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1 Knee arthroplasty until age 60 – role of sports and other injuries

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- 16 Short title: Knee arthroplasty until age 60
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27 ABSTRACT

 $\begin{array}{c} 12\\ 13\\ 14\\ 15\\ 16\\ 17\\ 18\\ 20\\ 21\\ 223\\ 24\\ 25\\ 26\\ 27\\ 28\\ 29\\ 30\\ 31\\ 32\\ 33\\ 34\\ 35\\ 36\\ 37\\ 38\\ 39\end{array}$

 BACKROUND: The primary aim of the study was to investigate how total knee arthroplasty
(TKA) patients with underlying injuries differ in injury type and physical activity after the
arthroplasty.

31 METHODS: A questionnaire was sent to TKA patients, ≤ 60 years at surgery, and knee 32 injury as the cause of knee OA. The final study group consisted of 70 patients.

RESULTS: Average age of patients at TKA was 51.8 years (Standard Deviation [SD] 5.2), and at follow-up 57.6 years (SD 6.5). Of the injuries, 26% were sports-related, 29% had occurred at work, 23% in traffic accidents, and 13% during leisure-time (no sports-related). Sports-related injuries had occurred at younger ages than others had (mean 23).4 vs. 35.2 years, p=0.001). Time from injury to arthroplasty was longer in patients with sports-related injuries compared to others (mean 26.6 vs. 17.4 years, p=0.003). At follow-up age-adjusted mean amount of weekly physical activity measured as leisure-time metabolic equivalent (MET) index (MET-hours/week) was higher in patients with sports-related injuries than in patients with other injuries (42.1 vs. 18.5, p=0.001)

42 CONCLUSIONS: Previous knee injury was the cause of severe knee osteoarthritis and TKA 43 in 20% of the patients 60 years or younger. The time from injury to arthroplasty was longer 44 among patients with sports-related than among those with others. Patients with previous 45 sports-related knee injury were more physically active after arthroplasty than patients with 46 others.

- 48 Key words: Knee Osteoarthritis Total Knee Arthroplasty Knee Injury Physical Activity

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Introduction

Recent meta-analyses and prospective studies have reported that subjects with previous knee injury are at an almost three-fold risk for knee osteoarthritis (OA) compared to those without such injuries.¹⁻³ In the early stage of the disease, conservative treatment is usually recommended, and operative treatment has traditionally been preferred for older patients with severe OA. In the 1980's the incidence of total knee arthroplasty (TKA) among Finns in Finland aged 30 to 59 was 0.5 operations per 100,000 inhabitants, but at the end of the follow-up period in 2006 the incidence had risen to 65 operations per 100,000 inhabitants.⁴

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Despite the fact that physical activity has many health benefits, some sports-related injuries may cause problems later in life. The type of knee injury has an impact on the risk of OA. A ligament or tendon injury, meniscal injury or meniscal resection and fracture of a lower limb carried a nearly six-fold risk of OA.² Among athletes, knee injury is often followed by OA and is the most common reason for permanent disability⁵ The increase in total knee replacements among younger patients may be a result of a growing number of knee injuries and expanding indications for the procedure. The role of knee injury, and especially the type of injury, as a risk factor for severe knee OA leading to TKA among people in their working age should be studied in more detail.

The aim of this study was to investigate the role of acute injuries (sports vs. others) in the aetiology of knew of leading to TKA in patients aged 60 or younger. The secondary aim was to study whether previous sports injury correlated with higher level of physical activity after arthroplasty.

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Materials and Methods

Between the years 2000 and 2013 total knee replacements were performed on 652 patients 78 aged 60 years or younger in Orton Orthopaedic Hospital, Finland. We excluded nine patients 79 not speaking Finnish or Swedish. The operating orthopaedic surgeons recorded his/her 80 opinion on the cause of the knee OA in light of the patient history. Based on this opinion, 350 81 patients with primary OA as the cause of OA were excluded. Of the remaining patients, 127 82 (20%) had previous knee injury as the cause of knee OA, and they were included in our 83 study. Ninety-six percent (122/127) of them could be reached (Fig. 1). 84

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A postal questionnaire was sent in 2014 to the patients with previous injury as the cause of 86 OA (n=122, 69 male). Besides detailed questions on previous knee injuries the questionnaire 87 included questions on anthropometrics, work history, chronic diseases other than OA, 88 symptoms, recent physical activity and also questions on possible OA among relatives. Body 89 mass index (BMI) was calculated based on patients self-reported height and weight at 90 follow-up. We calculated a leisure time activity metabolic equivalent (MET) index 91 (cumulative leisure MET hours/week) by assigning a multiple of resting metabolic rate to 92 activity, and by calculating the product of intensity x frequency x times of activity.^{7,8} 93

