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Sex-based differences in pain distribution in a cohort of patients with persistent post-traumatic neck pain

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ABSTRACT

Objectives: To analyse a cohort of 745 consecutive patients referred to a regional specialist clinic for evaluation of post-traumatic neck pain during a five-year period.

Methods: A cross-sectional observational study of baseline assessments performed by multi-professional rehabilitation teams according to a standardized checklist.

Results: The cohort contained nearly twice as many women as men (64% versus 36%). The type of injury mechanism described did not differ between sexes. Of the entire cohort, 38% were diagnosed with widespread pain, 50% with regional pain, and 12% with local pain. The pain distribution among the women was 43% widespread, 48% regional, and 9% local, and the corresponding figures among the men were 29%, 53%, and 18%. Longer time between trauma and assessment did not affect pain distribution among the men, but a tendency towards more widespread pain was observed among the women.

Discussion: Women may be more prone to developing persistent pain after neck trauma, and also more likely to develop widespread pain. We suggest increased awareness among clinicians and researchers for indications of persistent post-traumatic neck pain among female patients. Further investigation regarding the effect of earlier implementation of rehabilitation strategies based on sex is warranted. (196 words)

Keywords

Whiplash trauma, Persistent pain, Pain distribution, Sex differences

Implications for rehabilitation

- Patients suffering from pain and functional impairment after neck trauma constitute a significant proportion of chronic pain patients
- The role that sex plays in pain distribution and sensitization in this population is incompletely understood
- The results of the present study suggest that there is indeed substantial sex-based differences in the characteristics of populations with chronic pain after neck trauma
- Interactions between trauma type, sex, and parameters of chronic pain after neck trauma needs further study

INTRODUCTION

Persistent pain after neck trauma, especially whiplash trauma, has burdened motorized societies since train travel came into common use in the 19th century (1). The incidence of neck injuries in Sweden is currently estimated at 235/100,000/year (2). Despite safer cars and a lower rate of car crashes, neck injuries resulting from motor vehicle collisions continue to substantially contribute to the population with persistent neck pain (3, 4).

Although not all trauma to the neck can strictly be regarded as whiplash trauma, it is a common neck injury mechanism, and the term is used both in the clinic and in the literature to indicate a multitude of neck injury mechanisms. However, it is most commonly used to refer to an indirect trauma mechanism caused by acceleration–deceleration forces acting on the head and neck in a rear impact collision (5). The result is an extra-physiologic movement in the cervical spine, which can cause injury to a variety of structures (6) including the zygapophyseal joints (7, 8), stabilizing muscles (9, 10, 11), nerve structures (12), vertebral disks, and bones (13). Beyond physical injury, whiplash trauma and its sequelae can cause psychological (14), cognitive (15), and social consequences (16). This multitude of mechanisms, in combination with varied social situations and physical responses to the initial trauma, creates a heterogeneity in the resulting clinical presentation.

Long-term outcome measures typically indicate a 70-80% recovery rate following acute injury after whiplash trauma (17). While high initial pain intensity and disability serve as important prognostic factors for poor recovery (18), more specific predictors of long-term outcome have been elusive, largely due to a low number of prospective studies (19, 20) and high drop-out rates (21).

The female–male proportion of patients who are exposed to whiplash trauma and thereafter consume health care has been described in a number of studies. Styrke et al. reported a distribution of 48.1% female patients and 51.9% male patients in the acute phase of whiplash trauma (2). We previously reported a retrospective analysis of patients receiving an ICD-10 diagnosis indicating sprain or strain of the cervical spine (S13.4), with a sex distribution of 54% women and 46% men (22). Gustafsson et al. reported 50.7% female patients among 36,743 occupants injured in car crashes (3). In contrast, Carstensen et al. reported a 64%/36% distribution of women to men among 740 patients assessed in emergency departments following acute whiplash trauma (23). While there are a number of studies describing sex differences in acute and subacute post-traumatic neck pain, few have covered the transition into persistent pain. One mechanism in this process is the development of pain sensitization, described in a systematic review by Van Oosterwijk et al. (24). The sensitization process seems to be more frequent among patients with post-traumatic neck pain in comparison to those with non-traumatic neck pain (25, 26)

The current definition of widespread pain/central sensitization is closely related to the diagnostic criteria for fibromyalgia as defined by the American College of Rheumatology (ACR) in 1990 (27) and 2010 (28); the latter is still being discussed (29). Alternative criteria for central sensitization have also been introduced, categorizing pain distribution as local, regional, or widespread (26, 30, 31).

