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Analyzing Muscle Strength, Functional Performance and Metabolic Syndromes Associated in Women with Early Hysterectomy

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ABSTRACT:
Background: *Hysterectomy, particularly at an early age, has been associated with significant long-term health consequences. The removal of the uterus, often accompanied by ovarian dysfunction or oophorectomy, leads to hormonal imbalances, particularly oestrogen deficiency. Oestrogen plays a crucial role in maintaining bone density, muscle function, and metabolic syndromes. Understanding the implications of early hysterectomy on these physiological systems is essential for developing appropriate preventive and therapeutic interventions.*
Objectives: *This study aims to evaluate the correlation between early hysterectomy and its effects on muscle strength, functional performance and metabolic syndromes.*
Materials and Methods:*138 women of who underwent hysterectomy at the age between 35-45 years before natural menopause were taken. Outcome measures used were manual muscle testing, Musculoskeletal health questionnaire.*
Results:*Women who had hysterectomy at early age had a significant difference in core muscle strength, functional performance and metabolic syndromes than women without hysterectomy. Age and selected variables were highly correlated in the women with early age who had hysterectomy ($p<0.0001$).*
Conclusion: *Early hysterectomy is strongly correlated with adverse effects on muscle function and metabollic syndromes primarily due to oestrogen depletion. These findings emphasize the need for early intervention strategies, including hormonal management, physical rehabilitation, and cardiovascular risk monitoring, to mitigate long-term complications in affected individuals. Further research is warranted to explore targeted therapies for improving post-hysterectomy outcomes.*

INTRODUCTION:

Gynaecological surgeries are the surgeries performed on the female reproductive system. These surgeries include Hysterectomy, myomectomy, salpingectomy, ovarian cystectomy, etc. Among all these Hysterectomy is the surgical procedure in which removal of uterus and the structures surrounded to it. It is one of the most common procedures performed among all the procedures in gynaecological area. It benefits to reduce the complications if any. Causes to perform Hysterectomy are prolapsed uterus, fibroids, abnormal uterine bleeding, cancer of cervix, ovaries and uterus, adenomyosis, endometriosis etc [1].

In recent years, the prevalence of hysterectomy in India has increased. This surgical procedure terminates reproductive function by removing the uterus and, in some cases, the ovaries. The ovaries produce essential hormones that play a vital role in maintaining women's overall health [2]. While hysterectomy may alleviate the medical conditions for which it was performed, it can also lead to significant complications arising from the surgery itself or hormonal imbalances. Given the crucial role of the ovaries in hormonal regulation, their removal remains a matter of concern. Additionally, women may experience various long-term health issues following hysterectomy [3].

Since the uterus provides structural support to the back, its removal results in the loss of that support. As a result, the ability to lift heavy objects or loads is reduced. Consequently, back pain is one of the most frequently reported complaints among women following a hysterectomy. Additionally, significant weight gain is another common concern expressed by women after the procedure. Ultimately this will lead to other complaints such as joint pain and muscle stiffness [4,5].

Abnormal placentation, excessive hemorrhage, and lower gestational age were identified as significant risk factors for early hysterectomy in women. The primary complications associated with hysterectomy can be classified into several categories, including infectious complications, venous thromboembolism,

injuries to the genitourinary and gastrointestinal tracts, hemorrhage, nerve damage, and vaginal cuff dehiscence [6,7].

Hysterectomy may give rise to post-surgical sequelae, such as post-operative pain at the suture site, generalized weakness, decreased mobility, decreased strength, urinary incontinence, or organ prolapse [8]. In the present study, the aim was to analyze muscle strength, functional performance and metabollic syndromes associated with early hysterectomy.

MATERIALS AND METHODOLOGY:

Study population

This is an observational study which was conducted at Krishna hospital, Karad. Approval for the study was granted by the Institutional Ethics Committee of Krishna Institute of Medical Sciences (Deemed to be University), Karad. In the study, 138 women volunteered to participate. Participants were selected by simple random sampling method according to the inclusion and exclusion criteria needed for this study. Participants were divided into 2 groups. Group A included the women without hysterectomy and group B included the women with hysterectomy. 69 participants were divided in each group. Informed consent was obtained from the subjects before the beginning of study.

Inclusion criteria

1. Women with age 35-45 years
2.This study included the women with duration of hysterectomy atleast 5 years before.
3. Women who haven't had any other surgeries in 5 years.

Exclusion criteria

1.Patients on hormone replacement therapy.
2. Women with a history of malignancy or undergoing cancer treatment
3. Pre-existing musculoskeletal or metabolic disorders prior to hysterectomy

After applying inclusion and exclusion criteria, the final study population consisted of 138 women who underwent hysterectomy. The sample size was obtained by using formula ($n=4pq/L^2$).

