1 **Spinal Cord Injury and Development of Pressure Injury during Acute Rehabilitation in Norway; a National Retrospective Cross-**
2 **Sectional Study**

3
4 **Running title: Spinal Cord Injury and Pressure Injury in Norway**

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43 **Abstract**

44 **Study design** A national, retrospective, cross- sectional study.

45 **Objectives** To analyze the prevalence of pressure injury (PI), and characteristics associated with PI development in the hospitalized population of
46 persons with a newly acquired spinal cord injury (SCI) between 2004 and 2014.

47 **Setting** All three specialized Spinal Cord Units in Norway.

48 **Methods** Demographic data related to prevalence and potential risk factors was retrieved from the electronic medical record (EMR). Statistical
49 analyses were performed, using IBM SPSS Statistics, version 23.

50 **Results** We identified 1012 individuals with a new SCI. Mean age at injury was 48 years (SD 19). The period prevalence of PI was 16 % (95 %
51 CI=0.14-0.19), and identified PI associations were complete SCI (OR=0.1), being injured abroad (OR=2.4), bowel (OR=13) and bladder
52 (OR=9.2) dysfunction, comorbidity like diabetes mellitus 1 (OR=7.9), diagnosed depression (OR=3.8), ventilator support (OR=3.0), drug abuse
53 (OR=3.0), and concurrent traumatic brain injury (OR=1.7). Individuals in the age group 15- 29 years had higher odds of PI compared to middle-
54 aged individuals (45- 59 years).

55 **Conclusion** PI is a serious complication after SCI. The association between depression or comorbidity and PI occurrence should be investigated
56 more thoroughly. We recommend implementation of a simple follow- up program regarding observation and prevention of PI.
57 Increased awareness of factors that could contribute to PI, will help to focus on better prevention and early recognition of PI. This will contribute
58 to more optimal rehabilitation.

59 **Sponsorship** The DAM Foundation.

60

61 **Introduction**

62 Pressure injury (PI) is defined as localized damage to skin and underlying soft tissue, usually over a bony prominence or related to medical, or
63 other devices. It can present as a red spot on intact skin or as an open ulcer and can be painful. It occurs as result of intense or prolonged
64 pressure, or pressure in combination with shear [1]. A systematic review published in 2013 concluded that overall there is no single factor, which
65 can explain the risk of PI, but rather a complex interplay of factors that increase the probability of the development [2]. Impaired motor and
66 sensory function, altered perfusion and circulation, moisture, and incontinence, were found to be factors that significantly increased the risk of PI
67 [2].

68 Due to paralysis, sensory loss and prolonged exposure to moisture, individuals with spinal cord injury (SCI) are at particular risk for PI [2-5].

69 The occurrence of PIs during hospitalization of persons with SCI has shown to vary between 6 % and 52 % [6-7], and comorbidities can affect
70 the development of severe PI [6].

71 Persons with SCI are a heterogeneous group, and therefore risk factors may vary in specific subgroups [2, 8-9]. Verschueren (2011) found that
72 both complete injury and tetraplegia were significant risk factors for PI during the acute rehabilitation period [7], while Grigorian (2018) found
73 that a higher SCI level was associated with increased risk for PI as compared to lower [10]. The actual number of individuals with SCI and PIs in
74 Norway is unknown; moreover, we do not know if the risk factors for PIs in the Norwegian population correspond to risk factors reported in

75 other studies [2-5]. Therefore, a research program (NORSCIPI) at all three spinal cord units in Norway (NSCUs) was conducted to identify
76 characteristics associated with PI development in the hospitalized population of persons with acute SCI [11]. The first study of this research
77 program aims to investigate the prevalence of PI in the population, and further to investigate potential risk factors and associations for PI in these
78 individuals from admission to and discharge from the NSCU [11].

79 **Methods**

80 *Setting and population*

81 All individuals acquiring either a traumatic SCI (TSCI) or non- traumatic SCI (NTSCI) during 2004– 2014 and admitted to one of the three
82 specialized NSCUs for acute rehabilitation after the injury, were included in the study. The acute rehabilitation period is defined as the
83 continuous time period from admittance to the NSCU and to final discharge from the hospital. The electronic medical record (EMR) at each of
84 the three NSCUs, was used to identify individuals, and retrieve data. The system of care for persons with SCI in Norway has been described in a
85 recent publication [12]. Because of the strict legislation regarding privacy, and the data collecting permission from the Ethical Committee [13-
86 16], available information from the acute care hospitals is dependent on the information given in the transfer letters from the acute care hospitals
87 to the NSCUs. These transfer letters do not include any information regarding the time from injury to the arrival at the acute care hospitals,
88 neither any information regarding immobilization during transfer, mode of transport, or use of pressure-relieving devices or interventions.

