Research Article

Impact of Obesity on Mechanical and Inflammatory Neck Pain in Young Adult Males, Non- Pregnant Women and Pregnant Women

Ashraf E. Amer*, M.D, Taghrid M. Abdelwahab*, M.D, Hany M. Ali*,M.D, Alsaeed E. Askar, M.D, Hossam I. Abdelhamid***, M.D, and Abdullah M. Gaafar****, M.D**

* Department of Rheumatology and rehabilitation, Alazhar University, Cairo, Egypt
** Department of Gynecology and obstetrics, Alazhar University, Cairo, Egypt
*** Department of Radiology, Alazhar University, Cairo, Egypt
****Department of Clinical pathology, Alazhar University, Cairo, Egypt

Abstract

Background; Obesity and musculoskeletal pain have significant correlation, but there is paucity of studies assessing the correlation of neck pain with obesity, in reference to gender or pregnancy. **Aim of the study;** The aim of this was to assess the impact of obesity on mechanical and inflammatory neck pain in young adult males, non- pregnant and pregnant females. **Methods;** Sixty patients, ages (twenty- thirty) with disease duration of three- six years complaining of mechanical and inflammatory neck pain. Thirty patients are obese and the other thirty patients are non- obese were recruited in the study. They were divided into four equal groups and subjected for measurement of CRP, leptin and cervical MRI. Patients with previous history of trauma or neck surgery were excluded from the study. **Results;** The demographic data, clinical, laboratory and treatment characteristics of our study groups were presented in Table 1. The average age in group I to IV was 30.60±3.20, 30.46±2.94, 30.80±3.46 and 30.60±3.66 years respectively, where age was not found to affect either the occurrence of obesity or neck pain in both the obese or non- obese individuals. As regards of the weight, BMI, and waist circumference obesity was found to be of high significance with the occurrence of neck pain; either the mechanical or the inflammatory ($P \leq 0.001$) when compared to the non-obese, whereas obesity has no significant effect on both types of neck pain ($P > 0.05$). Pain was found to be significantly correlated to obesity in mechanical neck pain but not in inflammatory type ($P < 0.05$). CRP was significantly high in all groups ($P \leq 0.001$). Leptin was significantly correlated to neck pain in the non-obese individuals ($P < 0.05$). The positive MRI findings were significantly correlated to obesity in the inflammatory neck pain ($P < 0.05$). **Conclusion;** Based on our results, we concluded that there is a positive relationship between obesity and neck pain when compared to the non-obese. However, gender or pregnancy was found not to affect the occurrence of obesity or neck pain, yet the pain was aggravated in obese as compared to non-obese, females compared to males and pregnant to non-pregnant.

Keywords; Obesity, BMI, Mechanical, Inflammatory, Neck Pain, gender, pregnancy, leptin, CRP, Seronegative spndyloarthropathy, Ankylosing spondylitis, reactive arthritis neck pain."

Introduction

Obesity is defined as body mass index (BMI) over 30 kg/m^2.[1] Its prevalence is increasing rapidly in both Western and the developing countries, where it is assumed that the global obesity prevalence to reach up to 18% in men and 21% in women by 2025.[2] Obesity is considered a chronic relapsing and progressive disease and a leading risk factor for global deaths.[3] The associated musculoskeletal disorders as low back pain, osteoarthritis, and neck pain due to obesity are caused due to the mechanical overload caused by obesity and the resultant degeneration and inflammation of the musculoskeletal system. [4] According to the Global Burden of Disease 2010 Study, neck pain is the fourth leading cause of disability, with an annual prevalence rate exceeding 30%. The prevalence of neck pain is higher in females and peaks in middle age. Most episodes

of acute neck pain resolve whether the patient received treatment or not. History and physical examination can provide important clues as to whether the neck pain is neuropathic due to inflammation or mechanical.[5] The types of neck pain can be categorized according to the duration into acute <6 weeks; subacute, ≤3 months; and chronic, >3 months), the severity, etiology/structure, and type (ie, mechanical vs neuropathic), where duration is the best predictor of outcome. For a variety of different treatments, shorter duration has been found to be associated with a better prognosis than long-standing pain.[6]. Obese individuals may be predisposed to neck pain due to increase the systemic inflammation, deleterious structural changes, increased mechanical stress and ground reaction force, diminished muscle strength, more psychosocial issues, and greater disability related to kinesiophobia compared with non-obese individuals. [7]

Aim of the study

- Study the effects of obesity on patients complaining of mechanical and inflammatory neck pain in obese young adult males, non-pregnant, and pregnant women.
- To assess the relationships and roles of serum levels of CRP and leptin versus the clinical and radiological evaluation in all group patients.
- To compare the clinical, radiological, laboratory assessment of all group patients included in our study.

Subjects and methods

- **Study Subjects:**

The patients were recruited from the Department of Rheumatology, Obesity, Gynecology and Obstetrics, in corporation with Radiology and Clinical pathology department, inpatients and outpatients' clinics at Altharir medical Hospital, Doha, Qatar. The work started since January 2015 until January 2020. The research involved sixty patients, ages (20-30) with disease duration of 3-6 years complaining of mechanical and inflammatory neck pain. Thirty patients are obese and the other thirty patients are non- obese. Where, obesity is defined as BMI >30 kg./cm^2 and waist circumference for females > 88cm., for males >102 which is measured by positioning the measuring tape midway between the top of the hip bone and bottom of the rib cage. All patients were divided into four groups.

