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The Physiological Correlate Of *Meda Dhatu*: An Integrative Review Of Ayurvedic Principles And Modern Adipose Tissue Biology

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Abstract
One of the *Sapta Dhatu* (the seven primary tissues that support bodily growth and maintenance), *Meda Dhatu* has its roots in Ayurveda. The view of adipose tissue as an endocrine organ with a fundamental purpose beyond energy storage has shifted due to expanding knowledge. *Meda Dhatu*'s principles were applied to modern adipose tissue biology in this review. A systematic review found congruence between *Meda Dhatu* principles in Ayurveda and current adipose tissue physiology and their therapeutic significance in metabolic diseases. A PRISMA 2020-compliant literature review was conducted. Electronic databases were searched for peer-reviewed literature on Ayurvedic *Meda Dhatu* ideas, adipose tissue biology, metabolic functions, and integrative medicine from 2000 to 2025. Modern research on adipose tissue, adipokines, thermogenesis, and immunological function was evaluated alongside Ayurvedic classics, including *Charaka Samhita* and *Sushruta Samhita*. The results suggested that Ayurvedic *Meda Dhatu* fundamentals and modern adipose tissue biology may overlap. *Meda Dhatu* energy storage, insulation, lubrication, and metabolic control capabilities resemble white (WAT), brown (BAT), and beige adipose tissue. Both recognise tissue growth (*Meda Vriddhi*/obesity) and depletion (*Kshaya*/lipodystrophy). *Medodhatvagni* and *Medovaha Srotas* in Ayurveda connect with modern adipose tissue metabolism and the anatomy and physiology of the vascular network and metabolic pathways, respectively. A combination of these complementary models shows metabolic disease-related WAT impairment: Ayurveda's constitutional type (*Prakriti*) and personalised treatment fit metabolic health's Precision medicine. The holistic description in Ayurveda describes *Meda Dhatu*'s connection with other physiological systems, which matches recent research on adipose tissue's systemic endocrine and immunological effects. This investigation shows that the old Ayurvedic *Meda Dhatu* theory and modern medical understanding of adipose tissue overlap, supporting integrative metabolic health methods. Future investigations are needed to validate classical Ayurvedic therapies and develop individualised therapeutic strategies.

Keywords: *Meda Dhatu*, adipose tissue, Ayurveda, adipokines, thermogenesis, integrative medicine, metabolic disorders

Introduction

The intersection of traditional medical systems with contemporary scientific understanding represents a frontier of significant therapeutic potential, particularly in addressing the global epidemic of metabolic disorders.(1) Ayurveda, the ancient Indian system of medicine dating back over 5,000 years, conceptualises human physiology through the framework of three fundamental regulatory principles (*Tridosha*) and seven essential tissues (*Sapta Dhatu*). Among these tissue systems, *Meda Dhatu* occupies a pivotal position as the fourth dhatu, representing the fatty tissues responsible for lubrication, insulation, energy storage, and structural support.[1][2][3][4][5][6]

The physiological, pathological and therapeutic manifestations of *Meda Dhatu* are extensively mentioned in Ayurvedic textbooks like *Charak Samhita and Shusruta Samhita.*[7][8] According to these Ayurvedic textbooks, *Meda Dhatu* dominates *Prithvi* (Earth) and *Jala* (Water) *Mahabhuta* (Basic fundamental elements), which gives its fundamental *Guna* like *Snehatava* (Unctuousness), *Sthiratva* (Stability) and *Dridhta* (Perseverance), and also acts as a reservoir of energy in conditions of malnutrition.[9][10]

The contemporary concept of adipose tissue considers the adipose tissue not as an energy source but as an endocrine gland.[11] Most recent research has categorised adipose tissue into three types: the first is white adipose tissue (WAT), which serves as a source of energy; the second is brown adipose tissue (BAT), primarily related to thermogenesis; and the third is beige adipose tissue, which is associated with acquiring thermogenic capacity.[12][13] Adipokines, which are secreted by adipose tissue, like leptin, adiponectin, and resistin, regulate functions like inflammatory response and maintain cardiovascular health.[14][15][16]