89 *Study design*

90 We conducted a national, retrospective, cross- sectional study, with the aim to estimate the period prevalence of PI, and investigate potential risk
91 factors for PI during the period between admission to and discharge from the acute rehabilitation. Available information from the EMR at the
92 NSCUs was evaluated to retrieve potential risk factors.

93 *Study variables*

94 Study variables were recorded as “yes” if present, “no” if not present, and “unknown” if the information was missing. The term pressure injury
95 (PI) was used to describe pressure ulcers/ wounds, according to the newest recommendations [1].

96 The International Standards for Neurological Classification of SCI (ISNCSCI) was used, including the clinical findings standardized by the
97 American Spinal Injury Association (ASIA) Impairment Scale (AIS) [17]. Relevant information recorded from the EMR at the NSCUs, were
98 gender (male/ female), date of birth, date of injury, marital status (single and living alone, single but living with parents/ children, cohabitant,
99 partner/ married, divorced, widow/ widower, unknown), level of education (primary school, high school, college/ university, unknown)
100 occupational status (fulltime, part time, social welfare benefits, retired, unknown), etiology of the injury (traumatic, non- traumatic), neurological
101 level of the injury (cervical, thoracic- sacral, cauda equine) and any associated injury (brain injury, multi trauma). A complete examination of the
102 skin was recorded within the first weeks after the admission to the NSCU. Occurrence of PI, as well as use of alcohol and tobacco, and all abuse
103 of drugs, SCI associated problems, such as incontinence and ventilator dependence, in conjunction with premorbid comorbidities, such as
104 hypertension, cardiac disease, diabetes mellitus (DM), clinically diagnosed depression, allergy and skin disease were recorded from information
105 in the EMR. In addition, attention deficit/ hyperactivity disorder (ADHD/ADD), which was previously not evaluated as a potential risk factor for

106 PIs, was recorded if diagnosed before admittance to the NSCUs, and recorded in the EMR. The EMR documentation used in this study, does not
107 specify any diagnostic tools regarding depression or ADHD/ADD, the variables were recorded “yes”, “no” or “missing”, dependent on the
108 information given in the EMR.

109 *Data collection*

110 A selection of 84 EMR diagnoses were scrutinized for SCI, and only individuals with acquired traumatic or non- traumatic SCI between January
111 1st 2004 and January 1st 2014 were included. Based upon data obtained from the EMR, neurological level of injury and the AIS, were examined
112 and recorded during the first three weeks after admission to the NSCUs [12]. In some cases, the degree of impairment was not registered, but the
113 EMR described the sensory and motor grade and level, as well as the sphincter tonus. In these cases, the impairment was graded by the first
114 author (II) in accordance with the ISNCSCI [17-19].

115 *Ethics*

116 The Norwegian Data and Telecommunications Authority's requirements for safe information flow was followed [14]. The study was approved
117 by the National Regional Ethical Committee (2014/ 684/ REK- Nord) [15-16].

118 *Statistical analyses*

119 Potential risk factors diagnosed before the occurrence of the PI, were included in the analyses. Continuous variables are presented as mean with
120 standard deviation (SD). Categorical variables are presented as counts and percentages.

121 The categorization of age into age groups is performed, according to the newest recommendations [17-18].

122 Participants' demographics and injury characteristics are analyzed descriptively. The term period prevalence refers to the ten year- period
123 between 2004 and 2014. To identify factors associated with PI occurrence, potential risk factors were entered into a binary, logistic regression
124 model. Crude and adjusted (for gender and age) odds ratios (ORs) were calculated along with 95% confidence intervals (CIs). P-values less than
125 0.05, were considered significant. The common confounding variables age and gender were adjusted for in the analyses. The adjusted results will
126 be reported and discussed in the article. As a sensitivity analysis, we also performed logistic regressions where missing values on the PI- variable
127 were taken as "no PI". Our reasoning was that if there was no PI during acute rehabilitation, PI would not be mentioned in the EMR.
128 IBM SPSS Statistics, version 23, was used for all statistical analyses.