Outcome measures

1. Core muscle strength by manual muscle testing

Core muscle strength can be effectively assessed through Manual Muscle Testing (MMT), focusing on key muscles such as the rectus abdominis, obliques, and erector spinae.

For the rectus abdominis, which is responsible for trunk flexion, the patient lies in a supine position with legs extended and is asked to perform a sit-up. Muscle strength is graded on a scale from 0 to 5, where Grade 5 indicates full trunk flexion with hands behind the head, Grade 4 with arms crossed over the chest, and Grade 3 with arms extended forward. Grade 2 represents partial movement, while Grades 1 and 0 reflect a palpable contraction or no activity, respectively.

For the external and internal obliques, which contribute to trunk rotation and lateral flexion, the patient is also positioned supine and asked to rotate the trunk, such as bringing the right shoulder toward the left hip. Grading follows a similar pattern: Grade 5 is achieved with hands behind the head, Grade 4 with arms across the chest, Grade 3 with arms extended, Grade 2 indicates partial movement, and Grades 1 or 0 indicate minimal or absent contraction.

The erector spinae muscles, responsible for trunk extension, are tested with the patient lying prone. The patient is instructed to lift the upper body off the table. A Grade 5 is recorded when the patient performs full trunk extension with hands behind the head, Grade 4 with arms at the side, and Grade 3 for partial chest lift. Minimal movement or a palpable contraction is graded as Grade 2 or 1, and Grade 0 signifies no muscle activity. These tests are essential in evaluating core muscle function, especially in individuals recovering from surgical or musculoskeletal conditions [9].

2. MSK- HQ questionnaire:

The severity of such musculoskeletal symptoms was obtained by using the MSK-HQ. This questionnaire was about joint, neck, bone and muscle symptoms such as aches, pains and/or stiffness. It included questions about the severity of pain or stiffness during the day or night, during various activities such as walking, washing/dressing, social activities and hobbies. It also included a question which gives an idea of the level of fatigue or low energy. Each question had options valued from 4 to 0. Participants were supposed to select one option. The final score was calculated by summing the values given for the options that were selected by participants of each question out of 56 (total score) [10].

RESULTS:

Groups	Age	R value	P value
Without hysterectomy	35-40 years	0.2373	0.1698
	40-45 years	0.1857	0.2856
With hysterectomy	35-40 years	0.9441	<0.0001
	40-45 years	0.7108	<0.0001

Table 1. Correlation between age and core muscle strength in with and without hysterectomy groups.

In table 1, Spearman correlation analysis was performed to assess the relationship between age and core muscle strength among women with and without hysterectomy. In the group without hysterectomy, both age subgroups (35–40 years: r = 0.2373, p = 0.1698; 40–45 years: r = 0.1857, p = 0.2856) showed weak positive correlations that were not statistically significant. This indicates that age had little to no effect on core muscle strength in women who had not undergone hysterectomy. In contrast, women in the hysterectomy group demonstrated strong and statistically significant positive correlations between age and muscle strength decline (35–40 years: r = 0.9441, p < 0.0001; 40–45 years: r = 0.7108, p < 0.0001). These findings suggest that as age increased, core muscle strength markedly decreased in women who had undergone early hysterectomy, possibly due to the compounded impact of hormonal changes such as estrogen deficiency following surgery.

Groups	Age	R value	P value
Without hysterectomy	35-40 years	0.0303	0.6604
	40-45 years	0.0697	0.6905
With hysterectomy	35-40 years	-0.5840	0.0002
	40-45 years	-0.3742	0.0026

Table 2. Correlation between age and MSK-HQ score in with and without hysterectcomy groups.