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P Eighty-five patients (70%) responded to our questionnaire and 73 (60%) of these agreed to 95 participate; 12 patients declined to complete the questionnaire. After checking patients' 96 records three participants were excluded because of diagnoses other than OA (one patient 97 with recurring dislocation of the patella, one with juvenile idiopathic arthritis and one with 98 spastic diplegia. Thus, the final study group consisted of 70 patients, 36 females and 34 99 males. Patients' characteristics are shown in Table I. 100

Ethical aspects 102

The ethics committee of the Universities of Applied Sciences in Helsinki Area approved the 103 study protocol (16.10.2013), and permission to use the patient registration was granted by the 104 National Institute for Health and Welfare (Dnro THL/1648/5.05.00/2013). 105

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107 Statistical analysis

Statistical analyses were performed with SPSS (version 22.0; SPSS Inc., Chiqago, Illinois, 108 USA). Comparisons between the groups were performed with T-test. When comparing BMI 109 and MET index between patients with sports-related injuries and other injuries, analysis of 110 covariance (ANCOVA) were performed with using age at follow-up as a covariate. Results 111 are given in proportions or in mean differences and their 95 % Confidence Intervals (CI). p < 112 0.05 (two-tailed) was accepted as a statistically significant threshold 113 P.

Results

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The average age of the patients at the time of the JKA was 51.8 years (SD 5.4, range 38.0-116 60.0), mean age at the time of the follow-up questionnaire was 57.6 years (SD 6.4, range 117 44.0-70.0), and mean follow-up time between the TKA and questionnaire was 6.2 years (SD 118 3.6, range 0.5-13.0) (Table I). For of the patients were over 65 years at the time of follow-119 up, and were retired. Fifty eight patients younger than 65 years reported their employment 120 status and 53% of them were working full-time or part-time. Twenty-six of the patients 121 younger than 68 years were retired. Only two patients with earlier sports injury (2/18) 122 reported not working either full-time or part-time work while, as in the group with other 123 injuries, 67% (30/45) reported being retired. When responding to follow-up questionnaire 124 patients with sports-related knee injuries were on average younger than patients with other 125

injuries (54 years vs. 58 years, mean difference -4.3 years, 95 % CI 7.7 - 0.9, p=0.014) 126 (Table I). 127

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Previous knee injury 129

Twenty-six percent (18/70) of the knee injuries had occurred in sports and 29% (20/70) of the 130 knee injuries had occurred at work. All except one of the patients (17/18) with sports-related 131 injuries reported the sports in which the injury had occurred. Half of the injuries had occurred 132 in team sports (n=9), such as soccer, basketball, ice hockey or Finnish baseball. Sports-133 related knee injuries had also occurred in badminton, downhill and cross-country skiing. 134 Traffic accidents were the cause for the injury in 23 (16/70) percent of the patients, and 13% 135 (9/70) of the patients reported that the injury had occurred in leisure time, such as falling at 136 home or when hunting or disembarking from a boat. Seven of the patients did not provide 137 exact details of the injury situation. There was no gender difference in the type of injury 138 (p=0.369). Fifty-three percent (35/66) of the patients with knee injuries leading to TKA 139 reported more than one injury in the lower limb. 140

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One-third (33%, 16/48) of all patients with previous knee injuries reported that they had 142 suffered a combined knee ligament and meniscal injury. These types of injuries were more 143 common in sports than elsewhere (\$7% vs. 24%, p=0.025). Only five patients had had 144 isolated anterior cruciate ligament (ACL) injury and one of the fourteen lower-limb bone 145 fractures was sports-related (7% vs. 38%, p=0.031). Slightly fewer isolated meniscal injuries 146 had occurred in sports than elsewhere (7% vs. 27%, p=0.134). 147

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Sports-related injuries had occurred at younger ages than other injuries (mean age 23.4 vs. 149 35.2 years, mean difference -11.8 years, 95% CI 18.6 - 5.0, p=0.001), and the time from 150

injury to arthroplasty was longer in patients with sports-related injuries than with others 151 (mean 26.6 vs. 17.4 years, mean difference 9.2 years, 95% CI 3.4 - 15.0, p=0.003). In 152 seventeen patients, the arthroplasty was performed less than ten years after the knee injury, 153 and in only one of these was the injury sports-related. 154

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Almost every patient (97%, 57/59) reported having had knee surgery, such as meniscal 156 resection or ACL and medial collateral ligament (MCL) repair surgery before TKA. Some of 157 the patients had had several arthroscopies before TKA, no differences between sports-related 158 159 and others injury were seen.