Obesity and metabolic disorders are a global pandemic, affecting more than 2.1 billion people and resulting in devastating health consequences and mortality.[17] In today's era, intervention strategies are more focused on dietary change, medicinal

intervention, and surgical interventions.[18] The lack of success of contemporary science to treat and control metabolic disorders creates and validates the importance of a holistic approach to treat these types of disorders.[19][20]
Integrative medicine is the idea where traditional science practices are combined with evidence-based science.[21], [22] The National Centre for Complementary and Integrative Health finds the eminence of the ancient system of medicine, provided there is scientific evidence behind it.[23],[24] The modern era research focused on evidence-based Ayurveda for the treatment and management of obesity and metabolic disorders.[25] They applied the concept of *Jatharagni* (Digestive fire) for the understanding of the development or pathophysiology of disease and provided multiple strategies, such as lifestyle modification and herbomineral drug formulations.[26]
Now, a new study suggests a different view about the adipose tissue; it is suggested that it is the largest endocrine organ in the body, and its functions are not limited to fuel storage.[27] Recent researches suggest adipose tissue is divided into three types: White adipose tissue (WAT), which stores the energy, Brown adipose tissue (BAT), which produces heat, and beige adipose tissue, which acquires thermogenic properties. Adipokines like leptin, adiponectin, and resistin play an important role in regulating systemic metabolism, maintaining inflammatory responses, and maintaining the cardiovascular system.[28]
Systematic study of the physiological relation of *Meda Dhatu* and the thermogenic properties of adipose tissue from the lens of modern science is the objective of this extensive study. Through an in-depth analysis of Ayurveda textbooks and incorporating modern scientific studies.

Methods
This systematic review adhered to the PRISMA 2020 guidelines to ensure thorough and clear reporting. The approach included an examination of both traditional Ayurvedic texts and the integration of modern scientific studies.[29][30]

Inclusion Criteria
Studies were included if they met the following criteria:
- Peer-reviewed articles published in English between 2000 and 2025
- Studies addressing Ayurvedic concepts of *Meda Dhatu* or related metabolic principles
- Research on adipose tissue physiology, metabolism, or endocrine function
- Clinical or experimental studies on adipokines and metabolic regulation
- Integrative medicine approaches combining traditional and modern systems
- Reviews or meta-analyses relevant to the study objectives

Exclusion Criteria
Articles were excluded if they:
- Those are not peer-reviewed or published in predatory journals
- Focused solely on surgical or pharmaceutical interventions without a traditional medicine context
- Addressed adipose tissue pathology without physiological correlation
- Were case reports without broader theoretical implications
- Contained insufficient methodological detail for quality assessment

Results
The systematic search yielded 847 initial records, of which 312 met the inclusion criteria after screening and quality assessment. The final analysis comprised 156 peer-reviewed articles, eight systematic reviews, and a comprehensive examination of six classical Ayurvedic texts with scholarly translations.

Anatomical and Structural Correlations
Ayurvedic Samhita describes *Meda Dhatu* as a structural and functional unit of the body, and its anatomical description exhibits a significant correlation with adipose tissue structure and functions.[31] The *Charaka Samhita* describes the character of *Meda* as "*Snigdha*" (Unctuous), "*Guru*" (Heavy), "*Mridu*" (Soft), and "*Sandra*" (Dense), which corresponds to the properties of adipose tissue, which is described in modern science.[32],[33]
In modern science, adipose tissue is categorized into three types: white adipose tissue [WAT], which accounts for around 15-25% of body weight in non-obese individuals, brown adipose tissue (BAT), which accounts for less than 0.5% of body weight in lean individuals, while beige adipose tissue accounts for less than 0.1% which is associated with brown adipose tissue. These types of characters of different types of adipose tissue are analogous to *Meda Dhatu* types, which are described in Ayurvedic texts.[34]

Energy Storage and Mobilisation
In Ayurvedic texts, the *Meda Dhatu* is mentioned as *Bala Pradayaka,* which means it provides strength by accumulating energy and releasing it at the time of a lack of nutrition.[35] *Acharya Charaka* described *Meda Dhatu* as "*Shakti Sangraha,*" and this can be utilized in the condition of starvation.[36] This character fully resembles adipose tissue characters, which

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is the site of energy in the human body, containing 135,000-140,000 calories of triglycerides, which is high in energy.[37][38]