Between 2010 and 2014, we gathered data on patients from Southern Sweden with persistent pain after neck trauma; we are now using this to examine the consistency of the baseline presentation of these patients with what has been previously described in the literature. The present study describes consecutive patients referred to and assessed at a specialist neck pain clinic with a focus on sex distribution, pain distribution patterns, and types of trauma.

Materials and Methods

In 2010, the Department of Pain Rehabilitation in Lund, Sweden was tasked by the regional government with starting a regional specialist clinic for post-traumatic neck pain and disability. Once set up, this was the only such clinic in the region during the study period. Skåne Region, which is located in the southernmost part of Sweden, has a population of approximately 1.2 million people and spans both rural and urban areas. Between 2010 and 2014, the department recieved more than 1000 new patients each year, with a sex distribution of approximately 2/3 female and 1/3 male.

This is a cross-sectional observational study of data from medical records of 745 consecutive patients referred to and assessed at the clinic from 2010 to 2014. The study design and protocol were reviewed by the Regional Ethical Review Board in Lund, Sweden (ref: 2014/34 and 2016/484).

The patients were firstly identified in the department's common patient database, using the ICD-10 codes M53.0, M53.1, S13.4, and T91.8. Each patient record was then reviewed, by a designated nurse, who collected the necessary required data, taking special care that the patients reported symptoms that they themselves related to trauma. Thus the inclusion criteria for all patients in the cohort was exposure to neck trauma and symptoms persisting more than 6 months.

The medical records for the initial assessment were originally documented according to a standardized checklist. Most of the patients (80%) were assessed by a team consisting of a pain physician, a physical therapist specializing in orthopaedic manual therapy (OMT 2), and a pain psychologist. In the remaining 20% of cases, the patients were assessed by a pain physician and a physical therapist specializing in OMT 2, and, if needed, by a psychologist. All team members were well experienced in the assessment of patients with persistent pain and pain after neck trauma.

The following data were collected from the medical records:

- Year of the assessment

- Sex
- Age at the time of the initial assessment
- Type of trauma
- Time, in months, elapsed between trauma and the initial assessment at the department, as reported by the patient
- Pain distribution at the initial assessment
- Interventions administered as a result of the assessment

Trauma characteristics

Trauma was classified into car crashes and other neck traumas. The patients in the car crash group were further categorized as occupants of either the struck or the striking vehicle. Cases where information about the type of car crash could not be found in the medical records were registered as having unknown vehicle status. Of the entire cohort, 105 patients (14%) had been exposed to more than one trauma. In these cases we recorded the trauma that the patient considered to have initiated their symptoms.

Pain distribution

The determination of the category of each patient's pain distribution was established jointly by the assessment team as local, regional, or widespread. All patients had neck pain.

- Local pain was defined as pain in a specific body area (i.e. part of the neck/shoulder area), including muscle and joint pain, with no referred or radiating pain.
- Regional pain was defined as pain in a larger area, including pain in the neck, upper extremities, shoulders, and head, allowing for trigger points, referred pain, and radiating pain.
- Widespread pain was defined as pain in all quadrants of the body with at least 11/18 tender points in accordance with the 1990 ACR criteria for fibromyalgia [28].

Interventions administered as a result of the initial assessments

- Patients who currently received adequate treatment at the referring institution were referred back with recommendations.
- In cases where psychological distress was identified as having a major impact on the patient's health, for example major depression or PTSD, the patients were referred for psychiatric treatment before further in-house interventions.
- Patients who were treated in-house could be referred to a single-service pain rehabilitation physiotherapy program, a multi-professional pain rehabilitation program based on cognitive behavioural therapy, or a combination of the two.
- Pharmacological treatment was also considered, using medications such as NSAIDs or Cox2 inhibitors, paracetamol, SSRIs or SNRIs, and in some selected cases low-dose opioids.
- Of the 745 patients assessed, 542 were treated in-house whilst 203 were either referred to other specialties or referred back to the referring unit with recommendations.

Statistics

An ordinal logistic regression was fitted with *pain distribution* as the dependent variable and *months since the trauma*, *sex*, *age*, and *type of accident* (with *in struck vehicle* as reference category) as independent variables; no higher-order or interaction effects were investigated. Otherwise, the data and model were investigated for every relevant statistical assumption. R (R Core Team, Vienna, Austria) was used in all analyses, and the family-wise error rate (α) was set at $p < 0.05$. Percentile bootstrapped confidence intervals are given within square brackets.

