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Clinical Factors Associated with C - Reactive Protein in Chronic Spinal Cord Injury

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Abstract

Study Design—Cross-sectional study.

Objectives—Determine clinical factors associated with plasma C-reactive protein (CRP) in persons with chronic spinal cord injury (SCI).

Setting—Veterans Affairs Medical Center in Boston, MA.

Methods—Participants provided a blood sample, completed a respiratory health questionnaire, and underwent dual x-ray absorptiometry (DXA) to assess total and regional body fat. Linear regression models were used to assess cross-sectional associations with plasma CRP.

Results—In multivariable models, factors associated with a higher CRP included a greater BMI, urinary catheter use, a respiratory illness in the past week, and non-white race. Mean CRP also increased with decreasing mobility (motorized wheel chair >hand propelled wheel chair > walk with an assistive device > walk independently). Results were similar when adjusting for % android, gynoid, trunk, or total fat mass in place of BMI. Level and completeness of SCI was not associated with CRP in multivariable models.

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Conclusions—Clinical characteristics common in chronic SCI are associated with plasma CRP. These factors are more important than level and completeness of SCI and some are potentially modifiable.

Keywords

C-reactive protein; body fat; spinal cord injury

Introduction

Chronic spinal cord injury (SCI) is characterized by clinical factors that promote systemic inflammation including reduced mobility,[1-5] accumulation of central fat,[6-8] and recurrent infections.[9-10] The linkage between systemic inflammation as assessed by C-reactive protein (CRP) and the development of atherosclerosis and coronary heart disease is well established.[11] As individuals with SCI age, they are at increased risk for developing cardiovascular disease,[12] which has become a major cause of mortality in the SCI population.[13-18]

Although elevated CRP levels have previously been described in chronic SCI,[19-22] to date, there has been a limited description of clinical factors that contribute. Slowly healing pressure ulcers in 34 men with SCI,[9] urinary tract infections in 37 men,[10] tetraplegia compared to paraplegia in 69 men and women,[23] and greater fat mass and body mass index (BMI) in 77 men and women have been associated with elevated CRP levels.[24] In a previous report in 63 individuals, we found that mobility mode, a greater BMI, heart disease, and a pressure ulcer reported in the past year, were each associated with higher circulating CRP.[25] A limitation of these previous reports, however, is a reduced ability to assess multiple covariates due to small sample sizes. The objective of this report is to assess the robustness of our previous findings in a new chronic SCI cohort with more than five times as many participants, as well as to assess the impact of additional factors, including fat mass assessed by dual x-ray absorptiometry (DXA) on levels of CRP.

Methods

Subjects

Between 8/2009 and 4/2015 we recruited 360 individuals into a study of respiratory health among individuals with chronic SCI. Participants were recruited from patients receiving care at VA Boston, from the greater Boston area through advertisement, and by direct mail to persons who had received care at Spaulding Rehabilitation Hospital, Boston University Medical Center, were members of the National Spinal Cord Injury Association, or were subscribers to New Mobility Magazine. Individuals were eligible if they were 22 years of age or older, were 1 or more years post-injury, had no other neuromuscular disease, did not have a tracheostomy, and were able to breathe without chronic ventilatory support. Participants were eligible regardless of etiology of SCI and testing was scheduled when subjects were free of acute illness. The Institutional Review Board at VA Boston Healthcare System approved the protocol and informed consent was obtained. We certify that all applicable institutional and governmental regulations concerning the ethical use of human volunteers were followed during the course of this research.

Neurological exam, stature, and weight

SCI level and severity was assessed by exam and medical record review.[26] Motor incomplete SCI included AIS C (most key muscles below the neurological level grade < 3/5) or AIS D (most muscles below the neurological level grade ≥ 3/5). For analysis, participants were further grouped into cervical motor complete (AIS A or B) and cervical AIS C, high thoracic (T1-T6) complete (AIS A or B) and AIS C, others with T7 or below motor complete (AIS A or B) or AIS C, and all others (AIS D's). Height was obtained by measuring the body length from top of the head to the heel of the subject in a supine position. Supine length was measured in 307 (91%) and obtained by self-report in 31 (9%) when contractures precluded accurate measurement. If required, wheelchairs were weighed with and without the participant, and wheelchair weight subtracted. In 5 persons, self-report of weight was used. BMI (kg/m^2) was calculated from height and weight.

