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Ayurvedic Perspective on Metabolically Healthy Obesity: Understanding Staulya and Medho Sara

Sumith Kumar M [1*], Pradeep Grampurohit [2], Sunil S. Jalalpure[3], Masood Ahmed Tahashilda[4]

1. PhD Scholar, KLE Academy of higher education and research, Belagavi, Karnataka – 590010 & Associate Professor, Guru Gorakshnath Institute of Medical Sciences, Mahayogi Gorakhnath University, Gorakhpur.

2. Professor, KLE Shri BMK Ayurveda Mahavidyalaya, Belagavi, Karnataka.

3. Principal and Professor, College of Pharmacy, KLE Academy of higher education and research, Belagavi, Karnataka

4. KLE'S BASIC SCIENCE RESEARCH CENTER, Belagavi

*Corresponding Author

*Email: drsumith@gmail.com

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ABSTRACT

Obesity is a condition characterised by the excessive or abnormal deposition of fat or adipose tissue in the body which leads to complicated health issues connected with several harmful impacts on well-being, including an increased risk of various medical diseases and considerable cost burdens on healthcare systems and society. This study analyses the Ayurvedic concepts of Staulya and Medho Sara about Metabolically Healthy Obesity (MHO) and Metabolically Unhealthy Obesity (MUO). Medho Sara, characterized by excellence in adipose tissue, correlates closely with the notion of MHO, where persons with obesity do not exhibit conventional cardiometabolic concerns. In contrast, Staulya, indicating pathological obesity, correlates more with MUO, defined by metabolic abnormalities and elevated risks of type 2 diabetes and cardiovascular illnesses.

The research intends to illustrate how comprehending Medho Sara and Staulya can aid in the early identification of high-risk patients for metabolic imbalances and cardiovascular illnesses. By merging traditional Ayurvedic wisdom with modern medical viewpoints, this study hopes to bring fresh insights into the holistic management of obesity. Clinical and laboratory examinations were undertaken on individuals with obesity to differentiate between Medho Sara and Staulya phenotypes based on numerous factors such as BMI, blood pressure, glucose levels, lipid profiles, and markers of insulin resistance.

The data demonstrated a prevalence of 30.1% for the Medho Sara phenotype among people with obesity, showing major disparities in clinical and biochemical parameters between the two phenotypes. Medho Sara residents were considerably younger, had lower BMI and waist circumference compared to Staulya individuals. Additionally, biomarkers associated with insulin resistance differed considerably across the two groups, with higher adiponectin levels in Medho Sara and lower uric acid levels compared to Staulya.

This study adds unique insights into the varied metabolic profiles within obesity via the lens of Ayurvedic principles, underlining the significance of tailored approaches for controlling obesity-related illnesses based on specific phenotypic traits. The merging of ancient knowledge with modern scientific understanding offers a viable option for furthering obesity research and improving individual health outcomes.

Keywords: Obesity, Metabolically Healthy Obesity (MHO), Metabolically Unhealthy Obesity (MUO), Medho Sara, Staulya, Insulin resistance

Introduction

Obesity is a condition characterised by the excessive or abnormal deposition of fat or adipose tissue in the body which leads to complicated and multifaceted health issues that is related to a wide range of negative effects on an individual's well-being. According to a historical review, obesity is highly connected to over 50 medical disorders, with evidence from Mendelian randomization studies indicating causality(1).

Some of the primary health repercussions of obesity include a higher risk of at least 18 co-morbidities, such as metabolic diseases and catastrophic health consequences(2). Additionally, obesity can contribute to psychological deficits, social stigma, and prejudice, affecting numerous elements of an individual's life(2). Furthermore, obesity is associated with an enhanced risk of diseases such as diabetes, heart disease, some malignancies, high blood pressure, high cholesterol, and breathing problems(3). The economic consequence of being overweight and obese, including direct medical expenditures and increased absenteeism, has also been well-documented(4). Therefore, understanding and addressing obesity is crucial for improving individual health and reducing the economic impact on healthcare systems and society as a whole.(5).

Ayurveda provides an inimitable way of understanding a person with a higher BMI in the form of *Staulya* and *Medho Sara*, the term *Medho Sara* (Excellence of adipose tissue) is constituted by two components i.e. *Meda & Sara* which means *Vishuddhatara Medho Dhatu* (Excellence of adipose tissues), which signifies the characteristics of a *Dhatu* (Tissue) physiologically in respect of its quantity, quality and functions. On the other hand, *Sthaulya* (Obesity) has been explained to indicate the pathological nature of Adipose tissue.

