Association Between Metabolic Syndrome and Chronic Musculoskeletal Pain: An Updated Review

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ABSTRACT

Background: Metabolic syndrome is an increasing health problem worldwide. It is a syndrome encompassing the presence of central obesity and two of the three following criteria: high blood pressure, impaired glucose metabolism, and elevated non-high-density lipoprotein (non-HDL) cholesterol level (atherogenic dyslipidaemia) It is associated with an increased risk of cardiovascular disease.

Objectives: The objective of the current study was to explore the association between metabolic syndrome and chronic musculoskeletal pain.

Methods: The current literature on metabolic syndrome connection with chronic musculoskeletal pain has been reviewed and the evidence is collected to explore the above objectives.

Results: A total of 17 studies were included in this review among which 16 studies supported that there is a clear association between metabolic syndrome and chronic musculoskeletal pain.

Conclusion: The results of this review suggest a positive association existed between the presence of chronic musculoskeletal pain and metabolic syndrome components. Awareness of this association could enable an early MS diagnosis and the implementation of preventative measures.

Keywords: Metabolic Syndrome, Chronic Musculoskeletal Pain, Fibromyalgia, Knee Pain, Neck Pain, Shoulder Pain, Low back pain

INTRODUCTION

Metabolic syndrome (MetS) is becoming a prevalent problem worldwide. There has been a global shift in disease patterns with a decrease in the overall impact of infectious diseases and an increase in the impact of cardiovascular and metabolic diseases. Metabolic syndrome is a cluster of risk factors defined by high fasting glucose and triglycerides, low HDL cholesterol, high blood pressure, and abdominal obesity.¹ The overall association of metabolic syndrome and its individual risk factors with diabetes mellitus, cardiovascular diseases, and overall mortality has increased the interest of clinicians and researchers globally towards this syndrome. It is associated with a 2-fold risk of cardiovascular diseases and a 5-fold risk of diabetes.² The prevalence of metabolic syndrome has been reported as high as 35% in the United States and 37% in Finland.³ Almost one in
three adults in India suffers from MetS. In the urban Indian population, the prevalence of metabolic syndrome has been reported to be 19.52% in Mumbai, 24.9% in Jaipur, and 11.2% in Chennai. In urban Indian populations, the age-adjusted prevalence of metabolic syndrome was found to be overall approximately 25% (approximately 31% in women and 18.5% in men). In recent times, various researchers on musculoskeletal pains and disorders have seen an association of musculoskeletal pains with metabolic factors in general and metabolic syndrome in specific. Metabolic syndrome has been found to be associated with neck pain. Also, common risk factors have been found for atherosclerosis and carpal tunnel syndrome as well as shoulder pain. A large population-based study showed metabolic syndrome is associated with shoulder pain in men. Metabolic syndrome has been shown to be associated with pain intensity in upper extremity pain disorders. Musculoskeletal specialists are now giving importance to the role of various components of metabolic syndrome in patients with musculoskeletal pains. The exact underlying relationship between metabolic syndrome and musculoskeletal disorders is not known. However, researchers have given importance to this association to the extent that shoulder periarthritis has been reported as a red flag for metabolic syndrome in women. As individuals with musculoskeletal illnesses become more sedentary, their metabolic syndrome may worsen. This is because sedentary behaviour can lead to muscle loss, which increases the risk of injury to musculoskeletal structures. Thus, metabolic syndrome is a prevalent problem affecting the overall health of the individual. The present study was focused on better understanding the association between musculoskeletal disorders and MetS in the context of chronic musculoskeletal pain in individuals with metabolic syndrome.

MATERIALS & METHODS
An electronic search was performed covering the last 2 decades (2006–2023). The main search items were metabolic syndrome, shoulder pain, knee pain, fibromyalgia, carpal tunnel syndrome, chronic low back pain, neck pain and chronic musculoskeletal disorders. All of the identified literature was reviewed for titles and abstracts. The selected studies on chronic musculoskeletal pain were reviewed.