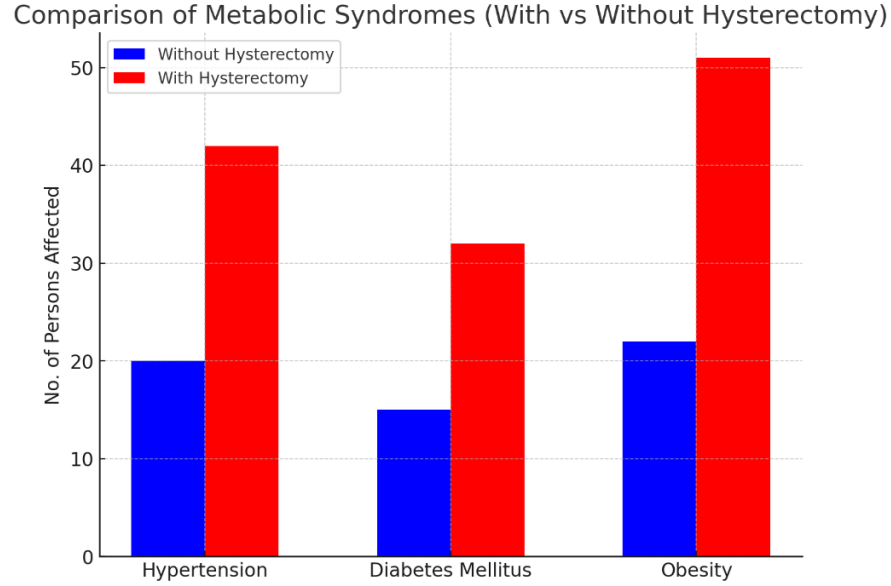
In table 2, Spearman correlation analysis was conducted to examine the relationship between age and MSK-HQ scores in women with and without a history of early hysterectomy. In the group without hysterectomy, no significant correlation was found between age and musculoskeletal health scores across both age ranges (35–40 years: r = 0.0303, p = 0.6604; 40–45 years: r = 0.0697, p = 0.6905), suggesting that age did not have a notable impact on MSK-HQ scores in this population. In contrast, the hysterectomy group demonstrated a significant negative correlation between age and MSK-HQ scores in both age subgroups (35–40 years: r = –0.5840, p = 0.0002; 40–45 years: r = –0.3742, p = 0.0026). These findings indicate that, among women who underwent early hysterectomy, musculoskeletal health—as measured by MSK-HQ—tended to decline with advancing age. This decline may be attributed to the compounded effects of estrogen deficiency and aging, resulting in increased musculoskeletal complaints such as pain, stiffness, and reduced functional capacity.

Metabolic syndromes	Without hysterectomy		With hysterectomy	
	35-40 years	40-45 years	35-40 years	40-45 years
Hypertension	9 (12.85%)	11 (15.71%)	22 (31.42%)	20 (28.57%)
Diabetes mellitus	7 (10%)	8 (11.42%)	18 (25.71%%)	14(20%)
Obesity (BMI > 25)	10(14.28%)	12(17.14%)	25(35.71%)	26(37.14%)

Table 3. Presence of metabolic syndromes present in with and without hysterectomy groups.

Table 3 states the prevalence of metabolic syndromes was notably higher in women who had undergone early hysterectomy compared to those without hysterectomy across both age groups. In the hysterectomy group, hypertension was reported in 31.42% of women aged 35–40 years and 28.57% of those aged 40–45 years, whereas the corresponding figures in the non-hysterectomy group were considerably lower at 12.85% and 15.71%, respectively. Similarly, the incidence of diabetes mellitus was markedly elevated in the hysterectomy group, affecting 25.71% of women aged 35–40 and 20% aged 40–45, compared to 10% and 11.42% in the same age ranges of the control group. The most pronounced difference was observed

in the prevalence of obesity (BMI >25), which was present in 35.71% (35–40 years) and 37.14% (40–45 years) of women with hysterectomy, nearly double the rates observed in the non-hysterectomy group (14.28% and 17.14%, respectively). These findings indicate a strong association between early hysterectomy and increased risk of developing metabolic syndromes, likely driven by hormonal changes, particularly estrogen deficiency, that negatively affect cardiovascular and metabolic regulation.



Graph 1. Presence of metabolic syndromes present in with and without hysterectomy groups.

The bar graph 1 clearly illustrates a higher prevalence of metabolic syndromes—namely hypertension, diabetes mellitus, and obesity—in women who underwent early hysterectomy compared to those who did not. For hypertension, approximately 42 women in the hysterectomy group were affected versus only 20 in the non-hysterectomy group. In the case of diabetes mellitus, the number of affected women in the hysterectomy group rose to around 32, whereas it remained much lower—about 15 women—in the comparison group. The most substantial difference was observed in obesity, with over 50 women affected in the hysterectomy group compared to approximately 22 in the non-hysterectomy group. This visual representation reinforces the association between early hysterectomy and an elevated risk of developing metabolic complications, likely due to estrogen deficiency and its impact on hormonal regulation, weight gain, and insulin sensitivity.

DISCUSSION:

Early hysterectomy, especially when performed before natural menopause, has profound long-term consequences on women's musculoskeletal and metabolic health due primarily to estrogen deficiency.

Research by Baltgalvis et al. (2010) supports this notion, showing that estrogen-deficient rodents displayed significant reductions in muscle contractility and increased markers of oxidative stress [11]. Furthermore, mitochondrial dysfunction, driven by hormonal changes, leads to reduced ATP production and increased apoptotic signaling, directly impairing muscle endurance and function. cellular-level changes manifest clinically as decreased core strength, reduced physical performance, and an increased risk of falls and disability in women who undergo early hysterectomy [12].

