Non-traumatic					
Ethiopia	Zenebe[14]	23–77%	1/8	40	—
Ghana	Nyame[15]	—	1/5	—	—
Nigeria	Ogunniyi *et al.*[16]	—	3/3	45	—
Zimbabwe	Parry *et al.*[17]	16–84%	1/2	39% 16–30 years, 37% >45 years	70–30%

Abbreviation: C/IC, complete/incomplete lesion.

Table 3 Technical examinations

Examinations	*Ethiopia*	*Ghana*	*Nigeria*	*Zimbabwe*
Full blood profile	X	x	x	x
Biochemics		x		x
Sedimentation erythrocytes	X	x	x	x
Protein electrophoreses		x		
Bacteriology		x		x
VDRL-test (Syphilis)		(x)		
HTLV-1 antibody test (TSP)	?	NOT		
HIV-1 serology test (AIDS)	x			x
Mantoux (tuberculosis)		(x)		x
Sputum sample (tuberculosis)	x			
Bence-Jones proteins		x		
Anatomopathology	x	x	x	x
Radiography	x	x	x	x
Myelography	x	x	x	x
CT and MRI			x	
Lumbar puncture	x	x		
Marrow puncture	x	x	x	
Electroencephalogram		x		

Abbreviations: AIDS, acquired immune deficiency syndrome; CT, computed tomography; HIV, human immunodeficiency virus; HTLV-1, human T-cell lymphotropic virus type 1; MRI, magnetic resonance imaging; NOT, for certain test not possible; TSP, tropical spastic paraparesis; VDRL-test, Venereal Disease Research Labarotory Test; x, test possible; (x), test not always possible.

and not population based, which leads inherently to a bias. The studies used were published as from 1990, meaning that etiology and epidemiology may have evolved, which stresses the need for concurrent reporting with recent data.

Comparing etiologies in the different countries, some tendencies become apparent. The most recurrent categories in the articles describing the etiology of spinal traumata and traumatic spinal cord lesions in SSA, are road traffic accidents, falls from heights and gunshot and stab wounds (Figure 2).

Road traffic accidents are the most common cause of traumatic spinal cord lesions. There are several explanations to this. In many African countries, there is a rapid increase in the number of vehicles without infrastructure being adapted. Moreover, many vehicles are not equipped with safety belts and transport of people in open lorries is very common.[7]

'Falls from height' are generally less frequent than traffic accidents. In Senegal, however, the former category is the most important one, without a clear explanation to this. And while in Europe and the United States, categorizing falls depends on whether or not the fall is a labor accident, in Nigeria categorizing is made according to the type of tree the patient fell from.[6,7]

In South Africa, 'violence' is an important category, to such an extent that the articles distinguish separate categories of stab wounds and gunshot wounds.[12,13] It should be mentioned that both the included hospitals were situated near a township, characterized by an above average degree of violence, mentioned by the investigators. Both studies may have partially used the same data.

Furthermore, there was the striking category 'collapsing tunnels' in the Plateau State of Nigeria, a region with a lot of illegal mining.[5] This category shows us that there are great differences among countries, but also between economically different regions.

Other rare causes are suicide attempts by strangulation, sports and carrying heavy burdens on the head.

A study from the United States of America by McKinley[18] concluded that MVAs constitute the main cause of SCI with 22%, followed by falls and gunshot injuries with respectively 19% and 16% (Figure 4).

The worldwide review by Van den Berg *et al.*[1] (not containing information on SSA) confirmed that MVA are the largest cause in the majority of the reviewed studies. Some studies showed, however, almost equal percentages for MVA as for falls (mainly elderly).

Etiology of non-traumatic SCIs

As far as the non-traumatic SCI are concerned, most articles distinguish between infectious or inflammatory causes, degenerative diseases of the spine and malignancies. Tuberculosis-related diseases of the vertebral column constitute, in view of their high incidence, a separate category (Figure 3).