Dual x-ray absorptiometry (DXA) for % body fat

A 5^{th} generation GE Healthcare iDXA scanner was used to assess % total body, % trunk, % android, and % gynoid fat using GE Lunar software analyzed by a certified clinical densitometrist (AAL). Daily quality assurance was performed utilizing a phantom. The trunk region was defined by cuts passing through the shoulders and extended inferiorly as close to the body as possible through the femoral necks. The lower boundary of the android region was a horizontal cut at the level of the iliac crests and the upper boundary extended upwards to 20% of the distance between the pelvis and shoulders. For the gynoid region, the upper boundary was the iliac crests and the lower boundary included the pelvis and extended downward 1.5 times the height of the android region.

Health Questionnaire

A questionnaire based on American Thoracic Society Division of Lung Diseases ATS DLD-78[27] was used to obtain a history of cigarette smoking, comorbid medical diseases, and statin use. Hypertension, diabetes, and asthma were defined based on report of a diagnosis by a doctor, and chronic obstructive pulmonary disease (COPD) was defined as either doctor-diagnosed emphysema or chronic bronchitis. Heart disease was defined as treatment for "heart trouble" reported in the 10 years prior to study entry. Participants were asked to report if a chest illness kept them off work, indoors at home, or in bed in the previous one and three years, if they had had a respiratory illness in the past week, if they currently had a urinary tract infection (UTI) or a skin ulcer, or if they had experienced either in the past one and three years, how they usually passed urine, and if they received regular dental care. Usual mobility mode (more than 50% of the time) was ascertained in four categories: motorized wheelchair use, hand-propelled wheelchair use, walk with aid such as crutch or cane, or walk without assistance.

Biochemical Analyses

Plasma samples were drawn into an EDTA tube and immediately delivered to a core blood research laboratory. The samples were centrifuged for 15 min at 2600 rpm (1459 x g) at 4°C and stored at -80°C until batch analysis. High sensitivity CRP concentrations using an immunoturbidimetric assay were determined at the Clinical & Epidemiologic Research

Laboratory, Department of Laboratory Medicine at Children's Hospital in Boston. This assay has a sensitivity of 0.03 mg/L. The day-to-day variability of the assay at concentrations of 0.91, 3.07, and 13.38 mg/L are 2.81, 1.61, and 1.1%, respectively.

Statistical Analysis

We excluded persons without a detectable SCI level (n=3), history of stroke (n=2), incomplete data collection (n=6), inability to obtain blood (n=6), incomplete data on body composition (n=4), or without CRP results (n=1), leaving a sample size of 338 participants. There were 26 subjects who participated in our previous study (2004-2005)[25] who were retested. Natural log-transformation of CRP was used to meet modeling assumptions. General linear models (PROC GLM, SAS version 9.4) were used to assess determinants of natural log CRP. A Tukey adjustment was used for multiple comparisons. Trends across %-fat and BMI quartiles were assessed using the median values and trends for mobility and SCI categories assessed by assigning ordinal numbers. Variables significant in univariable models at the 0.10 level or less were included in multivariate models. We *a priori* assessed characteristics associated with infection (i.e., ulcer history) and considered effects of comorbid diseases as potential confounders.

Results

Participant Characteristics

Participant characteristics are presented in Table 1 overall and by primary mobility mode. The mean ± standard deviation age and injury duration were 54.1±14.4 years and 17.3±13.3 years, respectively (Table 1). The majority of participants were male (82%) and white (86%). When screened by questionnaire at the time of testing, a mild cold or other respiratory illness was reported by 26 persons (7.7%) in the past week. A history of skin ulcers, urinary tract infections, and catheter use were more common among motorized and hand-propelled wheelchair users. There were 83 people (25%) with CRP levels <1 mg/L (defined as low cardiovascular risk),[11] 105 (31%) with CRP levels of 1-3mg/L, and 150 (44%) with CRP levels of >3 mg/L). There were 54 (16%) with very high CRP levels (>10mg/L). The distribution of natural log CRP was normally distributed (Shapiro-Wilks test W=0.996, p=0.640) and there was no evidence of outliers.