Medho Sara has high similarity to the current understanding of Metabolically healthy obesity (MHO) which is a notion drawn from clinical data that a subgroup of patients with high BMI does not exhibit overt cardiometabolic problems(6). It is characterised by the lack of metabolic abnormalities such as type 2 diabetes, glucose intolerance, dyslipidemia, hypertension, and inflammation, which are risk factors for cardiovascular diseases (CVD) (7).

Although there is no standardized definition of MHO, some proposed criteria include(6):

- Systolic blood pressure (SBP) ≤130 mmHg; diastolic blood pressure ≤85 mmHg
- Fasting blood glucose ≤ 6.1 mmol/l (≤100 mg/dl)
- Fasted serum triglycerides ≤1.7 mmol/l (≤150 mg/dl)
- HDL cholesterol serum concentrations >1.0 (>40 mg/dl) (in men) or >1.3 mmol/l (>50 mg/dl) (in women)

MHO has been associated with superior adipose tissue function, insulin sensitivity, and cardiorespiratory fitness compared to unhealthy obesity. Studies have shown that Individuals with MHO may have a lower risk of type 2 diabetes and CVDs, while the risk is still higher compared to healthy lean individuals(6).

The description of *Staulya* mentioned in *Ayurveda* can be more correlated to the definition of Metabolically unhealthy obesity (MUO) which is characterized by the presence of metabolic abnormalities, such as atherogenic dyslipidemia, insulin resistance, prediabetes and metabolic syndrome, which are most important four risk factors for type 2 diabetes and CVD (8).

This concept has implications for the study of persons with high BMI in the purview of *Medho Sara* and *Staulya* for the early identification of high-risk individuals or subgroups for prevention and treatment strategies

Aims and Objectives

The study aims to achieve the following objectives:

- To Explore the Ayurvedic ideas of *Medho Sara* and *Staulya* and their association with Metabolically Healthy Obesity (MHO) and Metabolically Unhealthy Obesity (MUO).
- Determine how knowing *Medho Sara* and *Staulya* can benefit in early detection of high-risk patients for metabolic imbalances and cardiovascular illnesses.

By addressing these aims and objectives, the study seeks to give new insights into the holistic management of obesity through an integrated approach integrating traditional Ayurvedic wisdom with modern medical viewpoints.

Materials and Methods

Individuals attending Utsaha OPD of KAHER Sri BMK Ayurveda Mahavidhyalaya, Belagavi with body mass index (BMI) >25 were approached to participate in the study.

The Data was collected through a structured questionnaire for assessing the basic characteristics mentioned for *Medho Sara* and *Staulya* as per Ayurveda classics.

Anthropometric and clinical assessments of *Medho Sara* and *Staulya* were performed as per the approved SOP guidelines.

Height was measured while standing without shoes to the nearest 0.1 cm using a calibrated stadiometer (Seca 213, Germany). weight was measured in light clothing without shoes and socks to the nearest 0.1 kg (Seca 803, Germany). BMI was calculated as weight in kilograms (kg) divided by the square of height in meters (m2). Waist circumference was measured twice to the nearest 0.1 cm over the skin midpoint between the tenth rib and the iliac crest at the end of a normal exhalation, using an inelastic measuring tape (Seca 201, Germany)

Systolic blood pressure (SBP) and diastolic blood pressure (DBP) were measured twice on the right arm using a digital sphygmomanometer (Omron HEM 7120) after 5 minutes of rest in a seated position with the arm supported at the heart level

Biochemical measurements

Blood investigations were conducted according to the principles of Good Clinical Practice that has its principles as reported in the Declaration of Helsinki. Experienced nurses and medical professionals conducted the venipuncture. Venous blood samples were promptly refrigerated and processed within 2 hours of collection at the Hospital Laboratory, Aliquots of serum/plasma were stored at -20°C for short-term storage or -80°C for long-term storage before examination in the Medical Research central laboratory. Fasting plasma glucose, total cholesterol, triglycerides, high-density lipoprotein-cholesterol, low-density lipoprotein-cholesterol, high-sensitivity C-reactive protein, adiponectin, and uric acid and were measured using an automated analyzer.