RESULTS

Between 2010 and 2014, the annual number of patients referred to and assessed at the department declined from 247 to 92, and the median time between trauma and assessment decreased from 36 months to 17.5 months (Figure 1). The sex distribution for the whole cohort was 476 (64%) women and 269 (36%) men. The greatest sex distribution difference was seen around the age of 45 (Figure 2).

In the entire cohort, 38% of the patients were diagnosed with widespread pain, 50% with regional pain, and 12% with local pain. Among women, the pain distribution was 43% widespread, 48% regional and 9% local, while among men the corresponding figures were 29%, 53%, and 18% (Figure 3). Regional pain distribution was proportionally the most common pattern within all age groups (woman and men), except for women aged 45-54, where widespread pain (48%) was proportionally most common (Table 1).

Analysis of the different types of trauma showed that 78% of the patients had been involved in car crashes, with about 33% being occupants of the striking vehicle and 62% of the struck vehicle; in 5%, the type of car crash could not be determined from the medical records. The sex distribution for the types of car crashes and the other types of trauma was comparable to the sex distribution in the entire cohort (Table 2). No differences in pain distribution were apparent with regard to type of trauma (i.e. car crashes compared to other traumas) or to whether the patient was occupying the striking or struck vehicle (Figure 4).

For women, but not for men, time since trauma at assessment at the department coincided with a shift in pain distribution from local to widespread. However, the proportion of patients with regional pain distributions remained similar over time (Figure 5).

The odds ratio (OR) of either regional or widespread pain compared with local pain, or of widespread pain compared with either local or regional pain was 1.88 [1.40; 2.53] for women ($p < 0.001$). The OR for those with 84 months between trauma and assessment (3rd quartile) compared to those with 11 months between trauma and assessment was 1.33 [1.14; 1.54] ($p < 0.001$). Neither age (1st quartile vs. 3rd quartile: OR = 0.84 [0.69; 1.02], $p = 0.081$) nor type of trauma (struck vs. striking: OR = 0.85 [0.61; 1.18], $p = 0.335$ and other vs. struck: OR = 0.75 [0.52; 1.07], $p = 0.114$) were significantly associated with the chance of being diagnosed with either local, regional or, widespread pain distributions.

Discussion

Our main finding was that twice as many women as men were referred to and assessed for persistent pain after neck trauma at a regional clinic specializing in post-traumatic neck pain. The majority of both female and male patients had regional or widespread pain distribution. Previous Swedish studies on exposure to neck trauma have not reported any major sex differences (2, 22), but the risk of developing persistent symptoms has been reported to be much higher for females up to the age of 44, compared to males in the same age group (3). Although we could not control the referral pattern to our clinic, there was no other specialist unit in the region of 1.2 million inhabitants during the study period, and so we can assume that the referral pattern reflects the fact that women are at higher risk of developing persistent pain after neck trauma.

Any analysis of persistent pain and disability after trauma must take into consideration not only the initial trauma/injury, but also possible pain-generating mechanisms, healing mechanisms, and factors that could affect these processes. Sex differences in dimensions and configurations of spinal components may result in an increased injury risk for women exposed to whiplash trauma. For example, cervical vertebrae differ between women and men, in that women's vertebrae are smaller even after compensating for head size (32, 33); this means that the segmental support area, including the disk and facet joints, is relatively smaller (34). In addition, women have significantly less muscle strength in the neck, compared to men (33, 35). Consistent trends (albeit non-significant ones) have been identified for women's cervical spine ligaments to have less stiffness and a lower failure force than those in men (36). All these factors may contribute to a decreased spinal stability in women, which may partly explain their greater range of motion during static (37) and dynamic (38, 39) loading as well as their considerably lower tolerance limit for lower neck shear force (women: 384 N; men: 636 N) (40). In addition, women's neck muscles react faster, which may cause greater tissue strain and increase the injury potential (41). Recent research based on 50th percentile male and female human body numerical simulation models suggests that the sex difference in head and cervical spine kinematics during simulated rear impacts is primarily due to anatomical differences rather than differences in muscular force (42).