Univariable associations

In univariable models, age, sex, injury duration, smoking status and pack-years of smoking, sex, statin use, dental care, and comorbidities were not associated with CRP (Table 2). Both mobility mode and level and completeness of SCI were statistically significantly associated with CRP, with the highest CRP levels observed among motorized wheelchair users and among cervical motor complete and AIS C SCI with a significant linear trend across mobility and SCI level and completeness categories (Table 2). Persons who reported a current skin ulcer or a UTI or reported either in the past one and three years had higher CRP levels compared to persons without these conditions. Persons who used a condom catheter, a chronic indwelling catheter, or used periodic catheterization had CRP values that were not statistically significantly different from one another (p=0.551-0.999), but each was statistically significantly different from participants who did not use a catheter. Therefore,

catheter use was considered as a dichotomous variable. Catheter use was strongly assocciated with report of a current UTI as 21 out of the 25 persons with a current UTI used a catheter. Persons who reported a respiratory illness (4.10; 95%CI: 2.28, 5.01mg/L) in the past week had greater CRP values compared to persons without an illness (2.54; 95%CI: 2.14, 2.97 mg/L, p=0.096). Participants who were self-identified as being white had lower CRP values compared to non-white participants (p=0.038). Each measure of adiposity was also statistically significantly positively associated with CRP, with a significant trend across quartiles (Table 3).

Multivariable associations

Due to the high level of collinearity between the DXA-derived measures of adiposity (Pearson r=0.705-0.979, p<0.0001) and a significant correlation between these measures with BMI (r=0.393-0.689, p<0.0001), we created five multivariable models including each adiposity measure separately with other predictors (Table 4). Each adiposity measure (including BMI) were statistically significantly associated with CRP levels in multivariate models (p<0.001). There was a significant positive linear trend across adiposity measure quartiles (not shown), so the continuous measures were used in the final models. Urinary catheter use also remained statistically significantly associated with CRP (p=0.002-0.013), with a better model fit than either current UTI or UTI in the previous year. Participants with a respiratory illness in the week before testing (usually a mild cold) had significantly greater CRP levels (p=0.005-0.015), as did those who identified as non-white (p=0.001-0.041). In each model (Table 4), participants who reported a current ulcer had a higher CRP compared to persons without an ulcer that was not statistically significant (p=0.096-0.173). Associations with an ulcer reported in the past year (p=0.254-0.450) were weaker and not significant.

In four multivariable models (Table 4), there was a significant linear trend across mobility categories with CRP (p<0.001-0.018), and a suggestive relationship in an additional model (p=0.069). When included in these models SCI level and completeness was not a statistically significant predictor of CRP (p=0.554-0.974).

Effect of chronic disease

In order to account for effects of comorbid diseases on CRP as potential confounders, we individually added heart disease, diabetes, hypertension, COPD, asthma, and any obstructive lung disease (asthma or COPD) into the final multivariable models. The effects of measures of adiposity, urinary catheter, respiratory illness in the past week, current skin ulcer, race, and mobility mode did not meaningfully change (data not shown). Heart disease was significantly associated with a greater CRP (p=0.021-0.039) in all models as was hypertension in the model that included gynoid fat (p=0.015). Hypertension in other models (p=0.100-0.157), diabetes (p=0.198-0.770), COPD (p=0.786-0.976), asthma (p=0.163-0.372), and any obstructive lung disease (asthma or COPD) (p=0.305-0.440) were not significantly associated with CRP.

Discussion

In this cross-sectional study in a cohort of individuals with chronic SCI, we found that measures of adiposity (BMI, % total body fat, % trunk fat, % android fat, and % gynoid fat), mobility mode, catheter use, race, and respiratory illness in the past week were all independently associated with circulating levels of CRP. There was a strong linear association found between SCI level and CRP in univariable models ($p<.0001$) that was not evident after adjustment for mobility mode. We previously reported similar results in a smaller study (n=63) in our earlier chronic SCI cohort, indicating that these findings are reproducible in the SCI population.[25] The effects of clinical factors identified in multivariable models were not affected after adjustment for comorbidities that included heart disease, hypertension, diabetes, COPD, and asthma. Although heart disease history was significantly associated with a higher CRP value in multivariate models, it did not confound the relationship between the clinical factors included in the multivariable models and CRP.