I) Group I: Consists of fifteen obese patients with mechanical neck pain. This group was divided into three subgroups.

- **Group I a:** Consists of five obese male patients with mechanical neck pain presented with three cases of degenerative spondolytic changes and two cases of cervical disc herniation.
- **Group I b:** Five obese non- pregnant women with regular menstrual cycle complaining of mechanical neck pain, three degenerative spondolytic cases, and two discs' herniation cases.
- **Group I c:** Five obese pregnant females with mechanical neck pain, two discs' herniation cases and three degenerative spondolytic changes of the cervical cases.

II) Group II: Consists of fifteen obese patients complaining of inflammatory neck pain. This group was divided into three subgroups.

- **Group II a:** Five obese male patients with inflammatory neck pain, two of them diagnosed with psoriatic arthritis and the three others were diagnosed with ankylosing spondylitis.
- **Group II b:** Five obese non- pregnant women with regular menstrual cycle complaining of inflammatory neck pain, three of them diagnosed with psoriatic arthritis and the other two cases were diagnosed with reactive arthritis.
- **Group II c:** Five pregnant women with inflammatory neck pain, three of them were diagnosed with psoriatic arthritis and the other two with inflammatory bowel disease.

III) Group III: Consists of fifteen non obese patients complaining of mechanical neck pain, divided into three subgroups.

- **Group III a:** Five non obese males complaining of mechanical neck pain, three with degenerative cases and the other two with disc herniation diseases.
- **Group III b:** Non obese non- pregnant females with regular menstrual cycle complaining of mechanical neck pain, three with degenerative spondylotic cases and the other two cases with disc herniation.
- **Group III c:** Five non obese pregnant women with mechanical neck pain, three

with degenerative cases and the other two with disc herniation diseases.

IV) **Group IV:** Consists of fifteen non obese patients complaining of inflammatory neck, divided into three subgroups.

- **Group IV a:** Five non obese male patients with inflammatory neck pain, three ankylosing spondylitis and the other two with psoriatic arthritis disease.
- **Group IV b:** Five non obese non-pregnant females with regular menstrual cycle complaining of inflammatory neck pain, three of them with psoriatic arthritis and the other two with reactive arthritis.
- **Group IV c:** Non obese pregnant women with inflammatory neck pain, three of them were diagnosed with psoriatic arthritis, and the other two patients with inflammatory bowel disease.

Patients with previous history of trauma or neck surgery were excluded from the study.

Study Methodology:

All patient groups were subjected to complete history, full accurate clinical examination, and accurate diagnosis of mechanical and inflammatory neck pain according to rheumatological criteria of diagnosis of seronegative spondyloarthropathy and mechanical degenerative and disc herniation disorders that were chosen for our study. Informed consent was obtained from all the patients recruited into the study.

The approval of the study was obtained from Tahrir Medical Hospital (Research Ethics Committee (REC) and Institutional Research Board (IRB) MS/17.08.69). The patients were subjected to pain assessment scales for determining the severity and quality of pain using Wong Baker facial grimace (0-10) numeric pain rating scale.

After an overnight fast, blood samples were obtained and poured into plain tubes and allowed to clot at room temperature. The serum for leptin was separated 20 minutes after collection by centrifugation at a speed of 2000-3000 G for 10minutes. Serum samples were aliquoted and frozen at -20 C for analysis later on. The quantitative determination of serum leptin was conducted by Sandwich Enzyme-Linked Immunosorbent Assay (ELISA) technique.

Using commercially available reagent kit DRG® Leptin (Sandwich) ELISA (EIA-2395) by RUO, Germany. Serum leptin level reference range for adult women (4.48- 11 mcg/ L), adult men (0.51- 1.22 mcg/ L) using human leptin enzyme immunoassay kit sandwich. CRP reference range is up 6 mg/ ml using MISPA-i2. All patients were assessed also for radiological evaluation using MRI, abnormal findings of the MRI were divided into mild, moderate, severe degrees by radiologist.

Statistical Analysis

The collected data was revised, coded and tabulated using Statistical package for Social Science (IBM Corp. Released 2011. IBM SPSS Statistics for Windows, Version 21.0. Armonk, NY: IBM Corp.).

Data were presented and suitable analysis was done according to the type of data obtained for each parameter. The Mean and standard deviation (mean ± SD**)** were used to describe the parametric numerical data, while the median and range were used for the non-parametric numerical data. The frequency and percentage were used to describe the non-numerical data. The Kolmogorov Smirnov test was done to test the normality of data distribution. The significant data was considered to be nonparametric.