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At the follow-up there was a trend for patients with sports-related injuries to report less knee 161 pain and fewer symptoms than patients with other injuries (p=0.055) (Table II). Otherwise, 162 no difference was seen in pain and symptoms between sports-related injuries and other 163 HE HOLD injuries regarding other anatomic locations. 164

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Most of the patients (82%) reported having received sufficient exercise instructions after 167 TKA, but 11% would have wanted to have more instructions - all of them were patients 168 suffering work or traffic-related accidents. 169

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Most of the patients (80%, 48/60) had exercised regularly during their lifetimes at least two 171 times per week. All patients (n=18) with a sports-related injury and 71% (n=30) of other 172 patients had exercised regularly before TKA (p=0.011) (Table III). At follow-up 78% (47/60) 173 of the patients exercised regularly; 89% (16/18) of patients with sports-related injuries and 174 74% (31/42) of other patients (p=0.194). Sixteen patients had been physically inactive 175

(exercised less than two times/week) before TKA, and seven of them were still inactive at 176 follow-up, all patients with other injuries. Twenty-one patients had bilateral TKA, and eight 177 of them were patients with sports-related injuries. Despite bilateral knee endoprosthesis these 178 patients were as physically active as the others (age-adjusted mean MET index 30.6 vs. 23.0, 179 mean difference -7.6 MET index, 95% CI 21.8 - 6.6, p=0.290). 180

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Preoperatively (11) 17.6% of the patients reported that they could walk only 200 meters or 182 less before TKA. Nine of those eleven patients responded to the specific question on physical 183 activity at follow-up, and all of them reportedly exercised regularly. One of the patients 184 reportedly exercised less than 15 minutes per time, and the others walked or jogged from 15 185 minutes to over 2 hours. 186

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Average exercise intensity corresponded to the intensity of walking among 68% of the cases 188 (43/63), but 14% of the patients reported engaging in higher-intensity physical activity, such 189 as jogging. Half of the patients exercised at least one hour at a time, and over half of them did 190 exercise 11 times or more during a month At follow-up the patients with sports-related 191 injuries reportedly exercised at higher intensity (p=0.002), and engaged more often in leisure 192 time physical activity at an intensity at least equivalent to jogging (p=0.001) compared to 193 patients with other types of injur. No gender differences were found in exercise type, 194 intensity, duration of frequency. Overall, the post-TKA volume of leisure-time physical 195 activity was higher among patients with sports-related injuries than the others (age-adjusted 196 mean MET index: 42.1 vs. 18.5, mean difference 25.0 MET index, 95% CI 10.5 - 39.6, 197 p=0.001). 198

200 In physically inactive patients BMI was slightly higher than in physically active patients (age-adjusted mean 32.2 vs 29.1, mean difference 3.1 kg/m², 95% CI $^{-}0.6 - 6.3$, p=0.054). 201 Recent physical activity among the patients is shown in more detail in Table III. Among the 202 sub-group of patients who reported to have some repetitive long-lasting pain at the follow-up, 203 patients with sports-related injuries had a higher age-adjusted MET index than did other 204 patients. The difference in the MET index was 42.3 vs. 18.6 in patients knee pain (mean 205 difference 25.4, 95% CI 8.8 – 41.9, p=0.004). Among patients reporting back pain the 206 corresponding MET index difference was 29.3; 95% CI 10.0 - 48.6, p=0,004 (means 41.8 vs. 207 14.4), and in patients with shoulder pain 24.4, 95% CI 0.6 - 49.5, p=0.055 (means 45.2 vs. 208 21.6). 209

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Discussion

Previous knee injury increases the risk of knee osteoarthring even at a young age. Our 212 primary aim was to investigate the role of acute injuries in the actiology of knee OA leading 213 to TKA until age 60. In the estimation of the orthopaedic surgeons, 18.7% of the 652 patients 214 treated with TKA in our clinic at the age of 60 years or younger, the cause of knee OA was 215 previous knee injury. Twenty-six percent of them had injured their knees in sports, and the 216 rest of the injuries had occurred mainly in traffic accidents or at work. Patients with sports-217 related injuries had their TKA nearly 30 years after the injury had occurred, but in the 218 patients with other injuries the mean time to TKA was ten years shorter. 219

Lohmander et al.⁹ in their review reported that 10-20 years after sports-related knee injury 221 (ACL injury or meniscal tear) half of the patients had radiological signs of OA of the knee 222 and pain with functional impairment. Only one patient with a previous sports-related knee 223 injury in our study had TKA less than ten years after the injury. Patients with sports-related 224

injuries were on average 12 years younger at the time of the injury than patients sustaining other injuries. In high–energy accidents the most common injuries were bone fractures and combinations of various knee ligament and meniscal tears. ACL and other ligament injuries besides the meniscal tears were especially common among sports-related injuries.