For the non-traumatic causes, besides the fact that the studies are again referral based, differences in diagnostic methods should be taken into account. Not all hospitals have the same technical examination methods at hand and it is not always clearly indicated how the

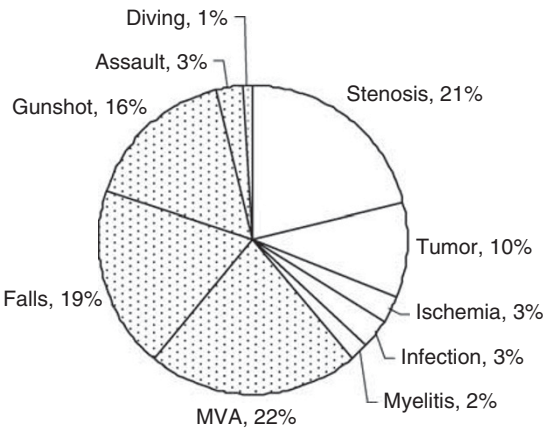

Figure 4 Causes of traumatic and non-traumatic SCI in the United States of America.[18,19]

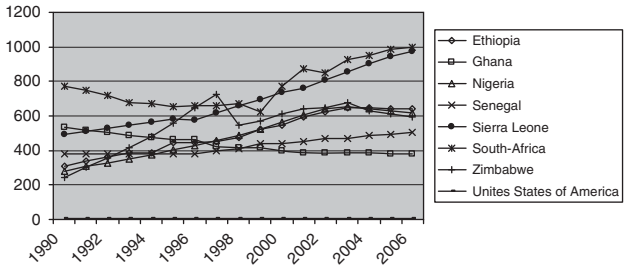

Figure 5 Prevalence of tuberculosis per 100 000 inhabitants from the year 1990 until 2006.[21]

reported diagnosis has been established. A survey of the used technical examinations can be found in Table 3. It should also be recognized that some articles included other neurological diseases such as the Guillain–Barré syndrome and motor neuron diseases.

Spinal tuberculosis is apparently the primary cause of non-traumatic spinal cord lesions in SSA and, together with neoplasms, represents almost half of the causes. Diagnosis is not, such as is the case in Europe, confirmed by a computed tomography-guided puncture, but by the clinical image, suspicious lung or skeletal lesions on plain radiographies, a positive Mantoux-test or sputum culture. The accuracy of the numerical data may be questioned, but even taking into account a certain margin of error, the importance of tuberculosis in the etiology of non-traumatic spinal cord lesions is clear.

In Europe and the United States, the percentage of neurological recovery after spinal tuberculosis is 90% as a consequence of the rapid initiation of treatment, the reasonable cost for the patient and the better therapy compliance during 12 months.[20]

The used data are dating from the late eighties and early nineties, and the evolution of prevalence of tuberculosis is indicated in Figure 5, based on WHO data.[21] The data show that tuberculosis is insufficiently controlled, presumably in part because of the increasing prevalence of HIV (Figure 5, Table 4).

The historical work of Brown[22] on non-traumatic paraplegia in SSA, published in 1979, learns us that in that period tuberculosis was known as the most important cause of non-traumatic SCI in Senegal, Nigeria and Malawi. It accounted for 30% of the non-traumatic SCI.

Only in the study of Zenebe[14] in Ethiopia, there was an almost routine screening on HIV (Table 3). According to this group, almost 17% of non-traumatic spinal cord lesions would be secondary to HIV. This contributes to the high part of myelitis as a cause of non-traumatic spinal cord lesions in this article (Figure 3). In most studies, there was no HIV screening available (Table 3). This means that the number of HIV-positive tuberculosis patients and the number of patients suffering spinal cord lesions as a consequence of HIV are not known.

Spinal cord lesions in HIV patients may be due to vacuolar myelopathy or to compression by HIV-associated neoplasms or opportunistic infections. Considering that in the United States 30% of the persons dying from acquired immune deficiency syndrome presented a vacuolar myelopathy and that in the articles being discussed the HIV prevalence is generally high, it is likely that in these articles there is an underestimation of the number of spinal cord lesions caused primarily and secondarily by HIV[20,23] (Table 4).

The denomination 'myelitis' comprises both infectious myelitis and acute transverse myelitis. Magnetic resonance imaging, which has an important diagnostic role in Western countries was seldom available in the studies consulted[20] (Table 3).

Acute transverse myelitis was withheld as the most common cause of myelitis both in Ghana, Nigeria and Zimbabwe.[15–17] Only in Ethiopia, where a routine HIV screening was made, HIV-infection was indicated as the most common cause.[14] However, both vacuolar myelopathy and infections secondary to HIV are lumped under the denominator 'myelitis because of HIV'.

Another cause of infectious myelitis is human T-cell lymphotropic virus type 1 associated myelopathy or tropical spastic paraparesis. Tropical spastic paraparesis is a slowly progressive myelopathy caused by human T-cell lymphotropic virus type 1 retrovirus but when presenting (sub-) acutely it can be difficult to differentiate from acute transverse myelitis. It is only diagnosed in the article from Ethiopia although it is not clear on which criteria the diagnosis was based[14] (Table 3).

Neoplasm is the second cause of paralysis. Neoplasm refers to both primary tumors such as meningiomas and to metastases of prostate, lung and breast cancer (Table 5).