129 **Results**

130 *Description of the population*

131 After reviewing data from 1488 EMRs at the three NSCUs, 1012 individuals, 742 men (73 %) and 270 women (27 %), were included in the
132 study. Demographics are presented in Table 1.

133 *Period prevalence and location of the pressure injuries*

134 We had information about PI in 891 of the individuals, and the period prevalence of PI in the studied population was 144/891 (16 %, 95 % CI=
135 0.14 to 0.19). We found that 61 % of the population with a known number of PIs, had a single PI (86/142 individuals), while 39 % (56/142
136 individuals) had two or more.

137 The total number of PIs recorded from the EMR were 373. Most of the PIs were located at the coccyx (33 %) (Figure 1).

138 *Factors associated with pressure injury development, classified by categories*

139 A detailed overview of factors associated with PI in our population, is provided in Table 2.

140 *Gender*

141 Men had an overall period prevalence of PIs of 19 % (95 % CI = 0.16 to 0.22), compared to 9.0 % (95 % CI = 0.05 to 0.13) among women.

142 *Age*

143 The mean age at injury was 48 years, standard deviation (SD) 19, (minimum

144 0.47 years – maximum 88 years). The age group 45– 59 years had significantly decreased odds of PI (OR= 0.5, 95 % CI = 0.3- 0.9) compared to

145 the reference group (15- 29 year).

146 *Marital status, education, occupational activity*

147 We did not find any significant variation in the occurrence of PI concerning marital status,

148 level of education, or occupational activity at time of injury.

149 *Cause and Severity of the spinal cord injury at admission*

150 The occurrence of PI was higher among those who were injured outside Norway.

151 There was no significant difference in the occurrence of PI, based upon having a traumatic

152 or non- traumatic injury, or based upon the neurological level.

153 Individuals with AIS D had a 90 % decreased odds of PI, compared to individuals with AIS A; (OR = 0.1, 95 % CI = 0.1 to 0.2, $p < 0.001$). The
154 decrease in odds of PI for individuals with AIS C was 70 %, compared to individuals with AIS A; (OR = 0.3, 95 % CI = 0.2 to 0.5, $p < 0.001$). A
155 test for trend in the AIS categories showed a significantly decreasing trend ($p < 0.001$) (Figure 2).

156 *Spinal cord injury sequelae*

157 A significantly higher occurrence of PIs was observed among individuals with bladder and bowel dysfunction related to the SCI, compared to no
158 dysfunction. A corresponding pattern was found regarding the need for ventilator support before or at admission to
159 The NSCUs. The occurrence of multi trauma together with the SCI did not associate with the occurrence of PI; however, having a concomitant
160 traumatic brain injury (TBI) did.

161 *Comorbidity, acquired prior to the spinal cord injury*

162 For patients diagnosed with Diabetes mellitus type1 (DM1) ahead of the SCI, there was
163 approximately an eight time increased odds of PI, compared to individuals with no DM1
164 diagnosis (OR= 7.9, 95 % CI= 2.4- 26, $p = 0.001$); however, we did not find any increased PI-
165 occurrence for DM2. Other comorbidities, such as hypertension (OR= 3.7, 95 % CI= 2.3 to
166 5.9, $p < 0.001$) and cardiovascular disease (OR= 3.6, 95 % CI= 2.3 to 5.9, $p < 0.001$) also
167 significantly increased the odds of PI.

168 Clinically diagnosed depression was present in 285 (28 %) of the total population during the

169 acute rehabilitation, and there was a higher PI occurrence in those with depression, than in
170 those without. ADHD/ ADD diagnosed before the SCI, did not show any association with PI
171 occurrence.

172 *Stimulants*

173 Abuse of illegal or prescribed drugs before the SCI and registered in the EMR, seemed to be associated with an increased occurrence of PI (OR =
174 3.0, 95 % CI = 1.5 to 6.9, $p = 0.002$), while being under influence of alcohol or drugs at the time of the injury (20 % of the population), did not.
175 Regular use of tobacco and alcohol did not show any significant increase in the risk of PI.