Pressure ulcers and UTI's have been previously associated with an elevated CRP levels.[9-10] The participants in this cohort were tested when they were feeling well and were able to sit upright for study-related procedures. This likely explains why relatively few persons reported a current skin ulcer (11.2%), and its weak association with CRP in the multivariate models. Considerably more persons (25.2%) reported a skin ulcer in the past year. Similarly, few persons in our cohort reported a current UTI (7.4%), but many reported having a UTI in the past year (40.2%). Both chronic, intermittent, and condom catheter use are known correlates of chronic bacteriuria and pyuria[28] which is most likely responsible for the higher CRP values associated with catheter use.

We directly assessed percent fat in the android, gynoid, and trunk regions as well as total body fat by DXA scan. In SCI, due to a decrease in lean mass and increase in increase in fat mass and in central (truncal) fat,[6-7,29] BMI may not accurately assess adiposity.[30] However, we found similar effects of BMI and other measures of adiposity on CRP levels in multivariate models, most likely attributable to the high degree of correlation between the fat measures.

Our findings support the hypothesis that physiologic changes that occur following SCI attributable to decreased mobility, bladder dysfunction, and skin ulcers contribute to CRP and systemic inflammation, and therefore, potentially future risk of cardiovascular disease. Many studies in persons without SCI have found higher levels of CRP to be an associated with lower levels of physical activity.[1-3,31] Evidence that chronic or recurrent infection may be associated with cardiovascular disease comes from positive associations between periodontal disease and carotid intima-media thickness,[32] and the timing of a myocardial infarction and a preceding systemic respiratory tract[33] or urinary tract infection[34] in persons without chronic SCI.

A considerable stength of this study is the use of a comprehensive standardized approach allowing the consideration of multiple factors potentially associated with CRP in a large chronic SCI cohort. Limitations includes reliance on self report of current ulcer, UTI and of chronic medical conditions. However, we have previously validated the use of self-report of

chronic medical conditions in this population.[14] Misclassification would make it more difficult to detect the true associations with CRP.

Our study findings support the importance of studying modifiable factors in chronic SCI that can impact on health. A longitudinal study is needed to assess relationship between factors identified, chronic elevations in CRP, and subsquent effects on cardiovacular health. Addressing modifiable factors related to obesity, reduced physical actvity, and recurrent infection could potentially help in lowering the risk of cardiovascular disease among those with chronic SCI.

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TABLE 1

Locomotive Mode and Participant Characteristics (N=338)