Selection of study participants and Definitions of measures

1. Participants having a BMI of > 25.0 were included in the study and classified as overweight and obese based on their BMI suggested by the world obesity federation.

2. Categorisation of the participants into Medho Sara and Staulya was done based on the classical description of Medho Sara and Staulya in Ayurveda Classics.(9)
3. Metabolic health classification was made as metabolically healthy or unhealthy based on a set of criteria,
   - Body Mass Index (BMI) ≥ 25 kg/m²
   - Fasted serum triglycerides ≤1.7 mmol/l (≤150 mg/dl)
   - HDL cholesterol serum concentrations >1.0 (>40 mg/dl) (in men) or >1.3 mmol/l (>50 mg/dl) (in women)
   - Systolic blood pressure (SBP) ≤130 mmHg; diastolic blood pressure ≤85 mmHg
   - Fasting blood glucose ≤ 6.1 mmol/l (≤100 mg/dl)
4. Age and gender: Participants belonging to an age group of 18 to 45 years with both male and female gender ranges to ensure a representative sample.
5. Participants were selected from different geographical sites to account for probable variations in diet, lifestyle and environmental factors.
6. A convenient sampling method representing the target population adequately was used to select 193 participants who fall under the inclusion criteria.

Statistical Analysis

The normality test for continuous data was analysed using the Kolmogorov-Smirnov test. Continuous variables were presented as mean (standard deviation) for normally distributed and median (25th percentile, 75th percentile) for non-normally distributed variables, and the differences between *Medho Sara* and *Staulya* were compared using an independent t-test and Mann-Whitney test respectively. Categorical variables were provided as frequency and proportion and comparisons between groups were done using the chi-square test. All analyses were performed using IBM SPSS 26.0 and statistical significance was defined at 2-sided $P < 0.05$.

Observations and Results

Overall, 305 participants gave consent to participate in the study and blood taking for the same. Out of these, 193 people with overweight and obese (BMI > 25) were examined for *Medho Sara* and *Staulya* phenotypes and obesity-related clinical and biochemical characteristics, using a convenient sampling technique.

The frequency of *Medho Sara* among adults with obesity was 30.1% (95% CI 23.7 – 37.1%) and the remaining 69.9% falls under *Staulya* phenotype.

The values factors used to define participants as either *Medho Sara* or *Staulya* like subjective parameters of *Ayata upachaya* (Improper growth), *Swedadhikya* (Excess sweating), *Daurgandhya* (Foul smell), *Ayasa Swasa* (Dyspnoea on exertion), *Nidradhikya* (Excessive sleep), *Snigdha Varna* (lustre), *Snigdha Kesha* (Hair), *Snigdha Pureesha* (Stool) and objective parameters like systolic BP, Diastolic BP, Fasting blood glucose test, HDL-cholesterol and Triglycerides were highly statistically significant between the two groups except for analysis based on BMI, which was significant at a p-value < 0.01 (Table 1).

TABLE 1 Comparison of parameters used as criteria to define Medho Sara and Staulya phenotypes

Parameters	*Medho Sara* n = 58	*Staulya* n = 135	p-value	n = 193

BMI	28.4 (3.3)	30.0 (3.9)	< 0.01	29.5 (3.8)
Systolic BP (mm Hg), mean (SD)	118 (9)	128 (11)	< 0.001	122 (11)
Diastolic BP (mm Hg), mean (SD)	84 (7)	93 (9)	< 0.001	86 (10)
Fasting blood glucose test (mmol/L), mean (SD)	5.13 (0.36)	5.37 (0.48)	< 0.001	5.30 (0.46)
HDL-cholesterol (mmol/L), mean (SD)	1.25 (0.16)	1.09 (0.21)	< 0.001	1.14 (0.21)
Triglycerides (mmol/L), mean (SD)	0.96 (0.31)	1.19 (0.50)	< 0.001	1.12 (0.46)

Among those with *Staulya* phenotype 52 (65.2%) exhibited only one among the four important risk factors for type 2 diabetes and CVD, 22 (28.1%) showed 2 risk factors, 6 (5.9%) had 3 risk factors and no one was found to have all four risk factors for type 2 diabetes and CVD. High blood pressure (SBP or DBP > 90th percentile) was the most represented risk factor (51.9%) across *Staulya* phenotypes and was considerably greater in males than in females (60.0% vs 41.7%, p-value = 0.03). Instead, high triglycerides (TG > 1.7 mmol/L) were the least detected risk factor among the *Staulya* phenotypic.