The deviations from Hardy Weinberg equilibrium expectations were determined using the chi-squared test. The groups were compared with Student *t* test. For all above mentioned statistical tests done, the threshold of significance is fixed at 5% level (p-value). The results were considered: non-significant when the probability of error is more than 5% ($p > 0.05$), significant when the probability of error is less than 5% ($p \leq 0.05$) and highly significant when the probability of error is less than 0.1% ($p \leq 0.001$). The smaller the p-value obtained, the more significant are the results

Results

The demographic data, clinical, laboratory and treatment characteristics of our study groups were presented in Table 1. The average age in group I to IV was 30.60±3.20, 30.46±2.94, 30.80±3.46 and 30.60±3.66 years respectively, where age was not found to affect either the occurrence of obesity or neck pain in both the obese or non- obese individuals. As regards of the weight, BMI, and waist circumference obesity was found to be of high significance

with the occurrence of neck pain; either the mechanical or the inflammatory (P ≤0.001) when compared to the non-obese, whereas obesity has no significant effect on both types of neck pain (P >0.05). Pain was found to be significantly correlated to obesity in mechanical neck pain but not in inflammatory type (P <0.05). CRP was significantly high in all groups (P ≤0.001). Leptin was significantly correlated to neck pain in the non-obese individuals (P <0.05). The positive MRI findings were significantly correlated to obesity in the inflammatory neck pain (P <0.05).

Table (1): Sociodemographic criteria, clinical and laboratory data of the participants:

Items	Group (1) n=15	Group (2) n=15	Group (3) n=15	Group (4) n=15	p-value
	obesity with mechanical	obesity with inflamm	Non-obese with mechanical	Non- obese with inflamm	
Age/Year	30.60±3.20	30.46±2.94	30.80±3.46	30.60±3.66	$P_{1,2}$=0.906 $p_{1,3}$=0.871 $p_{2,4}$=0.913 $p_{3,4}$=0.879
Weight/Kg.	127.60±7.05	130.33±4.05	84.26±3.55	83.40±2.66	$P_{1,2}$=0.204 $p_{1,3}$=≤0.001 $p_{2,4}$=≤0.001 $p_{3,4}$=0.456
Height/cm.	169.47±6.01	169±5.47	172.13±3.99	170.33±3.08	$P_{1,2}$= 0.826 $p_{1,3}$=0.164 $p_{2,4}$= 0.418 $p_{3,4}$=0.178
BMI Kg/cm^2	44.51±3.09	45.89±2.78	28.52±**0**.68	28.70±**0**.68	$P_{1,2}$=0.208 $p_{1,3}$= ≤0.001 $p_{2,4}$= ≤0.001 $p_{3,4}$=0.492
WC.cm	123.42±3.82	125.65±4.16	90±6.33	90.60±6.65	$P_{1,2}$=0.138 $p_{1,3}$=≤0.001 $p_{2,4}$= ≤0.001 $p_{3,4}$=0.802
Pain scale	3.80±1.08	4.20±1.52	2.53±**0**.91	3.33±1.29	$P_{1,2}$=0.414 $p_{1,3}$=0.002 $p_{2,4}$=0.104 $p_{3,4}$=0.06
CRP mg/ml	15.65±2.43	20.39±3.52	8±2.59	14.96±2.72	$P_{1,2}$=≤0.001 $p_{1,3}$= ≤0.001 $p_{2,4}$=≤0.001 $p_{3,4}$=≤0.001
Leptin mcg/L	10.34±6.41	11.33±6.34	12.33±0.57	14.90±1.08	$P_{1,2}$=0.674 $p_{1,3}$=0.608 $p_{2,4}$=0.235 $p_{3,4}$=0.01
MRI findings					
Mild	4(%)	3(%)	8(%)	9(%)	$P_{1,2}$=0.734 $p_{1,3}$=0.311 $p_{2,4}$=0.011 $p_{3,4}$=0.341
Moderate	7(%)	6(%)	5(%)	6(%)	
Severe	4(%)	6(%)	2(%)	0(0%)	

Data are expressed as Mean ± SD or number (%) *significance ≤0.05 *Highly significant ≤0.001. Student t-test and x2 test were used

In Table 2 we compared between group 1 and group three as regards of the sociodemographic criteria, clinical and laboratory data. Age had no significant effect on either obesity or neck pain. Obesity (in reference to weight, BMI and waist circumference) was found to be of high significance with the occurrence of mechanical neck pain (P ≤0.001). CRP was significantly high in females either pregnant or non-pregnant (P ≤0.001). Leptin was significantly correlated with obesity and mechanical neck pain in females either pregnant or non-pregnant (P <0.05), with higher values in the pregnant obese females with mechanical neck pain (15.51± 1.11). MRI findings were not affected by gender or obesity in patients with mechanical neck pain.