Characteristics	Motorized wheelchair (n= 64)	Hand propelled wheelchair (n=150)	Walks with an aid (n=57)	Walks without assistance (n=67)	Total (n=338)
CRP (mg/L) [median, 25%ile, 75%ile]	4.57 (2.71, 11.47)	2.55 (1.15, 7.18)	1.70 (0.85, 6.67)	1.42 (0.51, 2.91)	2.54 (1.04, 7.09)
Age (yrs) [mean, SD]	53.3±14.7	49.0±13.3	62.7±13.1	58.9±12.6	54.1±14.4
Injury Duration (yrs) [mean, SD]	17.2±15.2	17.7±12.0	18.7±15.3	15.5±12.3	17.3±13.3
BMI (kg/m^2) [mean, SD]	27.5±6.3	26.2±6.1	29.8±5.4	27.5±6.0	27.3±6.1
Percent fat [mean, SD]					
Android region, % fat	44.6±11.0	42.6±13.0	43.5±11.0	38.4±13.7	42.3±12.6
Gynoid region, % fat	44.6±8.8	41.8±9.5	37.8±9.3	33.8±8.7	40.1±9.9
Trunk region, % fat	42.6±9.4	39.9±11.4	39.9±9.6	35.1±11.7	39.4±11.0
Total body, % fat	40.5±7.5	36.8±9.0	35.9±8.1	31.6±8.6	36.3±8.9
Race	**[n, %]**	**[n, %]**	**[n, %]**	**[n, %]**	**[n, %]**
White	56 (87.5)	132 (88.0)	47 (82.5)	57 (85.1)	292 (86.4)
Black	7 (10.9)	9 (6.0)	8 (14.0)	5 (7.5)	29 (8.6)
Other	1 (1.6)	9 (6.0)	2 (3.5)	5 (7.5)	17 (5.0)
Sex					
Female	17 (26.6)	24 (16.0)	8 (14.0)	11 (16.4)	60 (17.8)
Male	47 (73.4)	126 (84.0)	49 (86.0)	56 (83.6)	278 (82.3)
SCI Classification					
Motor complete cervical & AIS C	43 (67.2)	36 (24.0)	1 (1.8)	0 (0.0)	80 (23.7)
Motor complete high thoracic * & AIS C	8 (12.5)	38 (25.3)	0 (0.0)	0 (0.0)	46 (13.6)
Other motor complete & AIS C	4 (6.3)	58 (38.7)	5 (8.8)	1 (1.5)	68 (20.1)
All AIS D	9 (14.1)	18 (12.0)	51 (89.5)	66 (98.5)	144 (42.6)
BMI (kg/m^2)					
Normal (<25)	20 (31.3)	68 (45.3)	13 (22.8)	23 (34.3)	124 (36.7)
Overweight (25 ≤ bmi < 30)	21 (32.8)	47 (31.3)	20 (35.1)	25 (37.3)	113 (33.4)
Obese (≥ 30)	23 (35.9)	35 (23.3)	24 (42.1)	19 (28.4)	101 (29.9)
Skin Ulcers					
Now	15 (23.4)	21 (14.0)	2 (3.5)	0 (0.0)	38 (11.2)

Characteristics	Motorized wheelchair (n= 64)	Hand propelled wheelchair (n=150)	Walks with an aid (n=57)	Walks without assistance (n=67)	Total (n=338)
In the past year	31 (48.4)	49 (32.7)	3 (5.3)	2 (3.0)	85 (25.2)
In the past 3 years	36 (56.3)	64 (42.7)	6 (10.5)	2 (3.0)	108 (32.0)
Urinary Tract Infections					
Now	10 (15.6)	13 (8.7)	1 (1.8)	1 (1.5)	25 (7.4)
In the past year	45 (70.3)	100 (66.7)	12 (21.1)	6 (9.0)	163 (48.2)
In the past 3 years	56 (87.5)	105 (70.0)	20 (35.1)	18 (26.9)	199 (58.9)
Use of urinary catheter					
No catheter use	11 (17.2)	31 (20.7)	44 (77.2)	61 (91.0)	147 (43.5)
Yes catheter use	53 (82.8)	119 (79.3)	13 (22.8)	6 (9.0)	191 (56.5)
Periodic catheterization	15 (23.4)	79 (52.7)	10 (17.5)	5 (7.5)	109 (32.3)
Chronic catheter	33 (51.6)	17 (11.3)	1 (1.8)	1 (1.5)	52 (15.4)
Condom catheter	5 (7.8)	23 (15.3)	2 (3.5)	0 (0.0)	30 (8.9)
Statin use	14 (21.9)	39 (26.0)	24 (42.1)	31 (46.3)	108 (32.0)
Heart disease	5 (7.8)	9 (6.0)	21 (36.8)	4 (6.0)	39 (11.5)
Hypertension	14 (21.9)	43 (28.7)	36 (63.2)	31 (46.3)	124 (36.7)
Diabetes	6 (9.4)	17 (11.3)	15 (26.3)	12 (17.9)	50 (14.8)
Regular dental care	40 (62.5)	98 (65.3)	32 (56.1)	35 (52.2)	205 (60.7)
Chest illness in past year	11 (17.2)	15 (10.0)	6 (10.5)	9 (13.4)	41(12.1)
Chest illness in past 3 years (n=337)	22 (34.4)	32 (21.3)	12 (21.4)	16 (23.9)	82 (24.3)
Respiratory illness in past 1 week (n=336)					
No respiratory illness	63 (100.0)	137 (92.0)	51 (89.5)	59 (88.1)	310 (92.3)
Mild cold ** or other respiratory illness	0 (0.0)	12 (8.0)	6 (10.5)	8 (11.9)	26 (7.7)
COPD	5 (7.8)	10 (6.7)	8 (14.0)	11 (16.4)	34 (10.1)
Asthma	10 (15.6)	14 (9.3)	10 (17.5)	11 (16.4)	45 (13.3)
COPD or asthma	14 (21.9)	22 (14.7)	16 (28.1)	19 (28.4)	71 (21.0)
Cigarette Use					
Current	11 (17.2)	22 (14.7)	11 (19.3)	15 (22.4)	59 (17.5)
Former	24 (37.5)	52 (34.7)	31 (54.4)	34 (50.8)	141 (41.7)
Pack years (n=200 ever smokers) [median, 25%ile,75%ile]	20 (9.0, 38.0)	12.8 (3.5, 26.0)	25 (11.0, 39.0)	26.5 (9.2, 45.0)	18.3 (5.1, 38.0)
Never	29 (45.3)	76 (50.7)	15 (26.3)	18 (26.9)	138 (40.8)