RESULT

Table 1: Research studies on Chronic musculoskeletal Pain in Metabolic Syndrome

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Author, year</th>
<th>Study design</th>
<th>Patient Population</th>
<th>Methodology</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Loevinger BL (2006)</td>
<td>Case-control study</td>
<td>109 Women with fibromyalgia were compared with 46 healthy women</td>
<td>Urine samples collected over a 12-hour period were used to measure cortisol and catecholamine levels.</td>
<td>Women who experience fibromyalgia-related chronic pain are more likely to develop metabolic syndrome, which is linked to comparatively high norepinephrine levels and comparatively low cortisol and adrenaline.</td>
</tr>
</tbody>
</table>
## Carpel Tunnel Syndrome

<table>
<thead>
<tr>
<th>Study</th>
<th>Design</th>
<th>Participants</th>
<th>Methods</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Çakit O (2020)</td>
<td>A cross-sectional study</td>
<td>24 female fibromyalgia syndrome patients with metabolic syndrome and 76 female fibromyalgia patients without metabolic syndrome and 38 healthy females</td>
<td>The outcome measurements included the visual analogue scale, fatigue severity scale, Beck depression inventory, fibromyalgia impact questionnaire, and pain threshold. Using the total myalgic score (TMS) and control point score, the severity of FMS was evaluated.</td>
<td>This research revealed that the prevalence of MetS was almost four times greater in patients with fibromyalgia syndrome, and the coexisting MetS may increase the severity of fibromyalgia syndrome.</td>
</tr>
<tr>
<td>3. Balci K (2007)</td>
<td>A cross-sectional study</td>
<td>107 right-handed patients, 96 of them female and 11 of them male, had a clinically and electrophysiologically confirmed diagnosis of CTS patients, both with and without metabolic syndrome</td>
<td>For individual instances in both upper extremities, electromyography and other neurophysiological investigations were carried out. Stevens American Association of Electrodiagnostic Medicine Mini Monograph was used for the severity of CTS.</td>
<td>Patients with CTS had a threefold higher prevalence of metabolic syndrome, and their CTS was shown to be more severe in those with metabolic syndrome than in those without it.</td>
</tr>
<tr>
<td>4. Onder B (2012)</td>
<td>Cross sectional study</td>
<td>150 patients who had electrophysiologically confirmed diagnosis of CTS patients with and without metabolic syndrome.</td>
<td>The motor and sensory nerve conduction was examined in the upper extremities' median and ulnar nerves.</td>
<td>According to the results, metabolic syndrome might be a risk factor for CTS. Simultaneously, the existence of MetS exacerbates the severity of the disease.</td>
</tr>
<tr>
<td>5. Yurdakul FG (2014)</td>
<td>Cross sectional study</td>
<td>200 CTS patients with and without diabetes and metabolic syndrome.</td>
<td>Stevens grade for severity of CTS based on electrophysiological data was used. The electrophysiological results were compared in four groups: no metabolic syndrome or diabetes (n=84), diabetes alone (n=20), combination MetS and diabetes (n=44), and MetS alone (n=52).</td>
<td>Patients with MetS seem to experience CTS more severely than those with diabetes. Although other elements of the metabolic syndrome may have a greater impact on the severity of CTS, diabetes is one of the well-known risk factors for the condition.</td>
</tr>
<tr>
<td>6. Roh YH (2015)</td>
<td>A Matched Case-Control Study</td>
<td>35 patients with metabolic syndrome and surgically treated carpal tunnel syndrome (CTS) were age- and sex- matched with 37</td>
<td>Preoperative and 3–6–12 month postoperative assessments were conducted for grip, pinch strength, sense of touch using Semmes-</td>
<td>After carpal tunnel release, individuals with CTS and MetS experience a delayed functional</td>
</tr>
</tbody>
</table>
7. **Mi J (2021)**  
**A Two-Sample Mendelian Randomization Study**  
**Carpel tunnel Syndrome.**  
From the largest T2D genome-wide association studies meta-analysis, which included 596,424 controls and 62,892 cases, summary-level data on the disease was retrieved. UK BioBank provided summary-level information on arm fat mass, arm fat-free mass, and waist circumference. From the FinnGen consortium, associations between single nucleotide polymorphisms and exposures associated with CTS were discovered (4505 patients and 86,854 controls). The results of this study suggest that T2D and obesity are independent risk factors for carpal tunnel syndrome. The inverse-variance-weighted approach combined with univariate Mendelian randomization revealed a favourable relationship between BMI and CTS risk.  