Recent studies detailed the molecular process of lipolysis and lipogenesis, which are the keys to energy storage and release. When the body requires energy, the stored food is hydrolyzed by hormone-sensitive lipase (HSL) and adipose triglyceride lipase (ATGL) into fatty acids and glycerol, etc.[48] The reverse of this is also true; that means when an excess of energy occurs, lipogenesis is stimulated by acetyl-CoA carboxylase and fatty acid synthase. [49] These processes are regulated by hormonal signals such as insulin, catecholamines, cortisol, and growth hormone.[50][51]

Thermal Regulation and Thermogenesis

According to classical Ayurveda texts, *Meda Dhatu* is responsible for regulating body heat and maintaining an optimal body temperature at a constant rate.[52] The physiological function of *Meda Dhatu* of *Ushna Rakashaka* and *Sheeta Nasha* is related to it, which resembles the functions of adipose tissue.[53]

Brown adipose tissue (BAT), which is specialized for thermogenesis, is abundantly present in mitochondria that contain uncoupling protein-1 (UCP-1).[54] This protein slowly releases energy as heat rather than producing ATP. The process of heat generation is initiated by stimulation of the sympathetic nervous system when we are exposed to cold, which is closely aligned with the Ayurvedic context of *Meda Dhatu* adaptive phenomena to surrounding environmental challenges.[55],[56] Recent studies show that beige adipose tissue can be induced to express UCP1 and can go through the process of thermogenesis in an appropriate and controlled environment.[57]

Endocrine and Signalling Functions

The Ayurvedic text does not clearly describe hormonal or endocrine function using modern terminology; these texts describe or emphasize the importance of *Meda Dhatu* in facilitating systemic communication and regulation.[58] The concept of *Dhatu Poshana,* which is explained by various Acharya by means of *Dhatu Poshana Nyaya*, describes the signalling processes for the interaction between different *Dhatu* that correspond with current modern understandings of adipokine and their effects.[59]

Recent studies have discovered and identified over 600 bioactive molecules that are emitted by adipose tissue; they are collectively known as adipokinase. The leptin, which is a key adipokinase that regulates hunger and energy use, while adiponectin, which enhances the insulin sensitivity of cells and has anti-inflammatory properties, and resistin, which contributes to insulin resistance.[60]

Recent research has identified over 600 bioactive compounds emitted by adipose tissue, collectively known as adipokines.[61] Key adipokines include leptin, which regulates hunger and energy use; adiponectin, which enhances insulin sensitivity and has anti-inflammatory properties; and resistin, which contributes to insulin resistance.[62] These compounds function as hormones, cytokines, and growth factors, highlighting adipose tissue as an important endocrine organ.[63]

Pathological Manifestations and Disease States

Both Ayurvedic medicine and modern science acknowledge that dysfunction in adipose tissue can lead to pathological conditions, with a notable similarity in both the clinical symptoms and the underlying mechanisms involved.[64][65]

***Meda Vriddhi* and Obesity**

Ayurvedic texts extensively describe "*Meda Vriddhi*" or "*Sthaulya*" as an abnormal increase in *Meda Dhatu*, marked by symptoms like increased body weight, reduced mobility, excessive sweating, shortness of breath, and increased hunger.[66] The *Charaka Samhita* offers detailed clinical accounts that closely align with modern presentations of obesity.[67]

Recent studies on obesity have identified various phenotypes, including metabolically healthy and metabolically unhealthy obesity, which correspond with Ayurvedic ideas of constitutional diversity and individual vulnerability.[68] Recognizing that not all individuals with obesity face metabolic issues is consistent with Ayurvedic principles of Prakriti (constitutional) and Vikriti (pathological) states.[69]

Meda *Kshaya* and Lipodystrophy

Traditional texts describe "*Meda Kshaya*" as a condition characterized by the pathological reduction of *Meda Dhatu*, leading to severe wasting, drying of the joints, enlargement of the spleen, and a craving for fatty foods.[70],[71] These descriptions closely match the modern understanding of lipodystrophy syndromes, which are rare disorders involving the selective loss of fat tissue and associated metabolic issues like insulin resistance, abnormal lipid levels, and fatty liver disease.[72][73]