Characteristics	Motorized wheelchair (n= 64)	Hand propelled wheelchair (n=150)	Walks with an aid (n=57)	Walks without assistance (n=67)	Total (n=338)
	0 (0.0)	7 (4.7)	5 (8.8)	4 (6.0)	16 (4.8)

*high thoracic= T1- T6

**Mild cold

TABLE 2

Univariable associations with ln CRP (mg/L; N=338)

Clinical factors, continuous covariates	**$e^{(\beta)}$**	**$e^{(95\%\ CI)}$**	**p-value**
Age (yrs)	1.00	0.99, 1.01	0.960
Injury Duration (yrs)	1.00	0.99, 1.01	0.689
Pack Years	1.00	1.00, 1.01	0.165
Clinical factors, categorical covariates	$e^{(\ln \text{mean CRP})}$	$e^{(95\%\ CI)}$	p
Sex			0.374
Female	2.27	1.59, 3.25	
Male	2.71	2.30, 3.20	
Race			0.038
White	2.47	2.10, 2.90	
Non-white	3.92	2.61, 5.89	
SCI Classification			p-trend<0.001
Motor complete cervical & AIS C	4.02	2.97, 5.43	
Motor complete high thoracic * & AIS C	3.57	2.40, 5.31	
Other motor complete & AIS C	3.00	2.16, 4.16	
All AIS D	1.77	1.41, 2.21	
Mobility mode			p-trend<0.001
Motorized wheelchair	5.53	3.98, 7.68	
Hand propelled wheelchair	2.79	2.25, 3.45	
Walk with aid	2.22	1.56, 3.14	
Walk without assistance	1.31	0.95, 1.81	
Skin Ulcers			
Now	2.40	2.05, 2.81	<0.001
None now	5.38	3.45, 8.37	
In the past year	4.03	2.99, 5.41	0.001
None in the past year	2.28	1.92, 2.71	
In the past 3 years	3.85	2.96, 5.01	0.001
None in the past 3 years	2.28	1.84, 2.63	
Uses urinary catheter			
Yes	3.67	3.02, 4.45	<0.001 **
Periodic catheterization	3.36	2.60, 4.34	
Chronic catheter	4.55	3.14, 6.59	
Condom catheter	3.48	2.14, 5.67	
No	1.70	3.02, 4.45	
Urinary Tract Infections (UTIs)			
Now	4.94	2.85, 8.56	0.020
None now	2.50	2.14, 2.92	
In the past year	3.61	2.86, 4.56	<0.001
None in the past year	2.12	1.75, 2.57	