Table (2): Comparison between group 1 and group three as regards of the sociodemographic criteria, clinical and laboratory data:

Items	Group (1)			Group (3)			p-value
	obesity with mechanical			Non-obese with mechanical			
	a	B	C	a	B	C	
	males	Non preg	Preg	males	Non preg	preg	
Age/Year	30.40±4.15	32±2.91	29.4±2.41	31±4	31±3.67	30.40±3.5	P_a=.822 p_b=.646 p_c=.613
Weight/Kg.	128.4±7.82	128±7.51	126.4±7.33	83.60±4.15	84.40±3.64	84.80±3.56	P_a=≤0.001 p_b=≤0.001 p_c=≤0.001
Height/cm.	172±7.31	169.6±7.23	166.8±1.92	173.60±5.31	171±3.74	171.8±3.03	P_a=.703 p_b=.711 p_c=.014
BMI Kg/ cm^2	43.48±3.17	44.62±3.81	45.43±2.54	27.73±0.47	28.85±0.39	28.99±0.29	P_a=≤0.001 p_b=≤0.001 p_c=≤0.001
WC.cm	121.4±4.15	123.4±4.04	125.46±2.71	98.20±2.38	84.40±1.67	87.40±0.54	P_a=≤0.001 p_b=≤0.001 p_c=≤0.001
Pain scale	2.80±0.83	4±1	4.6±0.54	1.60±0.54	2.60±0.54	3.40±0.54	P_a=.028 p_b=.025 p_c=.009
CRP mg/ml	13.04±0.85	15.86±1.37	18.06±1.49	-	6.25±0.50	9.40±2.79	P_a= - p_b=≤0.001 p_c=≤0.001
Leptin mcg/L	1.70±0.53	13.82±0.64	15.51±1.11	-	-	12.33±0.57	P_a= - p_b= - p_c=.004
MRI findings							
Mild	2(40%)	1(20%)	1(20%)	5(100%)	3(60%)	0(0%)	P_a=.117 p_b= .223 p_c=.513
Moderate	2(40%)	2(40%)	3(60%)	0(0%)	2(40%)	3(60%)	
Severe	1(20%)	2(40%)	1(20%)	0(0%)	0(0%)	2(40%)	

Data are expressed as Mean ± SD or number (%) *significance ≤0.05 *Highly significant ≤0.001. Student t-test and x2 test were used

In Table 3 we compared between group 2 and group 4 as regards of the sociodemographic criteria, clinical and laboratory data. Age had no significant effect on either obesity or neck pain. Weight, BMI and waist circumference was found to be of high significant correlation with the occurrence of inflammatory neck pain (P ≤0.001). CRP was significantly correlated to obesity in males when compared to the non-obese with inflammatory neck pain (P <0.05),

and highly significant in females either pregnant or non-pregnant (P ≤0.001). Leptin was not correlated with obesity in patients with inflammatory neck pain (P >0.05). MRI findings were not affected by gender or obesity in patients with inflammatory neck pain.

Table (3): Comparison between group 2 and group 4 as regards of the sociodemographic criteria, clinical and laboratory data:

Items	Group (2) obesity with inflamm.			Group (4) Non-obese with inflamm.			p-value
	A	B	A	b	a	b	
	males	Non preg	Preg	males	Non preg	preg	
Age/Year	30.60±4.39	30.20±1.48	30.60±2.96	30.40±4.56	31±3.67	30.40±3.50	P_a=.945 p_b=.664 p_c=.925
Weight/Kg.	131.40±4.21	130.60±4.03	129±4.41	82.40±2.3	83.20±1.92	84.60±3.57	P_a=≤0.001 p_b=≤0.001 p_c=≤0.001
Height/cm.	174.20±6.68	166.40±2.19	166.40±2.19	171.20±3.56	168.80±1.48	171±3.74	P_a=.402 p_b=.077 p_c=.045
BMI Kg/cm^2	43.68±3.06	46.70±1.94	47.31±2.11	28.12±0.84	28.99±0.45	28.99±0.29	P_a=≤0.001 p_b=≤0.001 p_c=≤0.001
WC.cm	121.80±3.96	126.20±2.58	128.96±2.41	99.20±2.77	85±2	87.60±0.54	P_a=≤0.001 p_b=≤0.001 p_c=≤0.001
Pain scale	4.20±0.83	5.80±0.83	2.60±0.54	3.60±.54	4.60±0.54	1.80±0.44	P_a=.217 p_b= .028 p_c=.035
CRP mg/ml	16.18±1.17	20.86±1.45	24.14±0.30	12.16±1.9	14.66±0.55	18.08±0.13	P_a=.004 p_b=≤0.001 p_c=≤0.001
Leptin mcg/L	2.71±0.12	15.02±0.52	16.28±0.34	-	-	14.90±1.08	P_a= - p_b= - p_c=.027
MRI findings							
Mild	1(20%)	0(0%)	2(40%)	2(40%)	2(40%)	5(100%)	P_a=.282 p_b= .030 p_c=.038
Moderate	2(40%)	1(20%)	3(60%)	3(60%)	3(60%)	0(0%)	
Severe	2(40%)	4(80%)	0(0%)	0(0%)	0(0%)	0(0%)	

In Table 4 we compared between group 1 and group 2 to assess the correlation of the age, gender, obesity, pain and MRI findings in both mechanical and inflammatory neck pain. We found no significant correlation between both types of neck pain as regards of the age, gender or obesity (weight, BMI or waist circumference). Pain was significantly high in correlation to pregnancy (P ≤0.001). CRP was high in both types of neck pain (P <0.05), but was significantly higher in pregnant females (P ≤0.001). Leptin and MRI findings were not affected by gender or pregnancy in patients with both mechanical or inflammatory neck pain.