Medho Sara and *Staulya*, related clinical and laboratory parameters were presented in Table 2. *Medho Sara* phenotype was considerably younger [21.9 (2.2) vs 22.6 (2.1) years, p-value = 0.03)], had considerably lower BMI [28.4 (3.3) vs 30.0 (3.9) kg/m2, p-value < 0.01] and had significantly lower waist circumference [86.6 (8.5) vs 91.3 (9.8), p-value < 0.01)] as compared with *Staulya* phenotype. The prevalence of physical markers of insulin resistance including acanthosis nigricans (areas of dark, thick velvety skin in body folds and creases) was more common among *Staulya* than in *Medho Sara* (p-value = 0.03). Serum adiponectin was substantially greater (p-value < 0.01) in *Medho Sara* as compared to *Staulya* participants with values of 7.1 (2.4) versus 5.5 (2.1) µg/mL respectively.

In addition, serum uric acid was significantly lower in *Medho Sara* as compared to *Staulya* [364.7 (65.1) vs 389.5 (65.8) µmol/L, p-value = 0.04)].

TABLE 2: *Medho Sara* and *Staulya*, related clinical and laboratory parameters

Parameters	*Medho Sara* n = 58	*Staulya* n = 135	p-value	n = 193
Waist circumference (cm), mean (SD)	86.6 (8.5)	91.3 (9.8)	< 0.01	89.9 (9.6)
Body fat percentage, mean (SD)	42.3 (5.1)	42.3 (4.9)	0.97	42.3 (4.9)
Fasting insulin (µU/mL), median (q25, q75)	14.8 (10.2, 23.6)	17.0 (11.0, 24.7)	0.24	16.7 (10.7, 24.6)
HOMA-IR, median (q25, q75)	3.4 (2.3, 5.3)	4.0 (2.7, 5.6)	0.22	3.9 (2.4, 5.6)
Insulin Resistance, n (%)	28 (48.3)	78 (57.8)	0.16	106 (54.9)
HbA1c (%), mean (SD)	5.2 (0.3)	5.2 (0.3)	0.43	5.2 (0.3)
Acanthosis nigricans, n (%)	28 (49.1)	87 (65.4)	0.03	115 (60.5)
Total cholesterol (mmol/L), mean (SD)	4.67 (0.57)	4.45 (0.86)	0.05	4.52 (0.79)
LDL-cholesterol (mmol/L), mean (SD)	3.20 (0.73)	3.18 (0.87)	0.92	3.19 (0.83)
Uric acid (µmol/L), mean (SD)	364.7 (65.1)	389.5 (65.8)	0.04	382.3 (66.3)
Adiponectin (µg/mL), mean (SD)	7.1 (2.4)	5.5 (2.1)	< 0.01	5.9 (2.3)
Leptin (ng/mL), mean (SD)	24.8 (11.1)	25.7 (11.5)	0.73	25.5 (11.3)
Interleukin-6 (pg/mL), median (q25, q75)	1.7 (1.2, 3.1)	2.3 (1.6, 3.4)	0.09	2.1 (1.5, 3.3)

Discussion on Observation and Results

Study Findings looked into the prevalence of *Medho Sara* and *Staulya* phenotypes among persons with obesity, giving insight into their clinical and biochemical aspects. The findings gave new insights into the distinctions between these phenotypes and their connection with various risk factors and biomarkers.

The study revealed a frequency of 30.1% for the *Medho Sara* phenotype among people with obesity, showing a high occurrence of this phenotype within the group under examination and it was more common among younger age groups. This underscores the necessity of recognising and discriminating between these phenotypes in the context of obesity-related treatment plans and research. Compared to *Staulya*, *Medho Sara* individuals had significantly lower BMI, lower waist circumference, lower serum uric acid and higher serum adiponectin levels. Furthermore, *Medho Sara* phenotype was found to be more common in women than in men, and this may be attributed to differences in lifestyle, hormone levels and body fat distribution(10,11)

Among individuals with the *Staulya* phenotype, the distribution of risk factors varied, with high blood pressure being the most prominent risk factor. Interestingly, this risk factor demonstrated a gender gap, with a larger prevalence in Males compared to Females. Conversely, elevated triglycerides were less typically observed among individuals with the *Staulya* phenotype, indicating the heterogeneity in risk factor profiles within this group.