8. **Mäntyselkä P (2010)**  
**A cross-sectional study**  
1294 middle-aged subjects in Pieksämäki, Finland. A total of 399 males and 500 females with metabolic syndrome.  
Using the 12-item General Health Questionnaire (GHQ-12), psychological distress was measured. Perceived neck discomfort daily was classified as neck pain. Using the National Cholesterol Education Programme guidelines, MetS was determined. This study showed that neck pain was associated with MetS. Although neck pain was more common in women than in men, this association was stronger in men.

**cross-sectional study**  
6,237 subjects with shoulder pain and chronic rotator cuff tendinitis.  
weekly alcohol intake was measured in units, and interviews were used to gather information on sociodemographic, lifestyle, and work-related physical strain factors. Carotid intima-media thickness was measured ultrasonographically. Results indicated that shoulder pain was correlated with carotid intima-media thickness, several other metabolic variables, and abdominal obesity.

10. **Contieri JPO**  
**Case-control**  
102 female patients (72 Fasting glucose, Higher levels of...
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<th>(2015) study</th>
<th>with shoulder periarthritis and 40 control group</th>
<th>HbA1c, cholesterol, triglycerides, LDL, and HDL cholesterol were measured for each participant. Patients with periarthritis responded to the SF-12 quality of life questionnaire and the PSS (Pennsylvania Shoulder Score) questionnaire for pain, function, and patient satisfaction with the shoulder's pathology.</th>
<th>LDL cholesterol, HbA1c, dyslipidemia, hypertension, and cardiovascular morbidity were observed in women with shoulder periarthritis. There was greater total cholesterol and BMI. Additionally, discovered that the group with shoulder disease had a more patients who met the criteria for MeTS.</th>
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<td>12. Sargin S (2022) prospective cross-sectional study</td>
<td>114 patients of shoulder joint pain</td>
<td>Every patient had a thorough examination of their shoulders, and their range of motion was measured. Body mass index and waist-to-hip ratio were computed. Measurements were made of blood pressure. Levels of lipids and blood glucose were measured while fasting. For present pain, a visual analogue scale was used.</td>
<td>This study demonstrated a strong correlation between MetS and shoulder pain.</td>
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**Low Back Pain**

| 13. Duruoz (2010) a cross-sectional study | 60 patients with chronic mechanical low back pain. | The Istanbul Low Back Pain Disability Index, Oswestry Disability Index, and Roland-Morris Disability Questionnaire were used to determine functional deficit. A depression assessment was conducted using Beck's depression scale. Based on the National Cholesterol Education Program's (NCEP) 2001 definitions, the findings showed that metabolic syndrome is more common in the elderly, in those with persistent low back pain, and in individuals with elevated body mass index. |

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14. Ha JY (2011) | a cross-sectional study | 1085 participants with chronic lower back pain. | The diagnosis of metabolic syndrome was established. | This study demonstrated that individuals with chronic lower back pain in Korea frequently have metabolic syndrome.[22]

### Knee Osteoarthritis

15. Xie (2017) | cross-sectional study | Knee OA in metabolic syndrome patients | Associations between MetS and its components with OA were evaluated by conducting multivariable adjusted logistic regression. | The findings of this study indicated that there was a positive association between the prevalence of MetS and knee OA. However, MetS as a whole was associated with the higher prevalence of knee osteophytes, but not joint space narrowing.[23]

16. Shinzato (2021) | Case-control study | Two groups of participants 64 with and 42 without MetS with similar age and sex distribution. | Using a standardised questionnaire, the researchers collected clinical and demographic data during an in-person interview, including details on drugs and comorbidities. Blood pressure at least twice, waist circumference, fasting glucose, triglycerides, high-density lipoprotein and cholesterol were all tested. | Chronic musculoskeletal pain was more common in MetS patients, especially in the weight-bearing sites, such as LBP and KOA, which may make walking difficult. As a result, physical activity is decreased, which exacerbates the condition and deteriorates musculoskeletal health.[11]

17. Ibrahim (2023) | cross-sectional study | Knee OA in metabolic syndrome patients | Multivariable regression was used to determine the association of MetS and its components, with the WOMAC total and subscale scores. | This study demonstrated that after adjustment for BMI, neither MetS nor its individual parameters were associated with worse knee symptoms.[24]
DISCUSSION