Inflammatory and Immune Dysfunction

The Ayurvedic concepts of "*Ama*" (metabolic toxins) and tissue inflammation in Meda Dhatu disorders align with current understandings of inflammation in adipose tissue related to metabolic diseases.[71] Recent research has identified chronic low-grade inflammation as a key mechanism linking obesity to metabolic disorders, driven by pro-inflammatory cytokines like TNF-α, IL-6, and IL-1β, which are released by enlarged fat cells and infiltrating immune cells.[74],[75],[76]

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Constitutional Assessment and Personalised Medicine
The Ayurvedic concept of treatment of any disease is based upon the patient's *Prakriti* (Constitution) and the *Vikrati* (Pathological state) of the body to finalize the specific treatment for an individual.[77] This Specialized individual plan of treatment is a result of progress in precision medicine, and also precised the pharmacogenomics, in which genetic variations, metabolic phenotype, and biomarker patterns have been understood, and this has led to personalized medicine determinat

Multi-modal Interventions
The Ayurvedic approach to treating *Meda Dhatu* disorders involves a comprehensive strategy that includes modification in diet (*Ahara*), modification in lifestyle (*Vihara*), use of herbomineral treatment, and detoxification techniques like *Vamana, Virechana,* etc.,which is *Panchakarma.*[78] These are all measures aligned with modern obesity management guidelines, which also stress the modification of diet and lifestyle changes, with the possibility of adding surgical management when it's needed.
Some clinical studies have established the fact through evidence-based trials of Ayurvedic drugs that they have anti-obesity and anti-metabolic homeostasis effects, which is a milestone development to combat obesity disorders. Some of the Ayurvedic formulations, like *Vidangadi Churna* and *Vyoshadi Guggulu,* show significant reduction in BMI in obese persons, waist circumference, and lipid profile when compared to the placebo group in a randomized controlled trial.[79] These compositions act by different types of mechanisms, such as increasing digestive fire (*Jatharagni*), *Pachana* of *Ama* (Metabolic toxins), and balancing of *Kapha Dosha.*

Discussion
This review demonstrates the correlation between the Ayurvedic view of *Meda Dhatu* and the modern aspects of adipose tissue, such as morphology, physiology, pathology, and therapeutic aspects, and the complexity of classical Ayurvedic literature descriptions, which was constructed thousands of years before modern scientific methodologies, it is the hurdled to for understanding this classical ancient science on the parameter of modern methodologies that's why in this review selective description of *Meda Dhatu* has been discuss and a map is created for better understanding of the functions of *Meda Dhatu* which are fairly align with adipose tissue, structure and functions. Some of the functions of *Meda Dahtu,* such as *Bala Pardayaka*, *Sheeta Nasha,* fairly align with the adipose tissue's function of storage of energy and thermogenesis.

Mechanistic Convergence
The correlation between *Meda Dhatu* and adipose tissue not only on the surface but also goes deeper. The concept of *Meda Dhatu,* according to Ayurveda, gives a clearer insight into metabolic networks that lead to the constitution of obesity or *Medovridhi* than the modern concept of physiology of adipose tissue. *Medodhatvagni,* which is one of the *Dhtavagni,* acts on the tissue level, related to the actual fat metabolism that is understood in the present era in terms of lipogenesis, lipolysis, and thermogenesis. Factors that regulate the *Meda Dhatu* are *Agni, Oja,* and *Prana;* these are affected by systemic factors, which are not only responsible for modern-day neuro-endocrine regulation, control of the autonomic nervous system, but also in metabolic regulation and integration.
The concepts of *Sroto-vigyan,* specifically *Medovaha Srotas,* which are related to *Meda Dhatu*, provide a panoramic explanation of the blood supply, lymphatic drainage, and metabolism, strengthening the function of adipose tissue. Clinical symptoms of *Srotodushti* of *Medovaha Srota* lead to *Medovridhi,* which is an obesity disorder, as described in Ayurvedic texts, and coincides with adipose tissue dysfunction like defective adipogenesis, dysregulated lipolysis, and abnormal adipokines.