It has also been reported that existing whiplash protection concepts are generally less effective for women than men, with a 31% risk reduction of permanent medical impairment for women and 52% for men, according to Swedish insurance claims records (43). Moreover, substantial differences were found when analysing different whiplash protection concepts separately. Seats designed to absorb energy in the seatback had equal or even somewhat higher effectiveness for women compared to men, while seats with reactive head restraints showed very high reduction effects for men (60–70%) and very low or no reduction for women (43). One reason may be that existing whiplash protection concepts are primarily adapted to an average-sized male, and so only the extremes of the female population are accounted for by the existing crash test dummies available for rear impact crash testing; that is, the 50th percentile male rear impact dummy, or possibly the 5th percentile female frontal impact dummy. Women of average stature are associated with the highest whiplash injury frequency/incidence in rear impacts (43, 44).

The prevalence of most common forms of pain conditions is higher in women than men, possibly because of underlying mechanisms such as sex differences in hormones, endogenous opioids, neurotransmitters, and receptors, as well as differences in the diffuse noxious inhibitory control system (45).
The prevalence of widespread pain in Swedish population studies has been estimated at 15-34% for women and 8-22% for men (46, 47), while the prevalence within those with persistent pain conditions is estimated to be 17.5-35.3% (48). Higher incidence of widespread pain has been reported in patients exposed to whiplash trauma than in patients with idiopathic neck pain, although sex differences were not presented (25, 26). Our results show a higher proportion of individuals with widespread pain than in other Swedish population studies (46, 47), but are in accordance with studies of populations with persistent pain (48).

In spite of the fact that sex inequality has garnered attention in the society and politics of Sweden, statistical population analysis (49) and analysis of women living in relationships and working at least 50% of full time (50) reveal several areas where women still face higher workloads and social distress than men.

Even if the role of these factors must be further studied, they imply less favourable conditions for women to recover after trauma.

In summary, this cross-sectional study of observational data from baseline assessments found twice as many women as men in a cohort of consecutive patients with persistent neck pain after trauma. There were no sex-related differences in types of trauma, but a high proportion of women in particular had widespread or regional pain. After analysing possible explanations for the sex-distribution pattern, we conclude that mechanisms related to the trauma, pain sensitization, and possibly social factors all point towards an increased risk for women to develop persistent pain after neck trauma. We therefore recommend that women and men should be studied separately, and that the care system needs an increased awareness of women's increased vulnerability.

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DISCLOSURE OF INTEREST

The authors report no conflicts of interest.

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FIGURE CAPTIONS

Figure 1

A: Tukey boxplots of months between trauma and assessment, as stated by the patients (n = 745). The horizontal bars of the boxes represent the 1st quartile, median, and 3rd quartiles respectively, while whiskers represent 1.5 times the interquartile range. Outliers are omitted from the plot.
B: Number of patients referred and assessed between 2010 and 2014.

Figure 2

Age at assessment, divided by sex.

Figure 3

Pain distribution (local, regional, or widespread) among men (n = 269) and women (n = 476). Each block is annotated with the corresponding number of patients.

Figure 4

Pain distribution according to sex and type of trauma in 719 of the 745 patients (in 26 cases, the type of car crash could not be determined). Each block is annotated with the number of patients belonging to that category.

Figure 5

Conditional density plot of pain distribution and time (in months) since the trauma. Cases exceeding 120 months (16% of the total sample) are omitted, since they were too few to provide accurate estimates. Sample frequency is given at the bottom of each facet by a rug plot, and density estimates are given on the y axis; these were computed using a Gaussian kernel (the normal distribution function).

TABLES

Table 1

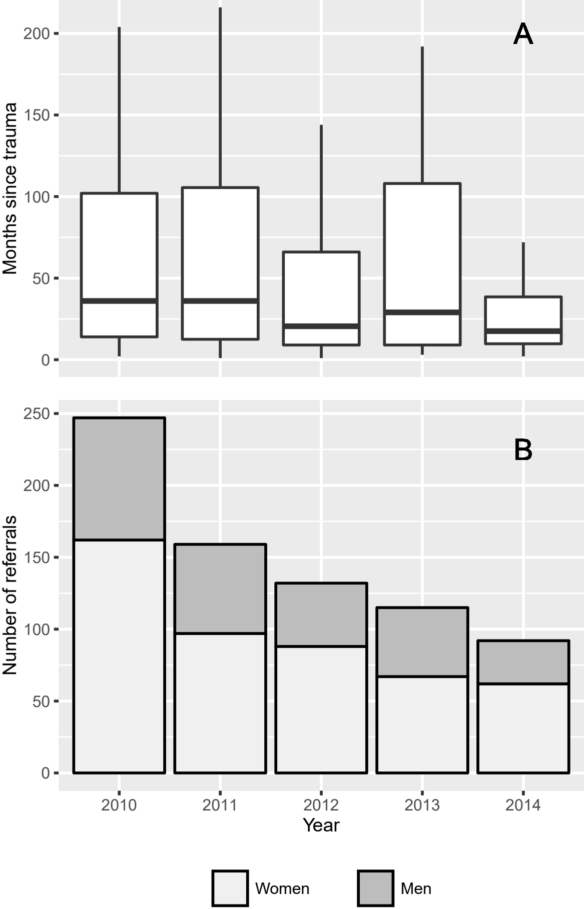
Pain distribution (local, regional, or widespread) grouped by age and sex.