176 **Discussion**

177 NORSCIPI is the first national study of PI in the SCI population in Norway. Our study-
178 population was representative and comparable with previous studies in Norway [20-21]. An
179 important finding in our study was the association between psychological impairments and
180 risk of PI, which is in accordance with previous studies [2, 22].

181 It should be noted that no standardized instrument to assess depression was applied in this study, since we build on information retrieved from
182 the EMR. There is some ambiguity in the recorded depression diagnoses; however, we refer to it as depression, based on clinical evaluation.
183 We found that the level of injury was insignificant regarding the risk of having a PI, while individuals with AIS A and B were more at risk of
184 having a PI, compared to AIS C and D. Previous findings are inconsistent when it comes to the association between the degree of impairment,

185 evaluated by the AIS grade and PI [23- 26]. However, our results are in accordance with previous studies, where the completeness of the injury
186 determines the risk of having a PI [2, 7, 23- 24]. In our study, the occurrence of PI was 16 %, which is lower than previous studies [6, 27- 28],
187 and lower than the occurrence of PI in the general inpatient population in both Norway and other comparable countries [6-9, 27-28, 30]. Mawson
188 (1988) postulated that the most likely time for the development of PI is the immediate post- injury period of spinal shock, and that some of the
189 PIs appearing during acute care may be the visible result of ischemic injuries occurring prior to acute admission [26]. Unfortunately we could
190 not obtain documentation on how patients were immobilized during transfer to the acute care hospitals or the NSCUs, the mode of transport,
191 transfer surfaces used, or whether pressure- relieving devices or interventions were utilized during transportation and hospitalization [28]. In
192 our study five percent of the population were injured abroad, and the occurrence of PI among them was significantly higher, compared to
193 those injured in Norway. We believe delay in admittance to the NSCUs might explain the findings of the increased occurrence of PI in those
194 injured abroad. Because of strict Norwegian guidelines, regarding prevention of multi- resistant bacteria, patients injured abroad are isolated at
195 home or at the local hospital, and not admitted to the NSCUs until their infection status is clarified [31]. PI preventing routines for the
196 transportation, in- hospital preventing care at both the acute care wards, and the NSCUs, are important issues in the future PI preventing
197 recommendations. Knowledge about PI prevention should be part of the education and training for all staff members, as well as newly injured
198 individuals, and their relatives [32]. The Norwegian “In safe hands” program [33], could be implemented as a simple way to identify patients at
199 risk of developing PI, by asking three questions for risk assessment immediately after admittance to hospital;

200 1) Does the patient have PI now?

201 2) Does the patient need assistance in position changing?

202 3) Is the patient at risk of develop PI during the hospitalization?

203 If the answer of any of these questions is “yes”, an action plan should be initiated, with the aim to prevent the occurrence of any PI, or to treat an
204 already existing PI. The flow chart in Figure 3 [33], provides a visual overview of the action plan and recommended measures to achieve the “No
205 PI” goal (Figure 3). Check lists should be used to record this information in the EMR.

206 In NORSCIPI, the occurrence of PI was more than doubled among men, compared to women. The association between gender and PI has been
207 studied with mixed results in previous studies [24, 26, 34]. We speculate that individuals with risk taking behavior may continue this behavior
208 into rehabilitation, and if there is more risk- taking behavior in the male population in our study, they may be more vulnerable to PI? This
209 question requires further investigation. Another possibility is the difference in fat distribution in women versus men, as women often have
210 increased adipose tissue at the buttocks and thighs, two areas that are especially vulnerable to PI [35]. Even if the cause for the gender difference
211 is not sufficiently explored, it highlights the need for repeated information about prevention actions in vulnerable individuals, and that staff
212 planning the rehabilitation are assessing each patient`s risk for PI individually.

213 It is known that aging causes reduction of the micro vascularization and of the proliferative activity of the dermis, as well as changes in the
214 elasticity of the skin, enhancing the effect of local pressure and stretch on the skin and thus increase the risk of PI [28]. Nevertheless, previous
215 studies show contradictory results concerning the association between age and PI [23- 24, 26, 33]. In the present study, the age group 45- 59 year
216 actually had a 50 % reduced odds of PI compared to the reference group (15- 29 year). An analysis regarding differences in the age groups