Clinical and Therapeutic Implications
The observation made in this analysis supports the feasibility of the integration of Ayurvedic concepts into the evidence-based treatment of metabolic health disorders. Multiple domains exhibit significant potential for clinical application of the integrative approach to treat these kinds of disorders.

Integration with Personalised Medicine: Ayurvedic assessment of *Prakriti* reveals the genetic pool of the individual, and it also reveals variation according to the genetic pool, which impacts the metabolic pathways, drug metabolism, and predisposes to disease susceptibility. The combination of *Prakrirti* analysis with contemporary biomarker examination and genetic profiling will allow more precision medicine strategies, which are going to be developed for the various metabolic disorders.

Multi-target Therapeutic Approaches: Ayurvedic herbo-mineral drugs have several bioactive molecules, which target different pathways simultaneously, aligning with modern understanding of metabolic syndrome as more complex, requiring multi-regulatory therapeutic intervention. Recent pharmacological approaches could also be applied to the study of this type of classical Ayurvedic medicine for a better understanding.

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Lifestyle Medicine Aids: The personalised changes in lifestyle, which are advocated by Ayurveda as per the unique constitution examination that is *Prakriti Parikshan*, suggest the changes according to the constitution of the body, which are ultimately helpful to reduce the burden of metabolic disorders. Integration of traditional ways of living with new behavioural science may increase adherence and hence result in successful weight management.

Development of new Biomarkers: Using classical Ayurvedic diagnosis approaches with contemporary advanced analytical techniques may reveal new biomarkers for the early diagnosis of metabolic disorders. The identification of the relation between tongue assessment and BMI with metabolic biomarkers, inflammation-related factors, and adipokine profiling gives an interesting direction for future studies.

Limitations and Challenges

There are several important limitations in interpreting and applying these findings. The limitations of observational design do not allow for causal inferences, and the variations of the included studies have the potential to obscure the strength of the conclusions. Differences in cultural and linguistic backgrounds in transitions of traditional ideas into a modern idiom may contribute to interpretative bias. Absence of standardised Ayurvedic therapeutic and diagnostic tools is a hurdle to systematic evaluation and practice.

There are practical challenges associated with integrating traditional and modern systems, including regulations, research among practitioners, quality control of herbal products, and the incorporation of traditional medicine into formal healthcare facilities. These challenges can only be overcome through the cooperation of practitioners of traditional medicine, modern researchers, regulatory agencies, and healthcare administrators.

Conclusion

This overview presents a remarkable correlation between classic Ayurvedic Meda Dhatu principles and contemporary knowledge of adipose tissue in various aspects, including anatomical organisation, physiological activities, clinical features, and management protocols. The complex, age-old understanding, based on clinical experience spanning countless generations, is of great value and constrains our knowledge of science. This acknowledged overlap provides the possibility for bridging Ayurveda concepts to modern metabolic health and especially shines in the context of the ongoing global epidemic of obesity and metabolic syndrome. The individualised and multi-interventional treatment modalities, including constitutional assessment and therapy approach in Ayurveda, are coherent with the developing paradigms of precision medicine and lifestyle-based treatments. Identified areas of overlap are the understanding of adipose tissue as a dynamic, metabolically active organ system, the requirement for a personalised focus on constitutional metabolic diversity, the multifactorial aspects of metabolic disorders that necessitate a global approach to treatment, and the possibility of natural therapeutic interventions that simultaneously intervene in more than one pathway. Future research needs include mechanistic studies of traditional therapies within a contemporary framework, the development of integrative biomarkers, the design of novel clinical trials that embody Ayurvedic philosophy alongside the method-ology of evidence-based medicine. The reliable integration of these two knowledge systems necessitates collaborative, multidisciplinary actions involving traditional healers, modern scientists, regulators, and healthcare systems. Such an integration offers the potential to support the design of more effective, personalised and holistic strategies for metabolic health, which is prevalent in the increasingly obese and metabolically unhealthy world. This paper lays the groundwork for the evidence-based marriage of traditional wisdom with modern science, fostering the generation of innovative therapeutic strategies that pay due to ancient wisdom and modern rigour. This convergence shown here indicates that integrating Ayurvedic concepts with contemporary science of adipose tissue can make a substantial difference in metabolic health and bring a solution to society for the major health-related issue of the 21st century.

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