Clinical factors, continuous covariates	$e^{(\beta)}$	$e^{(95\% CI)}$	p-value
In the past 3 years	2.93	2.41, 3.56	0.094
None in the past 3 years	2.26	1.78, 2.85	
Current statin use			0.166
Yes	2.25	1.73, 2.94	
No	2.83	2.36, 3.39	
Regular dental care			0.894
Yes	2.61	2.09, 3.39	
No	2.66	2.15, 3.17	
Chest illness in the past year			0.807
Yes	2.50	1.62, 3.85	
No	2.65	2.25, 3.11	
Chest illness in the past 3 years (n=337)			0.184
Yes	3.14	2.31, 4.26	
No	2.47	2.08, 2.94	
Respiratory illness in the past week (n=336)			0.096
Yes	4.10	2.28, 5.01	
No	2.54	2.14, 2.97	
Heart disease			0.325
Yes	3.24	2.08, 5.05	
No	2.56	2.18, 3.00	
COPD			0.351
Yes	2.12	1.32, 3.41	
No	2.69	2.30, 3.16	
Ashma			0.958
Yes	2.60	1.72, 3.93	
No	2.63	2.24, 3.10	
Doctor diagnosed COPD or asthma			0.417
Yes	2.33	1.68, 3.24	
No	2.71	2.29, 3.22	
Diabetes			0.518
Yes	2.96	2.00, 4.38	
No	2.58	2.19, 3.03	
Hypertension			0.378
Yes	2.87	2.24, 3.69	
No	2.50	2.07, 3.02	
Smoking Status			0.751
Current	2.95	2.06, 4.24	
Former	2.63	2.08, 3.33	
Never	2.50	1.97, 3.17	

*high thoracic=T1-T6

**Catheter/no catheter

TABLE 3

Associations between measures of body fat and natural log CRP (mg/L; N=338)

	BMI (kg/m^2)			DXA - Total body % fat			DXA - Trunk % fat			DXA - Android % fat			DXA - Gynoid % fat		
Fat predictor	**$e^{(\beta*IQR)}$**	**$e^{(95\% CI*IQR)}$**	**p-value**	**$e^{(\beta*IQR)}$**	**$e^{(95\% CI*IQR)}$**	**p-value**	**$e^{(\beta*IQR)}$**	**$e^{(95\% CI*IQR)}$**	**p-value**	**$e^{(\beta*IQR)}$**	**$e^{(95\% CI*IQR)}$**	**p-value**	**$e^{(\beta*IQR)}$**	**$e^{(95\% CI*IQR)}$**	**p-value**
	1.80	**1.48, 2.19**	**<0.001**	**2.28**	**1.90, 2.73**	**<0.001**	**2.16**	**1.82, 2.57**	**<0.001**	**2.15**	**1.78, 2.59**	**<0.001**	**1.93**	**1.58, 2.36**	**<0.001**
Quartiles	**$e^{(\ln \text{mean CRP})}$**	**$e^{(95\% CI)}$**	**p-value**	**$e^{(\ln \text{mean CRP})}$**	**$e^{(95\% CI)}$**	**p-value**	**$e^{(\ln \text{mean CRP})}$**	**$e^{(95\% CI)}$**	**p-value**	**$e^{(\ln \text{mean CRP})}$**	**$e^{(95\% CI)}$**	**p-value**	**$e^{(\ln \text{mean CRP})}$**	**$e^{(95\% CI)}$**	**p-value**
Quartile 1 (lowest)	1.56	1.16, 2.09	p-trend<0.001	1.12	0.85, 1.46	p-trend<0.001	1.12	0.86, 1.46	p-trend<0.001	1.23	0.94, 1.62	p-trend<0.001	1.32	1.00, 1.75	p-trend<0.001
Quartile 2	2.11	1.58, 2.81		2.15	1.63, 2.83		2.15	1.65, 2.81		1.92	1.46, 2.53		2.29	1.70, 3.10	
Quartile 3	3.39	2.53, 4.55		3.58	2.73, 4.71		3.27	2.49, 4.29		3.48	2.64, 4.60		3.97	2.99, 5.27	
Quartile 4 (highest)	4.33	3.24, 5.79		5.74	4.36, 7.56		6.56	4.98, 8.64		5.82	4.43, 7.66		3.93	2.97, 5.21	
Quartile 1	< 22.8			≤ 31			≤ 33			≤ 35			≤ 33		
Quartile 2	22.8 ≤ × < 27.0			31 < × ≤ 37			343< × ≤ 41			35 < × ≤ 45			33 < × ≤ 41		
Quartile 3	27.0 ≤ × < 31.2			37 < × ≤ 43			41 < × ≤ 47			45 < × ≤ 52			41 < × ≤ 47		
Quartile 4	≥ 31.2			> 43			> 47			> 52			> 47		

TABLE 4

Multivariable associations with natural log CRP (mg/L; N=336)