Beyond musculoskeletal consequences, estrogen deficiency is strongly linked to metabolic syndrome, a cluster of conditions including central obesity, insulin resistance, dyslipidemia, and hypertension. Estrogen exerts cardioprotective effects by modulating glucose uptake, improving lipid profiles, and enhancing insulin sensitivity. Its absence leads to adverse metabolic alterations, increasing the risk of type 2 diabetes and cardiovascular diseases. According to Carr (2003), women undergoing surgical menopause exhibited more severe manifestations of metabolic syndrome than age-matched premenopausal controls [13]. Studies also suggest that hysterectomy patients exhibit increased visceral fat accumulation, which is metabolically active and contributes to systemic inflammation and insulin resistance [14]. The loss of estrogen also promotes a pro-inflammatory environment characterized by elevated levels of cytokines such as TNF-α and IL-6, which further impair insulin signaling and muscle protein synthesis.[15] Chronic low-

grade inflammation thus establishes a vicious cycle that aggravates both muscle degeneration and metabolic dysfunction.

The current study's findings—highlighting significant differences in core muscle strength, bone mineral density, and metabolic health in women who underwent early hysterectomy—align with a growing body of evidence. Moreover, the strong statistical correlation between age at hysterectomy and health outcomes reinforces the argument for age-specific risks. Bone health is particularly vulnerable post-hysterectomy due to the essential role of estrogen in maintaining bone turnover balance. Estrogen inhibits bone resorption by suppressing osteoclast activity. Its depletion results in accelerated bone loss, increasing the risk of osteopenia and osteoporosis. According to studies by Greendale et al. (2009), postmenopausal women and those with surgical menopause exhibited similar patterns of bone density loss, but the latter had a more abrupt decline. This rapid bone loss can contribute to increased fracture risk, particularly in the spine and hips, further compounding mobility limitations caused by muscle weakness [16].

Given these extensive health implications, it is imperative to adopt early intervention strategies for women undergoing hysterectomy at a young age. Hormone Replacement Therapy (HRT) remains the most direct method to mitigate estrogen loss. When initiated soon after hysterectomy, HRT has been shown to preserve bone density, improve muscle strength, and reduce metabolic complications. However, HRT is not without risks, and its use must be personalized based on individual risk profiles, particularly regarding cardiovascular disease and hormone-sensitive cancers [17]. In addition to hormonal interventions, physical rehabilitation programs focusing on resistance training and aerobic exercise can significantly enhance muscle performance and metabolic outcomes. Exercise stimulates mitochondrial biogenesis, improves insulin sensitivity, and counteracts inflammation—all of which are beneficial in estrogen-deficient states. A study by Sipilä et al. (2011) found that postmenopausal women participating in a structured resistance training program showed marked improvements in muscle strength and functional mobility. Similarly, dietary modifications play a critical role. Adequate intake of protein, calcium, vitamin D, and omega-3 fatty acids supports musculoskeletal health and reduces the risk of metabolic syndrome. Nutritional counseling tailored to the needs of women post-hysterectomy should thus be an integral part of clinical management [18].

Women who underwent hysterectomy exhibited decreased core muscle strength, lower MSK-HQ scores, and a markedly higher prevalence of metabolic syndromes compared to their counterparts without hysterectomy. These results underscore the critical role of estrogen in maintaining musculoskeletal integrity and metabolic balance. The strong correlations observed between increasing age and worsening musculoskeletal outcomes in the hysterectomy group further emphasize the long-term impact of early surgical menopause.

These findings advocate for early identification, monitoring, and implementation of preventive strategies—such as tailored physical rehabilitation, nutritional counseling, and hormone management—to mitigate these adverse outcomes. Future longitudinal and interventional studies are warranted to develop individualized care protocols and to better understand the trajectory of health changes following early hysterectomy.

CONCLUSION:

In conclusion, early hysterectomy is strongly associated with adverse effects on muscle function and metabolic regulation, largely due to the abrupt decline in estrogen levels. The findings of this study reinforce the need for comprehensive strategies that encompass hormonal management, physical rehabilitation, nutritional support, and regular monitoring to mitigate these risks. Future research should focus on personalized intervention models, evaluating the long-term efficacy and safety of various therapeutic approaches. Furthermore, longitudinal studies with diverse populations are needed to better understand the trajectory of health changes post-hysterectomy and to inform clinical guidelines. As hysterectomy remains one of the most commonly performed gynecological surgeries worldwide, addressing its systemic consequences is a public health imperative.

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