217 identified a higher occurrence of depression and AIS grades A- B in the age group 15-29 year and we believe these were the reasons for the
218 increased PI odds. These findings reinforces the need to focus on particularly at- risk individuals, or sub- groups, during rehabilitation.
219 We did not find any association between the occurrence of PI and level of education or occupational activity. The social welfare system in
220 Norway gives everyone the same opportunity for health care, regardless of education, occupation or income [36], and this may influence the
221 results in our study, compared to other reports [2, 23- 24, 33].
222 Our findings reiterate that risk factors, such as incontinence, lack of sensation, ventilation support, hypertension and cardiovascular disease
223 increase the odds of PI [2-3, 5, 28, 37- 38].
224 Patients with diabetes mellitus type 1 (DM1) showed a higher occurrence of PI, with an OR close to eight. Although we cannot claim a causal
225 association, PI preventing actions regarding persons with DM1 who are acquiring a SCI, should be in focus at all terms of post- injury care and
226 follow- up. In contrast to previous research [2, 27-28], we did not find an association for PI and DM2. There is limited information about the
227 differences in the risk of PI in DM1 compared to DM2, and neuropathic abnormalities, together with poor circulation and immune function
228 changes, each contribute to vulnerable alteration in the tissue among individuals with DM1 and DM2 [39]. One study found that independent risk
229 factors include renal insufficiency [40]. About 30 % of individuals with DM1 (juvenile onset), and 10 % to 40 % of those with DM2 (adult
230 onset), eventually will suffer from kidney failure [41]. We speculate if renal insufficiency contributed to the differences in the association
231 between DM and PI in our population; however, the population with DM1 in NORSCIPI only consisted of 13 individuals, with a mean age of 42
232 years, while there were 68 individuals with a mean age of 62 years with DM2. Thus, with this small population, further research is warranted.

233 Surprisingly, we didn't find any association between the use of tobacco or alcohol and PI, while abuse of drugs seems to be associated with PI
234 development. Thus, our findings do not support findings in previous studies, related to the use of tobacco or alcohol [42]; however, uncertainty
235 in the number of reported users in the investigated population may partially explain our results.

236 *Study limitations*

237 There are a number of limitations in our study related to the clinical care of patients with SCI in Norway. Individuals with SCI not admitted to
238 one of the NSCUs post- injury due to limited need for third line rehabilitation, or comorbidity are not included in the study. Clinical transfer
239 protocols for individuals with newly acquired TSCI as compared to NTSCI are well known in Norway [12], but acute rehabilitation after NTSCI
240 is less well defined. Thus our NTSCI sample does not include all affected individuals, in contrast to our TSCI sample. Finally, we would
241 optimally have divided the time between injury through acute rehabilitation into two separate periods; accident to acute rehabilitation transfer,
242 and the acute rehabilitation period. Unfortunately, this was not possible to do, given the available information in the EMRs, and this is a
243 limitation in our study.

244 Because of variable reporting in the EMR, there was missing information about PI in 121 of the individuals. This may reduce the statistical
245 power of the results; [43] however, clinical experience indicates that if there is no information about PIs in the EMR, there is generally not a PI
246 problem. Moreover, performing a logistic regression, setting missing PI to 'No PI', did not change the (significance of the) results.

247 Information about drug abuse at the time of the injury, is retrieved from available information in the transfer letter from the acute care hospital.
248 Any missing information in this document, will also be missing in the study. The lack of recorded information in the EMR regarding those who
249 use tobacco, alcohol and/ or illegal drugs, and those who do not, results in missing data, and is another limitation of our study.
250 We have investigated a high number of potential risk factors. Thus, it was infeasible to develop causal models for all of them and to adjust for all
251 confounding factors. Hence, the identified associations should be taken as indications, worthy of further investigations to clarify casual
252 relationships. We have also performed a high number of statistical significance tests, increasing the risk of type I errors [44]; however, most of
253 our significant findings seem clear and robust, thus, we feel quite confident about our conclusions.

254 *Conclusion*

255 NORSCIPI has a unique design, because variables are recorded over a 10 year period, and data are retrieved from the EMR. Results are unique
256 because they represent the national status of PI in the entire SCI population of Norway. We identified several factors, including DM1 and
257 depression that may be worthy of further research to clarify their role in the causal path to PI. We give recommendations for a simple program on
258 observation and prevention of PIs for health care providers, patients and next of kin. An increased understanding of factors that associate for PI,
259 will allow providers to focus on patients at particular risk. Check lists on factors associated with the occurrence of PI, as well as check lists and
260 better focus on PI prevention should be part of the acute care SCI rehabilitation. For better outcomes, further research should focus on PI
261 prevention routines and actions during the acute post- injury rehabilitation.