A study of clinical and biochemical markers between the *Medho Sara* and *Staulya* phenotypes found substantial differences. The *Medho Sara* phenotype was noticeably younger, had a lower BMI, and had reduced waist circumference compared to the *Staulya* phenotype. These findings underline the different metabolic features associated with each condition.

The study also highlighted changes in biomarkers linked with insulin resistance between the two phenotypes, Acanthosis nigricans, a physical indication of insulin resistance, was more common in persons with the *Staulya* phenotype, there is evidence indicating that acanthosis nigricans is a marker of glucose metabolism derangement and was linked with insulin resistance in obesity(12). The hyperinsulinemic-euglycemic clamp is widely regarded as the preferred method for detecting insulin resistance. However, due to its intricate nature and invasiveness, the most commonly used approach for evaluating insulin resistance is the calculation of HOMA-IR. Our study findings indicate that *Medho Sara* phenotype demonstrates a lower HOMA-IR score in comparison to individuals displaying the *Staulya* phenotype(13–16). It is important to highlight that 50% of the participants in our study exhibited insulin resistance. This implies that, in addition to obesity itself, variations in the genetic susceptibility of each individual to develop insulin resistance may also contribute. However, it is important to note that this is not the focus of this article.

Moreover, blood adiponectin levels were considerably greater in people with the *Medho Sara* phenotype, indicating potential metabolic differences between the two groups.

Notably, blood uric acid levels were much lower in those with the *Medho Sara* phenotype compared to those with the *Staulya* phenotype. This observation contributes to the detailed understanding of metabolic differences between different phenotypic groupings and may have consequences for developing treatment protocols or subsequent studies on obesity-related comorbidities.

The prevalence of *Medho Sara* in individuals of high BMI may be a transient phenotype, and it is essential to consider long-term follow-up, especially covering elderly people, in understanding the conversions between *Staulya* and *Medho Sara*. There is an inconsistent risk profile among obese individuals, suggesting the existence of a subgroup of obesity that is metabolically healthy.

It is essential to evaluate the combinations of environmental factors, genetic vulnerability, and the mechanisms encouraging weight increase and protecting a higher body weight in comprehending the variances between *Staulya* and *Medho Sara*,

Additionally, the incidence of *Staulya* and *Medho Sara* may vary based on the particular criteria used to describe these characteristics, and there are uncertainties in a reliable international comparison of obesity phenotype prevalence. Possible factors contributing to *Medho Sara* may be because these individuals have lower amounts of visceral and liver fat, which are associated with better metabolic health and can be understood from whole-genome transcriptome studies which have found distinct gene expression profiles linked with MHO(17), providing insights into the protective molecular processes in *Medho Sara.*

Our study revealed that individuals with the *Medho Sara* phenotype exhibited significantly lower BMI and waist circumference compared to those with the Sthaulya phenotype. However, it is important to note that these two measures of adiposity did not serve as predictors for the *Medho Sara* phenotype within the population under investigation. This finding suggests that there may be additional underlying factors that contribute to the MHO phenotype, even though obesity is a risk factor for metabolic morbidities(18). In addition, greater BMI found among *Medho Sara* in our study may be related to larger skeletal muscle mass and fat mass. Indeed, BMI has been described as a poor predictor of adiposity due to the inability to discriminate between body fat mass and lean tissue mass(19). These characteristics combined lead to the distinctive metabolic profile of *Medho Sara* individuals, demonstrating the intricate interplay of genetic, molecular, environmental, and lifestyle factors in the emergence and upkeep of metabolic health in the setting of obesity

Limitations of the study

Despite the remarkable outcomes in this study, some limitations need to be addressed. current studies on *Medho Sara* and *Staulya* had a small sample size, which limits the generalizability of the findings. As this was a cross-sectional study with no follow-ups, which limits the ability to assess the long-term health outcomes of *Staulya* phenotype of obesity.

Conclusion

In conclusion, the study on the Medho Sara and Staulya phenotypes among patients with obesity has exposed considerable differences in clinical and biochemical characteristics of these morphologies and this understanding may help in the early identification of high-risk people or subgroups for prevention and treatment methods. This can also lead to developing individualised interventions tailored to the individual's metabolic health state, thereby improving their entire health and minimising the financial impact on healthcare systems as well as society in general. Hence this study has potential implications for clinical practice and public health policies.

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