Table (4): Comparison between group 1 and group 2 as regards of the sociodemographic criteria, clinical and laboratory data:

Items	Group (1) obesity with mechanical			Group (2) obesity with inflamm.			p-value
	a	b	C	A	B	c	
	males	Non preg	Preg	Males	Non preg	preg	
Age/Year	30.40±4.15	32±2.91	29.4±2.41	30.60±4.39	30.20±1.48	30.60±2.96	P_a=.943 p_b=.253 p_c=.502
Weight/Kg.	128.4±7.82	128±7.51	126.4±7.33	131.40±4.21	130.60±4.03	129±4.41	P_a=.472 p_b=.515 p_c=.516
Height/cm.	172±7.31	169.6±7.23	166.8±1.92	174.20±6.68	166.40±2.19	166.40±2.19	P_a=.633 p_b=.371 p_c=.767
BMI Kg/ cm^2	43.48±3.17	44.62±3.81	45.43±2.54	43.68±3.06	46.70±1.94	47.31±2.11	P_a=.923 p_b=.311 p_c=.239
WC.cm	121.4±4.15	123.4±4.04	125.46±2.71	121.80±3.96	126.20±2.58	128.96±2.41	P_a=.880 p_b=.228 p_c=.063
Pain scale	2.80±0.83	4±1	4.6±0.54	4.20±0.83	5.80±0.83	2.60±0.54	P_a=.029 p_b=.015 p_c=≤0.001
CRP mg/ml	13.04±0.85	15.86±1.37	18.06±1.49	16.18±1.17	20.86±1.45	24.14±0.30	P_a=.001 p_b=.001 p_c=≤0.001
Leptin mcg/L	1.70±0.53	13.82±0.64	15.51±1.11	2.71±0.12	15.02±0.52	16.28±0.34	P_a=.003 p_b=.012 p_c=.178
MRI findings							
Mild	2(40%)	1(20%)	1(20%)	1(20%)	0(0%)	2(40%)	P_a=.717 p_b=.368 p_c=.513
Moderate	2(40%)	2(40%)	3(60%)	2(40%)	1(20%)	3(60%)	
Severe	1(20%)	2(40%)	1(20%)	2(40%)	4(80%)	0(0%)	

In Table 5 we compared between group 3 and group 4 to assess the correlation of the age, gender, pregnancy, pain and MRI findings in both mechanical and inflammatory types of neck pain in non-obese patients. We found no significant correlation between both types of neck pain as regards of the age, gender or weight, BMI or waist circumference. Pain was significantly correlated to both types of neck pain in both males and females. CRP was significantly high in females in both types of neck pain (P ≤0.001). Leptin, mild and moderate MRI findings were not affected by gender or pregnancy in patients with both mechanical or inflammatory neck pain in non-obese patients but severe neck pain, either the mechanical or the inflammatory types were significantly correlated to pregnancy (P <0.05).

Table (5): Comparison between group 3 and group 4 as regards of the sociodemographic criteria, clinical and laboratory data:

Items	Group (3)			Group (4)			p-value
	Non-obese with mechanical			Non-obese with inflamm.			
	a	b	c	a	b	c	
	males	Non preg	Preg	males	Non preg	Preg	
Age/Year	31±4	31±3.67	30.40±3.5	30.40±4.56	31±3.67	30.40±3.50	P_a=.831 p_b= 1 p_c= 1
Weight/Kg.	83.60±4.15	84.40±3.64	84.80±3.56	82.40±2.3	83.20±1.92	84.60±3.57	P_a=.588 p_b= .533 p_c=.932
Height/cm.	173.60±5.31	171±3.74	171.8±3.03	171.20±3.56	168.8±1.48	171±3.74	P_a=.426 p_b= .256 p_c=.720
BMI Kg/cm^2	27.73±0.47	28.85±0.39	28.99±0.29	28.12±0.84	28.99±0.45	28.99±0.29	P_a=.399 p_b=.626 p_c= 1
WC.cm	98.20±2.38	84.40±1.67	87.40±0.54	99.20±2.77	85±2	87.60±0.54	P_a=.558 p_b=.621 p_c=.580
Pain scale	1.60±0.54	2.60±0.54	3.40±0.54	3.60±.54	4.60±0.54	1.80±0.44	P_a=≤0.001 p_b=≤0.001 p_c=.001
CRP mg/ml	-	6.25±0.50	9.40±2.79	12.16±1.9	14.66±0.55	18.08±0.13	P_a= - p_b=≤0.001 p_c=≤0.001
Leptin mcg/L	-	-	12.33±0.57	-	-	14.90±1.08	P_a= - p_b= - p_c=.010
MRI findings							
Mild	2(40%)	2(40%)	5(100%)	2(40%)	2(40%)	5(100%)	P_a=.038 p_b=.527 p_c=.007
Moderate	3(60%)	3(60%)	0(0%)	3(60%)	3(60%)	0(0%)	
Severe	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)	

Discussion

Neck pain (NP) is a common musculoskeletal disorder, however, its etiology in obesity remains equivocal.[8] Multiple hypotheses explained the association between overweight and obesity and musculoskeletal symptoms including, increased mechanical demands and inflammatory factors related to obesity.[9]