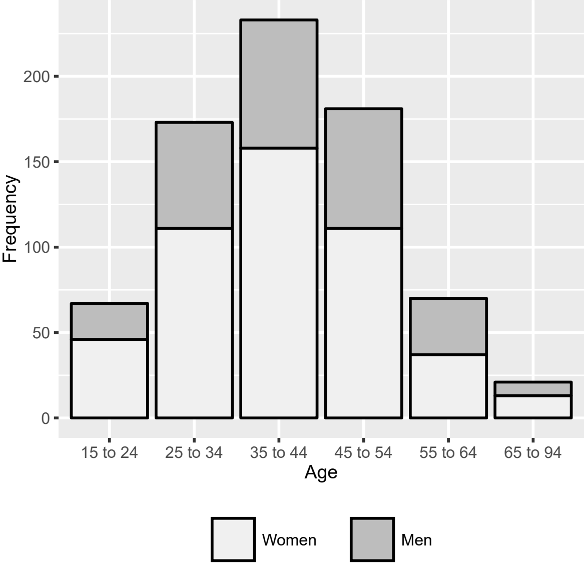
Age	Pain distribution	Women	Men	All
15–24	Widespread	16	8	24
	Regional	27	12	39
	Local	3	1	4
25–34	Widespread	50	12	62
	Regional	50	39	89
	Local	11	11	22
35–44	Widespread	64	23	87
	Regional	82	37	119
	Local	12	15	27
45–54	Widespread	53	28	81
	Regional	47	32	79
	Local	11	10	21
55–64	Widespread	16	6	22
	Regional	18	18	36
	Local	3	9	12
65–94	Widespread	5	1	6
	Regional	5	5	10
	Local	3	2	5
	All	**476**	**269**	**745**