Malignancies are also in the United States an important cause of non-traumatic SCI[18] (Figure 4).

Degenerative spinal disease is a large category comprising several types of disorders. There is no clear explanation to the fact that in the article from Ogunniyi *et al.*[16] from Nigeria there is such an important number of degenerative diseases.

In the United States, degenerative diseases and specifically spinal canal stenosis together with neoplasms are the most important causes of non-traumatic SCI[19] (Figure 4).

Other epidemiological data

In traumatic SCI, the male–female ratio is much higher than in non-traumatic causes. This can partly be explained assuming that only a minority of the working population are women and therefore are less prone to traffic accidents and falls. However, also in non-traumatic SCI the number of men is higher than the number of women (Figures 6 and 7).

In the worldwide systematic review of Van den Berg *et al.*,[1] a higher male–female ratio in traumatic than in non-traumatic SCI is also mentioned.

Average age in non-traumatic SCI seems to be higher than in traumatic SCI (Table 2). In American literature, average age is 38.6 years for traumatic spinal cord lesions and 61.2 years for non-traumatic SCI.[18,19] Paraplegia outnumbers tetraplegia both in the traumatic and the non-traumatic group. In reviews from Ackery *et al.*[2] and Wyndaele and Wyndaele[3] paraplegia accounts for 55% up to 75% of the SCI.

Table 4 Socioeconomic data from the World Health Organization and from the United Nations Development Program (2006)[21,23]

	Order of ranking according to HDI	*GDP per capita (in US$)*	*Hospital beds/10.000*	*HIV prevalence/ 100.000*	*TBC prevalence/ 100.000*
Ethiopia	169	630	2	—	641
Ghana	142	1240	9	2225	379
Nigeria	154	1410	5	3547	615
Senegal	153	1560	1	837	504
Sierra Leone	158	610	4	1361	977
South Africa	125	8900	28	16 579	998
Zimbabwe	151	—	30	19 210	597
United States of America	13	45 592	32	508	3

Abbreviations: HDI, Human Development Index from the United Nations Development Program; HIV, human immunodeficiency virus; TBC, tuberculosis.

Table 5 Part of neoplasms in non-traumatic SCI

Country	*Authors*	*Neoplasms (%)*	*Of which*	
			Primary (%)	*Metastases (%)*
Ethiopia	Zenebe[14]	23.90	8.50	15.40
Ghana	Nyame[15]	14.10	9.40	4.70
Nigeria	Ogunniyi *et al.*[16]	15.40	1.90	13.50
Zimbabwe	Parry *et al.*[17]	28.00	19.90	8.10

Abbreviation: SCI, spinal cord injury.

The number of complete lesions reported as mentioned in Table 2 is high in comparison with the 50% stated by Wyndaele and Wyndaele[3] The National SCI Database (NASCIS III) cited by Ackery *et al.*[2] also shows 50% complete lesions (Table 2).

Recommendations for the collection of data in the future

The lack of data in combination with not collecting the data in a uniform way has hampered this study. In order to support and facilitate injury prevention, there is a need for standardized reporting and registration of SCI worldwide.

Trauma registration data sets have been proven to be possible and useful in SSA.[24]

Data sets more specific to SCI were, however, required and an international meeting on SCI data collection and analysis occurred in 2002, before the combined ASIA and International Spinal Cord Society (ISCoS) meeting in Vancouver, Canada. The results of this meeting were presented by Biering-Sørensen, De Vivo *et al.*[25,26] They described the International Spinal Cord Injury Core Data Set to standardize the collection and reporting of information on SCI as a basis for future studies of SCI.

Members of the Executive Committee of the International SCI Standards and Data Sets (ECSCI) have worked with the National Institute of Neurological Disorders and Stroke (NINDS), National Institutes of Health (NIH) and the Common Data Element (CDE) Project to integrate the International SCI Data Sets with the other NINDS CDE resources. Biering-Sørensen *et al.*[27] described the collaborative work of the ECSCI and the NINDS CDE Team.