	BMI (kg/m^2)			DXA - Total body % fat			DXA - Trunk % fat			DXA - Android % fat			DXA - Gynoid % fat		
Fat measures	**$e^{(\beta*IQR)}$**	**$e^{(95\% CI*IQR)}$**	**p-value**	**$e^{(\beta*IQR)}$**	**$e^{(95\% CI*IQR)}$**	**p-value**	**$e^{(\beta*IQR)}$**	**$e^{(95\% CI*IQR)}$**	**p-value**	**$e^{(\beta*IQR)}$**	**$e^{(95\% CI*IQR)}$**	**p-value**	**$e^{(\beta*IQR)}$**	**$e^{(95\% CI*IQR)}$**	**p-value**
	1.84	**1.53, 2.21**	**<0.001**	**2.06**	**1.71, 2.47**	**<0.001**	**1.99**	**1.68, 2.35**	**<0.001**	**1.98**	**1.66, 2.37**	**<0.001**	**1.66**	**1.35, 2.05**	**<0.001**
Other clinical factors	**$e^{(ln\ mean\ CRP)}$**	**$e^{(95\% CI)}$**	**p-value**	**$e^{(ln\ mean\ CRP)}$**	**$e^{(95\% CI)}$**	**p-value**	**$e^{(ln\ mean\ CRP)}$**	**$e^{(95\% CI)}$**	**p-value**	**$e^{(ln\ mean\ CRP)}$**	**$e^{(95\% CI)}$**	**p-value**	**$e^{(ln\ mean\ CRP)}$**	**$e^{(95\% CI)}$**	**p-value**
Ulcer(s) now	5.35	3.33, 8.59	0.096	5.64	3.55, 8.94	0.167	5.51	3.49, 8.72	0.154	5.41	3.41, 8.60	0.173	5.98	3.68, 9.71	0.130
No ulcer(s) now	3.70	2.76, 4.96		4.18	3.14, 5.56		4.06	3.06, 5.39		4.02	3.02, 5.36		4.23	3.13, 5.72	
Urinary catheter	5.62	3.86, 8.18	0.009	6.30	4.37, 9.08	0.003	6.18	4.30, 8.88	0.002	6.07	4.21, 8.75	0.003	6.33	4.31, 9.29	0.013
No urinary catheter	3.52	2.43, 5.09		3.73	2.61, 5.35		3.62	2.53, 5.18		3.59	2.50, 5.15		4.00	2.74, 5.84	
Respiratory illness in the past 1 week	6.13	3.63, 10.35	0.012	6.69	4.02, 11.14	0.010	6.40	3.86, 10.62	0.015	6.39	3.83, 10.66	0.012	7.26	4.25, 12.42	0.005
No respiratory illness in the past 1 week	3.22	2.49, 4.17		3.52	2.74, 4.53		3.50	2.73, 4.49		3.41	2.65, 4.38		3.48	2.67, 4.54	
White	3.63	2.64, 4.99	0.041	3.56	2.61, 4.85	0.001	3.51	2.58, 4.78	0.002	3.55	2.60, 4.85	0.005	3.87	2.79, 5.35	0.010
Non-white	5.45	3.52, 8.43		6.62	4.33, 10.12		6.37	4.18, 9.71		6.12	4.00, 9.37		6.55	4.19, 10.23	
Mobility mode			p-trend<0.001			p-trend=0.069			p-trend=0.013			p-trend=0.003			p-trend=0.018
Motorized wheelchair	8.36	5.37, 12.99		6.83	4.41, 10.57		7.31	4.75, 11.24		7.74	5.01, 11.93		7.80	4.94, 12.31	
Hand propelled wheelchair	4.61	3.20, 6.63		4.31	3.02, 6.15		4.22	2.97, 6.01		4.22	2.95, 6.03		4.33	2.98, 6.29	
Walk with aid	3.66	2.32, 5.75		4.73	3.06, 7.33		4.44	2.88, 6.84		4.27	2.76, 6.62		5.06	3.20, 8.02	
Walk without assistance	2.78	1.77, 4.35		3.98	2.56, 6.20		3.66	2.36, 5.66		3.40	2.19, 5.28		3.75	2.35, 5.99	