262

263 **Data Archiving** The data set is stored in a locked and fireproof research cabinet at the research department, Sunnaas Rehabilitation Hospital,
264 Norway, and can be made available on request, according to the Norwegian Data and Telecommunications Authority's requirements for safe
265 information flow [14].

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270 **Statement of Ethics**

271 The research project was carried out in accordance with current ethical guidelines and privacy rights for health services in Norway [14], based on
272 the Code of Ethics of the World Medical Association (Declaration of Helsinki) [45] for experiments involving humans. The research project was
273 approved by the Norwegian Regional Ethical Committee (REC) on January 9th 2015 (2014/684 REK Nord) [15], and Registered in Clinical
274 Trials.gov in May 2016 (NCT02800915).

275 **Conflict of interests**

276 The authors declare no financial or competing interests. The study was performed independently and without any influence from the investigators
277 or founders.

278 **Author contributions**

279 II is a medical doctor (MD) at Sunnaas Rehabilitation Hospital, and a PhD fellow at the University of Oslo. She is the main investigator of the
280 study, and the only investigator with access to the complete data set collected in the study. She is also the main contributor in the writing of the
281 manuscript. Professor MD TR is the main supervisor. TR and II were responsible for the design of the study. Professor MD JKS is the Research
282 Director at Sunnaas Rehabilitation Hospital, and the project manager. Professor MD JMH and MD DMSC RJ are co- supervisors in the project.
283 Professor MD MA is a collaborator in the project. Professor MT is a statistician, guiding in the statistical design of the study and analyzes of the
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289 The DAM foundation has no influence on the trial protocol or the results.

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385 Figure legends

386 Figure 1. Location and frequency of the PIs

387 Figure 2. The trend between the AIS grade and the PI risk

388 Figure 3. Action Plan for Prevention of Pressure Injury

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393 Table legends

394 Table 1. Demographics

395 Table 2. Pressure Injury Associations

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416 **Figure 1.**

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Figure 2.

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449 **Figure 3.**

469 **Table 1. Demographics**

	N	Percentage
470 Total	1012	100
471 Gender		
472 Male	742	73
473 Female	270	27
474		
475 Mean age		
476 At injury	48, 26 years (min. 0.47- max. 88.48), SD 19.18	
477 At admission acute rehabilitation	48. 46 years (min. 0.97- max. 88.50), SD 19.16	
478		
479 Age grouping at admission to the NSCU		
480 0–14	14	1.4
481 15–29	201	20
482 30–44	208	21
483 45–59	239	24
484 60–74	273	27
485 75+	64	6.4
486		
487 Geographical site of injury		
488 Norway	959	95
489 Outside Norway	53	5.2
490		
491 Drugs/ alcohol use at time of injury		
492 Yes	110	11
493 No	715	71
494 Unknown	182	18

495			
496	<i>TSCI</i>	639	63
497	<i>NTSCI</i>	372	37
498			
499	<i>Level of injury at admission</i>		
500	<i>C1-C4</i>	224	22
501	<i>C5-C8</i>	222	22
502	<i>T1-S3</i>	566	56
503			
504	Cauda equine	86	8.5
505	AIS at admission		
506	<i>A</i>	258	26
507	<i>B</i>	58	5.7
508	<i>C</i>	298	30
509	<i>D</i>	385	38
510	<i>Unknown</i>	12	1.2
511			
512	Pressure Injury		
513	No	747/891	84
514	Yes	144/891	16
515	SD = Standard deviation, Min = minimum, Max = Maximum		
516			
517			
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520			
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523			
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525			