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Many factors contribute to the development of early OA after ACL injury, such as trauma to 230 the articular cartilage, age at the time of injury, changes in gait, multiple injurties and knee 231 joint instability.¹⁰⁻¹² Kettunen et al.¹³ concluded that participating in sports involves a risk of 232 knee injuries and this may lead to disability later in life. Tveit et al.¹⁴ also reported that 233 previous knee injury is associated with knee OA in former impact athletes but not in non-234 impact athletes. According to the review by Øiestad et al.¹⁵ patients with isolated ACL 235 injuries had lower prevalence of knee OA than with knee ligament injury combined with 236 meniscal tears. Claes et al. 16 in their meta-analysis found that the prevalence of radiographic 237 knee OA after ligament ACL reconstruction was lower than had been thought. When 238 meniscal resection was associated with reconstruction if increased the risk for developing 239 OA. Nearly the entire study group reported having undergone some kind of knee surgery 240 before TKA such as arthroscopy, meniscal resection and ACL or other knee ligament 241 reconstruction. However, the question whether ACL reconstruction leads to early OA is still 242 S under debate.¹⁷ 243

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Seventy-six percent of the patients had exercised regularly earlier in their lifetimes. After TKA, 78% of all patients reported they had continued their exercise habits. Patients with sports-related injuries were more active than other patients before TKA, but after TKA the difference between the groups disappeared. Likewise in Chang et al.¹⁸ study, low-impact sports, such as walking, cycling and swimming were common in our patients. In Waldstein

and co-authors review¹⁹ low-impact activities increased and high-impact activities decreased 250 after unicompartmental knee arthroplasty. On average our patients with sports-related injuries 251 continued to engage in physical activity at higher levels of intensity than other patients. This 252 was also seen in the amount of physical activity. Patients with sports-related injuries had 253 higher weekly MET index values than the others. It has been concluded that sports activities 254 are not dependent only on TKA itself, but also on the motivation of the patient.²⁰ This may 255 also be the reason for cause of our patients with sports-related injuries; they had been 256 exercising regularly before TKA and were willing to continue physical activities after TKA at 257 the same level of intensity as before TKA. However, Chang et al. 18 retuted the hypothesis 258 that patients participate more actively in physical activities after TKA than they did before 259 surgery. After all the recent review ¹⁹ showed that patients, who participated regularly in 260 sports before knee arthrosis, sports participation decreased slightly after unicompartmental 261 knee arthroplasty. Also Arnold et al.²¹ found in their systematic review postoperative physical 262 activity levels in TKA patients were lower than activity levels in their healthy controls. 263 However, our patients had TKA in younger age and this may partly explain that patients with 264 sports-related injury had higher MET index values than patients with other injuries. 265

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We compared pain and symptoms to MET index values and when patients reported pain and 267 symptoms in the knee, pattents with sports-related injuries had significantly higher MET 268 indices than others Raxton et al.²² concluded that patients reported being more physically 269 active after TKA before TKA. However, in their report accelerometry-based outcomes 270 showed that physical activity was lower or at the same level as before surgery. We did not 271 have either pre-injury, preoperative or post-operative accelerometer recordings. Although 272 TKA improves functional performance and reduces pain associated with knee osteoarthritis, 273 little is known about the influence of TKA on overall physical activity levels.²² Overall, 274

musculoskeletal symptoms were common in our patients. However, despite self-reported pain 275 in the knee, spine and shoulder, patients with sports-related injuries reported significantly 276 more physical activity than patients with other previous injuries. However, patients with 277 knee injuries sustained at work or in traffic also had more concomitant injuries at different 278 locations in the body. This may explain their slower recovery and return to physical activity. 279 Our material was taken from the knee arthroplasty register of one orthopaedic hospital during 280 the period 2000-2013. Seventy patients responded to our questionnaire, and the final number 281 of patients with sports-related injuries was low, which limits the conclusions that can be 282 drawn from the results. Furthermore, we used a retrospective study design with self-reported 283 questionnaire. The injuries had occurred long ago, thereby increasing the risk of memory 284 medical records, which recall bias. However, we were able to check the patients 285 considerably improved the reliability of the results of this study. 286

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Previous knee injury was the cause of severe knee osteoarthritis in one-fifth of the young 289 TKA patients, and one-fourth of the injuries were sports-related. Patients with sports-related 290 injuries engaged in more higher-intensity physical activity after arthroplasty than did the other patients. 291 292