Recent evidence suggests that systemic inflammation associated with obesity may also be an important contributor to NP as obesity has been linked to systemic inflammation which contributes to the pathogenesis of metabolic dysfunction (inflammatory neck pain).[10] In our study, we found no significant correlation between both types of neck pain as regards of the age or gender. This was similar to the results of a study based on a large working population sample (n = 44,793), using the data from The Netherlands Working Conditions Survey (NWCS) to investigate the association between BMI and musculoskeletal symptoms in interaction with physical workload to assess whether obesity is associated with an increase in occurrence of symptoms and/or decrease in recovery from symptoms. This study reported that no association between BMI and musculoskeletal symptoms was found for age or gender.[9] As regards of the weight, BMI, and

waist circumference, obesity was found to be of high significance with the occurrence of neck pain; either the mechanical or the inflammatory (P ≤0.001) when compared to the non-obese, whereas obesity has no significant effect on both types of neck pain (P >0.05). This comes in line with Viester et al., in their study, where they reported an association between high BMI and neck/shoulder symptoms could be supporting a non-mechanical hypothesis.

The effect of obesity on the increase of the neck pain is attributed primarily to bone demineralisation, deformity, dysfunction which eventually causes the associated pain due to these changes in body structures. It is suggested that the results on neck/shoulder symptoms indicate that most likely metabolic factors are part of the underlying mechanism in the association with high BMI. [9] Numerous studies report the significant impact of being overweight or obese on bone and joint health in adults. [10,11,12] Our results are supported by studies showing the association between BMI and the development of osteoarthritis (OA) in non-weight bearing joints, such as the hands[13,14], as well as the link between high BMI and other rheumatic diseases, such as fibromyalgia[15,16,17] However, one study reported that the association between obesity and other cervical disorders (Overweight: OR = 0.890, p = 0.304; Obese: OR = 0.852, p = 0.865) is insignificant,[18] which was also consistent with findings of previous studies,[19-272] which may be reported to that the cervical segment need not bear as much bodyweight as the lower segments such lumbar segments, or may be attributed to the small sample size of cervical diseases which does not provide enough power to detect any significant association in most research samples.[23,24] CRP was significantly high in all groups, particularly in females generally in both types of neck pain, but was significantly higher in pregnant females in mechanical or inflammatory neck pain and significantly correlated to obesity in males when compared to the non-obese with inflammatory neck pain. This comes in line with several studies that investigate the role of obesity in initiating or exacerbating MSK diseases which are numerous.[25] Also Walsh et al., in their study of the association between body fat and musculoskeletal pain, confirmed that systemic inflammation is up-regulated with obesity with the acute inflammatory phase marker, C-reactive protein (CRP), higher in obese people.[26]

Recently, associations between obesity and inflammation, inflammation and pain signaling, and MSK diseases and inflammation have been postulated, through inflammatory mediators as C-reactive protein (CRP), tumor necrosis factor alpha (TNF-α), interleukin-6 (IL-6), and adiponectin due to the profusion of evidence and their connection to deleterious musculoskeletal conditions. [25]

Leptin was significantly correlated to neck pain in the non-obese individuals and was significantly correlated with obesity and mechanical neck pain in females either pregnant or non-pregnant. However, it was not correlated with obesity in patients with inflammatory neck pain and tends to be higher in obese patients, and also, reduction in body weight results in a significant decrease in leptin concentration. [27] Thomas et al.,[28] showed that leptin acts on human bone marrow stromal cells to enhance osteoblastic differentiation. However, very little is known about the effects of leptin on musculoskeletal conditions and neck pain. Leptin, is associated with pain in females and leptin levels in both serum and synovial fluid are associated with osteoarthritis, particularly in women. It has functional receptors on articular chondrocytes, and may be involved with cartilage generation. [25]Our results showed that leptin had higher values in the pregnant obese females with mechanical neck pain (15.51± 1.11). This is supported by other studies, which reported high leptin levels particularly with high maternal BMI during pregnancy.[29-31] Similar findings were also reported by some recent studies that directly related leptin levels with groups of obese and non-obese pregnant women. [30-35]

The explanation is attributed to the fact that during pregnancy, leptin is synthesized by the placenta and plays an important role in regulating maternal energy metabolism and the induction of physiological insulin resistance. The high leptin levels occur in pregnancy, gestational diabetes (GDM), pre-eclampsia, and intrauterine growth restriction (IUGR). [39]Pain was significantly correlated to both types of neck pain in both males and females. However, it was found to be significantly correlated to obesity in mechanical neck pain but not in

inflammatory type but severe neck pain, either the mechanical or the inflammatory types were significantly correlated to pregnancy. Obese were shown to have raised sensitivity to pain.[37] Other studies reported that inflammatory markers are involved in pain signaling and hyperalgesia.[38,39] The positive magnetic resonance imaging (MRI) findings were significantly correlated to obesity in the inflammatory neck pain due to intervertebral disk degeneration but its findings were not affected by gender, obesity or pregnancy in patients with mechanical or inflammatory neck pain. This differs from the results, which did not succeed to assess the association of overweight and obesity with the extent (i.e., levels with disk degeneration) and severity of disk degeneration of the cervical spine because previous studies have failed to quantitatively assess such parameters on advanced imaging. [40] Based on these results, MRI is considered the gold standard for assessing intervertebral disk degeneration in vivo.