526 **Table 2. Pressure Injury Associations**

			<i>Crude values</i>			<i>Adjusted (gender and age) values</i>		
	<i>n PI/n Subgroup</i>	<i>PI percentage</i>	<i>OR</i>	<i>95% CI</i>	<i>p- value</i>	<i>OR</i>	<i>95% CI</i>	<i>p- value</i>
Gender								
Male	123/654	19	1.0			1.0		
Female	21/237	9.0	0.4	0.3- 0.7	0.001	0.4	0.3- 0.7	0.001
Age at injury								
0–14	1/15	6.7	0.3	0.04- 2.1	0.22	0.3	0.04- 2.2	0.22
15–29	39/188	21	1.0			1.0		
30–44	31/189	16	0.8	0.4- 1.3	0.23	0.7	0.4- 1.3	0.28
45–59	26/210	12	0.5	0.3- 0.9	0.03	0.5	0.3- 0.9	0.03
60–74	35/240	15	0.7	0.4- 1.1	0.10	0.7	0.4- 1.1	0.14
75+	12/49	25	1.2	0.6- 2.6	0.62	1.4	0.7- 2.9	0.40
Geographical location at time of injury								
Norway	130/847	15	1.0			1.0		
Abroad	14/44	32	2.6	1.3- 5.0	0.005	2.4	1.3- 4.8	0.009
Marital status at injury								
Single, living alone	37/193	19	1.0			1.0		
Single, not living alone*	27/136	20	1.0	0.6- 1.8	0.9	1.1	0.6- 1.9	0.76
Cohabitant	23/135	17	0.9	0.5- 1.5	0.62	0.9	0.5- 1.6	0.69
Married/Partner	48/372	13	0.6	0.4- 1.0	0.049	0.61	0.4- 1.0	0.068
Divorced	4/19	21	1.1	0.4- 3.6	0.84	1.2	0.4- 3.8	0.78
Widow/ widower	2/12	17	0.8	0.2- 4.0	0.83	1.1	0.2- 5.5	0.94
Unknown	3/24	13						
Educational level at injury								

556	Not finished primary school	6/26	233	1.7	0.6- 4.6	0.30	1.8	0.6- 5.2	0.31
557	Primary school	36/242	15	1.0	0.6- 1.7	0.97	1.0	0.6- 1.7	0.96
558	High school	33/234	14	0.9	0.5- 1.6	0.77	0.9	0.5- 1.6	0.76
559	College/ University	29/193	15	1.0			1.0		
560	Unknown	40/194	21						
561									
562	Occupational activity at injury								
563	Full time work	49/329	15	1.0			1.0		
564	Part time work	4/62	6.5	0.4	0.1- 1.1	0.084	0.5	0.2- 1.3	0.14
565	No work**	70/409	17	1.2	0.8- 1.8	0.42	1.3	0.8- 1.9	0.26
566	Unknown	21/90	23						
567									
568	Cause of injury								
569	Traumatic	96/567	17	1.0			1.0		
570	Non- traumatic	48/324	15	0.9	0.6- 1.2	0.41	1.0	0.7- 1.5	0.95
571									
572	Neurological level of injury at admission								
573	C1–C4	25/191	13	0.8	0.5- 1.3	0.39	0.8	0.5- 1.3	0.32
574	C5–C8	40/197	20	1.4	0.9- 2.1	0.15	1.4	0.9- 2.1	0.15
575	T1- S3	79/503	16	1.0			1.0		
576									
577	Tetraplegia	65/386	17	1.1	0.8- 1.5	0.67	1.1	0.7- 1.5	0.74
578	Paraplegia	78/501	16	1.0			1.0		
579									
580	AIS at admission***								
581	AIS A	77/233	33	1.0			1.0		
582	AIS B	14/51	28	0.8	0.4-1.5	0.44	0.8	0.4- 1.6	0.54
583	AIS C	33/263	13	0.3	0.2- 0.5	<0.001	0.3	0.2- 0.5	<0.001
584	AIS D	18/331	5.4	0.1	0.1- 0.2	<0.001	0.1	0.1- 0.2	<0.001
585	Unknown	2/13	15						