Conclusions

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304 Conflicts of interest

305 The authors have none to declare.

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patients with total knee arthroplasty
Table III. - Leisure-time physical activity reported by patients with a history of sports-related injuries or other injuries at follow-up among patients with total knee arthroplasty
TITLE OF FIGURE
Figure 1 - TKA had been done between years 2000-2013 to 60 years or younger

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Table II. - Self-reported prolonged pain and/or recurrent symptoms in different joints among

Table I. - Characteristics of patients undergoing with total knee arthroplasty

Table I Characteristics of patient	s undergoing with total	knee arthroplasty.
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	All	Group with	Group with	Mean	95% CI ^b	p - value ^c	
		previous sports-	previous	difference		Π	
		related injuries	other injuries			16	OIII
					$\langle \rangle$		
	n=70	n=18 ^a	$n=45^{a}$				•
	mean±SD ^u	mean±SD ^u	mean±SD ^d				
Gender, male (n (%))	34 (49)	7 (39)	25 (56)			0.645	
At the time of surgery					e C	J ^{II}	
Age (yrs)	51.8±5.2	50.0±5.3	52.2±5.3	2.2	5.00.8	0.219	
BMI^{e} (kg/m ²)	29.0±5.0	27.8±4.1	28.7±4.8	0.9	-3.5 - 1.6	0.155	
At the time of follow-up							
Age (yrs)	57.6±6.5	54.1±5.9	58.4±6.2		7.7 - 0.9	0.064	
Time from surgery to follow-up (yrs)	6.2±3.7	4.5±3.0	6.6±3.7	2.2	-4.10.2	0.075	
BMI^{e} (kg/m ²)	29.9±5.3	28.6±4.3	29.9±55	-1.2	⁻ 4.2. - 1.7	0.645	
^a The study group consisted of 70	patients, 63 of them	reported where their inj	ury occurred				

^b 95% Confidence Interval, 95% CI ^cp - values for statistical difference between groups with previous sports injuries and previous other injuries ^dSD=Standard deviation ^BMI=Body mass index

Pain and symptoms					
	All	Group with	Group with		
		previous	previous		
		sports-	other		
		related	injuries		
		injuries			
Region	n (%)	n (%)	n (%)	p-value*	
Hip	24 (48)	8 (47)	16 (49)	0.924	
Knee	50 (88)	18 (16)	32 (82)	0.055	
Ankle	18 (34)	5 (28)	13 (37)	0 495	
Shoulder	26 (47)	9 (50)	17 (46)	0.778	
Hand	14 (27)	5 (28)	9(27)	0.919	
Back	31 (54)	8 (44)	1 23 (590)	0.306	
Other pain, no arthrosis pain	21 (36)	7 (41)	14(33)	0.569	

Table II. - Self-reported prolonged pain and/or recurrent symptoms in different joints among patients with total knee arthroplasty.

*p-values for statistical difference between the group with previous sports-related injuries and group with previous other injuries

Table III. - *Leisure-time physical activity reported by patients with a history of sportsrelated injuries or other injuries at follow-up among patients with total knee arthroplasty.*

		1	1
		Group with	1
	Group with previous	previous other	\searrow
	sports-related injuries	injuries	
		()	R W
	n=18	⇒ n = 42 (S)
	n (%) ((<u>)</u> n (%)	<i>p</i> -value ^a
			•
Exercise at least 2 times /week	18 (100)	30 (71)	0.011
Present exercise (yes)	16(89)	31 (74)	0.194
Average exercise intensity corresponds		² O ²	0.002^{b}
to walking	10 (56)	>>>> 29 (71)	
alternative walking and jogging	1(6)	10 (24)	
jogging	7(39)	2 (5)	
Average exercise duration per session		1	0.544 ^b
less than 15 minutes		5 (12)	
15 minutes and less than 30 minutes		6 (14)	
30 minutes and less than 1 hour	6 (33)	10 (24)	
1 hours and less than 2 hours	(50)	19 (45)	
over 2 hours	↓ [™] 1 (6)	2 (5)	
Monthly exercise frequency			0.202^{b}
5 times or less	1 (6)	12 (29)	
6 to 10 times	4 (22)	7 (17)	
11 to 19 times	5 (28)	12 (29)	
20 times or more	8 (44)	11 (26)	
MET index (MET-hour week) ^c	42.3	18.5	0.001
[age-adjusted mean]			

^a*p*-values for statistical difference between the group with previous sports-related injuries and the group with previous other injuries

^bp-values for differences over categories.

^cIndex used in the calculation of MET hour/week based on intensity * duration * frequency