Conclusion

This study supports the role of mechanical factors and inflammatory markers for the relationship between obesity and both the mechanical and inflammatory neck pain which eventually increase in pregnancy too. Inspite of the small sample size and the cross sectional design of the study, it is the first study (that to the best of our knowledge) to assess the correlation between neck pain and obesity with reference to other variables (i.e gender, pregnancy). Also, we have used a measurement scale for measuring the intensity of the pain/ discomfort which was reported by respondents; where the patients were subjected to pain assessment scales for determining the severity and quality of pain using Wong Baker facial grimace (0-10) numeric pain rating scale. Also, the inflammatory markers, the serum levels of CRP and leptin were assessed and all patients were assessed also for radiological evaluation using MRI. Third point, we have assessed obesity in reference to waist circumference which is more specific to assess obesity than BMI. Waist circumference is more reliable indicator of health problems than total body mass for people with a body mass index (BMI) of less than 35.

References

1. James WP. (2013): Obesity-a modern pandemic: the burden of disease. Endocrinol Nutr.;60 Suppl 1:3-6.
2. Collaboration NCDRF. (2016): Trends in adult body-mass index in 200 countries from 1975 to 2014: a pooled analysis of 1698 population-based measurement studies with 19.2 million participants. Lancet; 387(10026):1377-96.
3. Kyrou I, Randeva HS, Tsigos C, et al., (2018): Clinical Problems Caused by Obesity. In: Feingold KR, Anawalt B, Boyce A, et al., editors. Endotext [Internet]. South Dartmouth (MA): MD Text.com, Inc.; 2000-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK278973/
4. Hozumi, J., Sumitani, M., Matsubayashi, Y., Abe, H., Oshima, Y., et al., (2016). Relationship between Neuropathic Pain and Obesity. Pain research & management, 2016, 2487924.
5. Steven P. and Cohen, MD (2015): Epidemiology, Diagnosis, and Treatment of Neck Pain. Mayo Clin Proc.;90(2):284-299.
6. Royuela, A., Kovacs, F.M., Campillo, C., Casamitjana, M., Muriel, A., et al., (2014): Predicting outcomes of neuroreflexotherapy in patients with subacute or chronic neck or low back pain. Spine J.; 14: 1588– 1600.
7. Vincent, H.K., Adams, M.C., Vincent, K.R., and Hurley, R.W. (2013): Musculoskeletal pain, fear avoidance behaviors, and functional decline in obesity: potential interventions to manage pain and maintain function. Reg Anesth Pain Med.; 38: 481– 489.
8. Roffey D.M., Budiansky A., Coyle M.J and Wai E.K (2013): Obesity and Low Back Pain: Is There a Weight of Evidence to Support a Positive Relationship? Curr Obes Rep. 2:241– 250
9. Viester, L., Verhagen, E. A., Oude Hengel, K. M., Koppes, L. L., van der Beek, A. J., et al., (2013). The relation between body mass index and musculoskeletal symptoms in the working population. BMC musculoskeletal disorders, 14, 238.