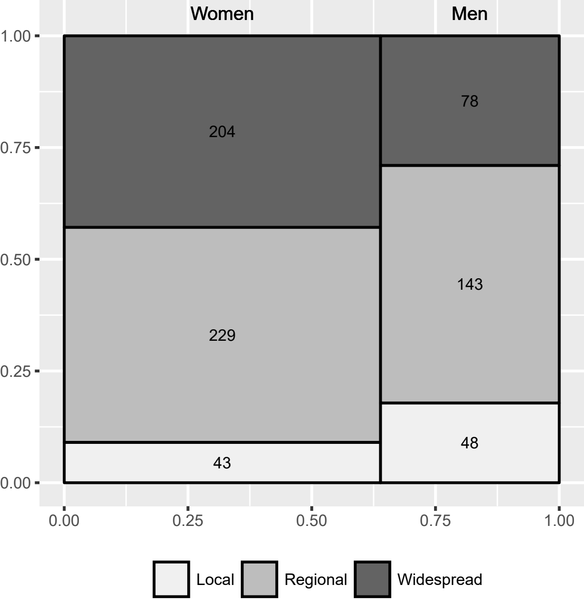
Table 2

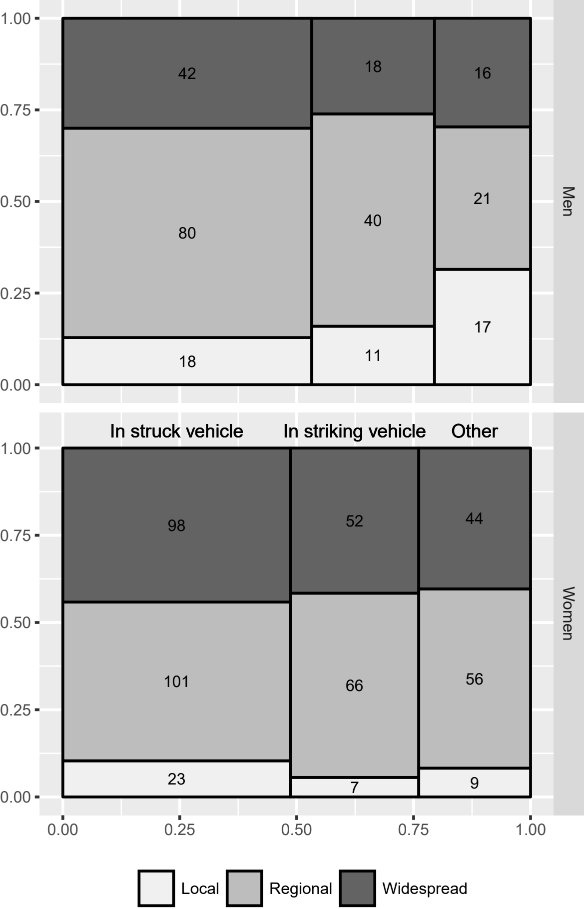
Description of types of traumas. In cases involving multiple traumatic events, only the event which the patient considered to have produced the symptoms is displayed.

Type of trauma	Women	Men	All
Car crashes			
In striking vehicle	125	69	194
In struck vehicle	223	139	362
Vehicle status unknown	20	6	26
			582
Other neck traumas			
Bike accidents	14	5	19
Other traffic accidents	14	7	21
Sports-related accidents	19	7	26
Falls	31	13	44
Direct head or neck traumas	12	8	20
Miscellaneous accidents	18	15	33
			163
Total	**476**	**269**	**745**

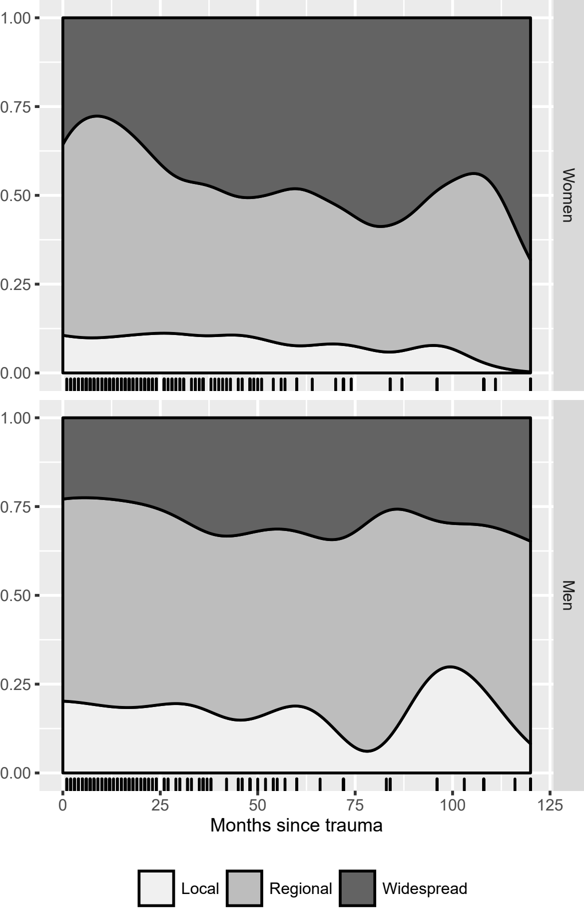

A
B
Months since trauma
Number of referrals
200
150
100
50
0
250
200
150
100
50
0
2010
2011
2012
2013
2014
Year
Women
Men


Frequency
200
150
100
50
0
15 to 24
25 to 34
35 to 44
45 to 54
55 to 64
65 to 94
Age
Women
Men


Women
Men
1.00
0.75
0.50
0.25
0.00
204
229
43
78
143
48
0.00
0.25
0.50
0.75
1.00
Local
Regional
Widespread



1.00
0.75
0.50
0.25
0.00
42
18
16
80
40
21
17
18
11
Men
In struck vehicle
In striking vehicle
Other
98
52
44
101
66
56
23
7
9
Women
0.00
0.25
0.50
0.75
1.00
Local
Regional
Widespread


1.00
0.75
0.50
0.25
0.00
Women
Men
0
25
50
75
100
125
Months since trauma
Local
Regional
Widespread