The International Classification of the External Cause of Injury (ICECI) is a tool of the International Classification of Diseases (ICD) family and is designed to improve the precision of coding injury events. It has been shown useful in an epidemiological study of injury prevention.[28]

Lee *et al.*[29] evaluated the SCI application of the ICECI in a mixed group of trained and untrained coders to assess agreement, refine coding and training methodology. They report that the content validity of the training data set is adequate, however, more cases specific for SCI are required. Increasing familiarity with the ICECI should help us to understand injury mechanism en will help toward injury prevention.[4]

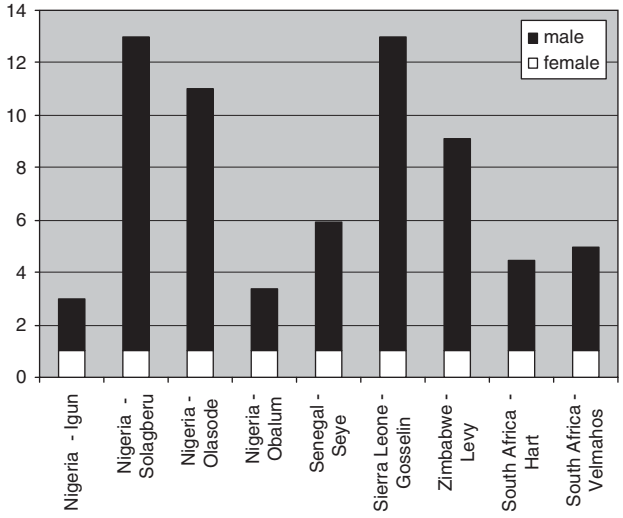

Figure 6 Male–female ratio in traumatic SCI.

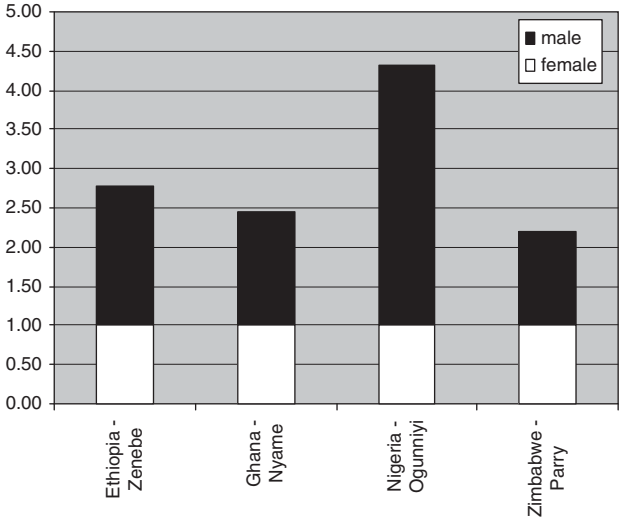

Figure 7 Male–female ratio in non-traumatic SCI.

Cripps *et al.*[4] therefore suggested a data registration tool with a global map for traumatic SCI epidemiology as an initiative of the prevention committee of ISCoS. This is an epidemiological database that will annually be updated and is a living data repository with information to allow valid local and international comparing for use in prevention. The data are presented within the format of a Map of Global Epidemiological trends, which aims to present information in an intuitive manner.[29] Their current software allows to combine ISCoS core data set reporting with injury coding through the ICECI.[4]

This tool seems promising for reporting and registration of SCI worldwide and will facilitate injury prevention planning. It might be difficult, however, to include all regions. Therefore, the existence and knowledge of this tool should be communicated, its use should be encouraged and access should be facilitated in all countries.

Furthermore, ISCoS is cooperating with the WHO to improve classification systems for use in SCI and prevention.[30,31]

We would like to mention an original initiative to collect data we came across from the Quadpara Association of South Africa. In the project, 'Bags of Hope' rehabilitation centers provided patients on discharge from hospital with a standard package of information and equipment such as bladder catheters in exchange for filling out a questionnaire of data such as cause and nature of their disease.[32]

CONCLUSION

To our knowledge, this review is the first attempt to make a survey of the etiology of SCIs focused SSA over the last 20 years. Scarcity of data, incomplete information and the lack of a uniform classification are obvious obstacles for definite conclusions.

Within the group of traumatic spinal cord lesions, traffic accidents have a prominent place. Traffic safety should therefore be a point of particular interest. As far as non-traumatic spinal cord lesions are concerned, it is striking that, despite the enormous effort in coping with tuberculosis, it continues to be the main cause. Also, the number of spinal cord lesions as a consequence of HIV and HIV-related diseases is presumed to be underestimated because of the absence of routine screening in most studied countries.

As far as prevention is concerned, the main conclusion to be urged on is that priority should be given to improving traffic safety and coping with tuberculosis and HIV.

Standardized registration of SCI is needed for prevention and further research. The use of the current International SCI core data set should be encouraged as a uniform classification method. The data registration tool proposed by Cripps *et al.*[4] and initiated by the ISCoS prevention committee seems very promising for SCI data registration and will facilitate injury prevention.[31] Therefore, its existence and use should be promoted worldwide.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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