10. Baker JF, George M, Baker DG, Toedter G, Von Feldt JM, et al., (2011): Associations between body mass, radiographic joint damage, adipokines and risk factors for bone loss in rheumatoid arthritis. Rheumatology; 50:2100– 2107.
11. Buchholz AL, Niesen MC, Gausden EB, Sterken DG, Hetzel SJ, et al., (2010): Metabolic activity of osteoarthritic knees correlates with BMI. Knee;17:161– 162.
12. Felson DT, Goggins J, Niu J, Zhang Y and Hunter DJ. (2004): The effect of body weight on progression of knee osteoarthritis is dependent on alignment. Arthritis Rheumatol.;50:3904– 3909.
13. Oliveria SA, Felson DT, Cirillo PA, Reed JI, and Walker AM. (1999): Body weight, body mass index, and incident symptomatic osteoarthritis of the hand, hip, and knee. Epidemiology; 10:161– 166.
14. Hart DJ and Spector TD. (1993): The relationship of obesity, fat distribution and osteoarthritis in women in the general population: The Chingford Study. J Rheumatol.; 20:331– 335.
15. Ursini F, Naty S and Grembiale RD. (2011): Fibromyalgia and obesity: the hidden link. Rheumatol Int.; 31: 1403– 1408.
16. Mork PJ, Vasseljen O and Nilsen TIL. (2010): Association between physical exercise, body mass index, and risk of fibromyalgia: longitudinal data from the Norwegian Nord-Trondelag Health Study. Arthritis Care Res (Hoboken); 62: 611– 617.
17. Cordero MD, Cocer-Gomez E, Cano-Garcia FJ, Sanchez-Dominguez B, Fernandez-Riejo P, et al., (2013): Clinical symptoms in fibromyalgia are associated to overweight and lipid profile. Rheumatol Int.
18. Singh S., Kumar D. and Kumar S. (2014): Risk factors in cervical spondylosis. J. Clin. Orthop. Trauma;5:221– 226.
19. Giannadakis C., Nerland U.S., Solheim O., Jakola A.S., Gulati M., et al., (2015): Does Obesity Affect Outcomes After Decompressive Surgery for Lumbar Spinal Stenosis? A Multicenter, Observational, Registry-Based Study. World Neurosurg.; 84:1227– 1234.
20. Sato S., Yagi M., Machida M., Yasuda A., Konomi T., et al., (2015): Reoperation rate and risk factors of elective spinal surgery for degenerative spondylolisthesis: Minimum 5-year follow-up. Spine J.; 15: 1536– 1544.
21. Samal S., Panigrahi P. and Dutta A. (2015): Social epidemiology of excess weight and central adiposity in older Indians: Analysis of Study on global ageing and adult health (SAGE) BMJ Open;5:e008608.
22. Smith K.B. and Smith M.S. (2016): Obesity Statistics. Prim. Care;43:121– 135.
23. Wang Y., Wang L., Du C., Mo Z. and Fan Y. (2016): A comparative study on dynamic stiffness in redtypical finite element model and multi-body model of redC6-C7 cervical spine segment. Int. J. Numer. Methods Biomed. Eng.
24. Carrier C.S., Bono C.M. and Lebl D.R. (2013):Evidence-based analysis of adjacent segment degeneration and disease after ACDF: A systematic review. Spine J.;13: 1370– 1378.
25. Roffey D.M, Budiansky A, Coyle M.J and Wai E.K (2013): Obesity and Low Back Pain: Is There a Weight of Evidence to Support a Positive Relationship? Curr Obes Rep.; 2:241– 250.
26. Walsh, T. P., Arnold, J. B., Evans, A. M., Yaxley, A., Damarell, R. A et al., (2018). The association between body fat and musculoskeletal pain: a systematic review and meta-analysis. BMC musculoskeletal disorders, 19(1), 233.
27. Kocyigit, H., Bal, S., Atay, A., Koseoglu, M., and Gurgan, A. (2013). Plasma leptin values in postmenopausal women with osteoporosis. Bosnian journal of basic medical sciences, 13(3), 192– 196.
28. Thomas T, Gori F, Khosla S, Jensen MD, Burguera B and Riggs BL. (1999): Leptin acts on human marrow stromal cells to enhance differentiation to osteoblasts and inhibit differentiation to adipocytes. Endocrinology; 140:1630– 1638.
29. Zavalza-Gomez AB, Anaya-Prado R, Rincon-Sanchez AR and Mora-Martinez JM. (2008): Adipokines and insulin resistance during pregnancy. Diabetes Res Clin Pract.;80(1):8– 15.
30. Misra VK and Trudeau S (2011): The influence of overweight and obesity on longitudinal trends in maternal serum

leptin levels during pregnancy. Obesity (Silver Spring); 19(2):416-21.
31. Castellano Filho, D. S., do Amaral Correa, J. O., Dos Santos Ramos, P., de Oliveira Montessi, M., Aarestrup, B. J., et al., (2013). Body weight gain and serum leptin levels of non-overweight and overweight/ obese pregnant women. Medical science monitor: international medical journal of experimental and clinical research, 19, 1043– 1049.
32. Misra VK, Straughen JK and Trudeau S. (2013): Maternal serum leptin during pregnancy and infant birth weight: The influence of maternal overweight and obesity. Obesity (Silver Spring); 21(5): 1064– 69.
33. Misra VK, Trudeau S and Perni U. (2011): Maternal serum lipids during pregnancy and infant birth weight: the influence of prepregnancy BMI. Obesity (Silver Spring); 19(7):1476– 81.
34. Ostadrahimi A, Moradi T, Zarghami N and Shoja MM. (2008): Correlates of serum leptin and insulin-like growth factor-I concentrations in normal weight and over weight/obese Iranian women. J Womens Health (Larchmt); 17(8): 1389– 97.
35. Straughen JK, Misra DP, Kumar P, and Misra VK. (2013): The influence of overweight and obesity on maternal soluble fms-like tyrosine kinase 1 and its relationship with leptin during pregnancy. Reprod Sci.;20(3):269– 75.
36. Eriksson B, Lof M, Olausson H and Forsum E. (2010): Body fat, insulin resistance, energy expenditure and serum concentrations of leptin, adiponectin and resistin before, during and after pregnancy in healthy Swedish women. Br J Nutr.; 103(1):50– 57.
37. Iannitti T, Graham A and Dolan S. (2012): Increased central and peripheral inflammation and inflammatory hyperalgesia in Zucker rat model of leptin receptor deficiency and genetic obesity. Exp Physiol.; 97:1236– 45.
38. Zhang L, Berta T, Xu ZZ, et al., (2011): TNF-alpha contributes to spinal cord synaptic plasticity and inflammatory pain: distinct role of TNF receptor subtypes 1 and 2. Pain;152:419– 27.
39. Manjavachi MN, Motta EM, Marotta DM, et al., (2010): Mechanisms involved in IL-6-induced muscular mechanical hyperalgesia in mice. Pain; 151:345– 55.
40. Samartzis, D., Karppinen, J., Cheung, J. P. Y., and Lotz, J. (2013). Disk Degeneration and Low Back Pain: Are They Fat-Related Conditions? Global Spine Journal, 3(3), 133– 143.