586									
587	Cauda Equine								
588	No	140/812	17	1.0			1.0		
589	Yes	4/79	5.1	0.3	0.1- 0.7	0.01	0.3	0.1- 0.7	0.01
590									
591	SCI ASSOCIATED PROBLEMS DIAGNOSED BEFORE THE PI OCCURENCE								
592	Bladder dysfunction								
593	No	5/194	2.6		1.0			1.0	
594	Yes	136/676	20	9.5	3.8- 24	<0.001	9.2	3.7- 23	<0.001
595	Unknown	3/20	15						
596	Bowel dysfunction								
597	No	5/239	2.1	1.0			1.0		
598	Yes	136/623	22	13	5.0- 33	<0.001	13	5.3- 33	<0.001
599									
600	ventilator support								
601	No	128/848	15	1.0			1.0		
602	Yes	15/41	37	3.2	1.7- 6.3	<0.001	3.0	1.6- 5.9	0.001
603									
604	PREMORBID COMORBIDITY								
605	Multi trauma								
606	No	85/611	14	1.0			1.0		
607	Yes	50/259	19	1.5	1.0- 2.2	0.045	1.4	0.9- 2.1	0.14
608	Unknown	9/21	43						
609	Brain Injury****								
610	No	106/746	14	1.0			1.0		
611	Yes	29/126	23	1.8	1.1- 2.9	0.01	1.7	1.1- 2.8	0.021
612	Unknown	9/19	47						
613	Diabetes Mellitus								

614	No	111/774	14	1.0			1.0		
615	Diabetes Mellitus 1	7/12	58	8.4	2.6- 27	<0.001	7.9	2.4- 26	0.001
616	Diabetes Mellitus 2	12/56	21	1.6	0.8- 3.2	0.15	1.6	0.8- 3.2	0.19
617	Unknown	13/47	28						
618	ADHD/ADD								
619	No	129/848	15	1.0			1.0		
620	Yes	4/13	31	2.5	0.8- 8.2	0.14	2.7	0.8- 9.1	0.11
621	Unknown	11/30	37						
622	Cardiovascular disease								
623	No	78/653	12	1.0			1.0		
624	Yes	51/192	27	2.7	1.8- 4.0	<0.001	3.6	2.3- 5.9	<0.001
625	Unknown	15/46	33						
626	Hypertension								
627	No	78/653	12	1.0			1.0		
628	Yes	52/193	27	2.7	1.8- 4.0	<0.001	3.7	2.3- 5.9	<0.001
629	Unknown	14/45	31						
630	Depression								
631	No	47/492	9.6	1.0			1.0		
632	Yes	67/251	27	3.4	2.3- 5.2	<0.001	3.8	2.5- 5.8	<0.001
633	Unknown	30/147	20						
634	Allergy/ Eczema*****								
635	No	94/613	15	1.0			1.0		
636	Allergy	30/188	16	1.0	0.7- 1.6	0.84	1.2	0.8- 1.9	0.44
637	Exema	20/90	22	1.6	0.9- 2.7	0.1	1.5	0.9- 2.7	0.13
638									
639	STIMULANTS								
640	Alcohol/Drug use at time of injury								
641	No	91/632	14	1.0			1.0		

642	Yes	19/97	20	1.4	0.8- 2.5	0.19	1.3	0.8- 2.3	0.33
643	Unknown	33/159	21						
644									
645	<u>Regular use</u>								
646	Tobacco								
647	No	47/356	13	1.0			1.0		
648	Yes	35/197	18	1.4	0.9- 2.3	0.15	1.4	0.8- 2.2	0.22
649	Unknown	62/338	18						
650	Snuff								
651	No	29/229	13	1.0			1.0		
652	Yes	8/32	25	2.3	0.9- 5.6	0.07	2.2	0.9- 5.6	0.09
653	Unknown	107/630	17						
654	Alcohol								
655	No	13/141	9.2	1.0			1.0		
656	Yes	60/365	16	1.9	1.0- 3.7	0.041	1.8	0.9- 3.4	0.07
657	Unknown	71/385	18						
658	Drug abuse (illegal and prescribed)								
659	No	26/216	12	1.0			1.0		
660	Yes	19/64	30	3.1	1.6- 6.1	0.001	3.0	1.5- 6.0	0.002
661	Unknown	99/610	16						

662

663 OR = odds ratio, CI = Confidence interval. The “Single, not living alone” subgroup consists of persons living with their parents, kids, in a collective, etc. ** The ”No work”

664 group consists of people on sick leave, retirement, disability benefits, unemployment benefits and other social welfare benefits. ***AIS American Spinal Injury Association

665 Impairment Scale, AIS A motor/sensory complete, AIS B motor complete/sensory incomplete, AIS C and D motor/sensory incomplete, AIS E normal examination **** Brain

666 Injury consists of all kinds of injury affecting the brain function, including concussion. ***** The “Allergy/ skin disease” group consists of all kinds of allergy, eczema and

667 skin diseases

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