In this review study, two fibromyalgia syndrome studies are included. According to Loevinger et al., women who suffer from persistent pain associated with fibromyalgia have an increased risk of developing metabolic syndrome. According to Çakit O et al. fibromyalgia syndrome patients had a nearly four-fold higher prevalence of MetS, and having a concomitant MetS may exacerbate the condition. The association between fibromyalgia and metabolic syndrome is corroborated by both investigations. For Carpel Tunnel Syndrome five studies are included in this review. According to research by Balci K et al. and Onder B et al. individuals with CTS had a three-fold increased prevalence of metabolic syndrome, and their condition was demonstrated to be more severe in those with metabolic syndrome than in those without it. According to Yurdakul FG et al. individuals with MetS appear to have a more severe case of CTS than those with diabetes. Diabetes is one of the well-known risk factors for CTS, even if other components of the metabolic syndrome may have a bigger effect on the condition's severity. According to Roh YH et al. people with CTS and metabolic syndrome had a delayed functional recovery following carpal tunnel release; yet, a year following surgery, notable improvements in symptom severity and hand function are similar to those in patients without MetS. Moreover, Mi J et al. found that obesity and type 2 diabetes are separate risk factors for carpal tunnel syndrome. The association between carpal tunnel syndrome and metabolic syndrome is corroborated by all five investigations. Neck pain has been linked to MetS, according to Mäntyselkä P et al. Research by Rechartd M et al. linked shoulder pain to carotid intima-media thickness, several other metabolic variables, and abdominal obesity. According to Contieri JPO et al., women with shoulder periarthritis had increased levels of dyslipidemia, hypertension, LDL cholesterol, HbA1c, and cardiovascular morbidity. Both total cholesterol and BMI were higher. It was also shown that a higher number of patients who met the MetS criteria belonged to the group with shoulder illness. Burne G et al. found low-to-moderate quality evidence points to a connection between MetS and RCRSP. Additionally, Sargin S et al. discovered a significant association between MetS and shoulder discomfort. According to research by Duruoz et al. people with an elevated body mass index, chronic low back pain, and the elderly are more likely to have metabolic syndrome. Moreover, Ha JY et al. found that metabolic syndrome is commonly present in Koreans with chronic lower back pain. According to Xie DX et al. there is a correlation between knee OA and the prevalence of MetS. Higher rates of chronic musculoskeletal pain in MetS have been reported by Shinzato et al. especially in weight-bearing sites, such as LBP and KOA, which may make walking more difficult. As a result, physical activity is decreased, which exacerbates the condition and deteriorates the health of the musculoskeletal system. Ibrahim T et al. showed that neither MetS nor any of its component factors was linked to worsening knee symptoms when BMI was taken into account.

There is a complex underlying mechanism through which metabolic syndrome may result in chronic musculoskeletal pain. The key components of metabolic syndrome are impaired fasting glucose, obesity, dyslipidaemia and elevated blood pressure. The relationship between metabolic syndrome and chronic musculoskeletal pain may be explained by considering the individual components of metabolic syndrome. Impaired fasting glucose which is also a characteristic of diabetes mellitus may lead to changes in microcirculation and the formation of non-enzymatic glycosylation products and advanced glycosylation end products. These changes affect the structure of tendons and capsular
fibrosis. Musculoskeletal implications of diabetes mellitus are well established. Obesity has been found to lead to chronic inflammatory state through the release of proinflammatory cytokines by adipocytes.\textsuperscript{25} This inflammatory state may also lead to the development of musculoskeletal symptoms Dyslipidaemia has been linked with Xanthoma formation and ectopic fat accumulation.\textsuperscript{27} Hypertension may affect the overall cardiovascular endurance of the individuals. Two key factors that may play a role in both metabolic syndrome and musculoskeletal pain are physical inactivity and nutrition. The relationship between metabolic syndrome and chronic musculoskeletal pain is summarized in figure 1

CONCLUSION
The results of this review suggest a positive association existed between the presence of chronic musculoskeletal pain, and MetS components. Therefore, MetS has emerged as a top concern for our nation's doctors and public health experts, requiring coordinated, comprehensive efforts for research, management, early detection, prevention, and treatment. Awareness of this association could enable an early MetS diagnosis and the implementation of preventative measures.

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Conflict of Interest: The authors declare no conflict of interest.

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