



Research Article

Agni as a predictor of Basal Metabolic Rate (BMR) in young adults using the Harris-Benedict Equation: Evidence from a cross-sectional analytical study

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Abstract

Background: India faces a severe rise in metabolic disorders, underscoring the need for reliable metabolic indicators. Although Ayurveda describes *Agni* as central to metabolism, scientific correlation of *Agnibala* with contemporary measures like BMR is insufficient. Objective: To evaluate whether *Agnibala* can predict Basal Metabolic Rate (BMR) in young adults by assessing the association between *Agni* levels and BMR estimated using the Harris–Benedict equation. Materials & Methods: A cross-sectional analytical study was conducted on 160 healthy adults (19–25 years) selected through quota sampling and classified into four *Agnibala* groups using a validated assessment tool. Anthropometric measurements were recorded, and Basal Metabolic Rate (BMR) was estimated using the Harris–Benedict equation. Data were analyzed using descriptive statistics, one-way ANOVA, Chi-square test, and t-test with $p < 0.05$ considered significant. Result: BMR showed significant variation across *Agnibala* groups in both sexes, with *Tikshna* exhibiting the highest and *Manda* the lowest mean BMR values ($p = 0.0001$). BMR/kg and BMR category distributions further demonstrated strong associations with *Agnibala*, as *Tikshna* predominantly showed above-normal BMR while *Manda* and *Sama* were mainly below-normal ($p < 0.05$). Conclusion: *Agnibala* showed a strong and consistent association with both absolute and weight-adjusted BMR, indicating its validity as an indicator of intrinsic metabolic efficiency. These findings scientifically support the *Ayurvedic* concept of *Agni* and highlight its relevance in assessing metabolic health in young adults.

Keywords: *Agni*, Basal Metabolic Rate, Harris–Benedict Equation, Metabolic Health

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Introduction

Recent global analyses indicate that the prevalence of metabolic diseases has escalated to epidemic proportions over the past two decades (1). Findings from the ICMR–INDIAB study demonstrate an alarmingly high prevalence of diabetes (11.4%), prediabetes (15.35%), hypertension (35.5%), generalized obesity (28.6%),

abdominal obesity (39.5%), and dyslipidemia (>81%) among Indian adults (2). This increasing burden underscores the pressing need for early identification of metabolic dysfunction and implementation of preventive strategies. Metabolic disorders are defined as conditions resulting from disturbances in biochemical pathways responsible for energy generation and the regulation of glucose, lipid, and protein metabolism, leading to an imbalance in overall metabolic homeostasis (3).

In Ayurveda, *Agni* is considered the fundamental principle governing digestion and metabolism and is regarded as essential for the maintenance of *Oja*, *Teja*, *Prana*, vitality, complexion, strength, and overall health (4). Derangement of *Agni* is believed to play a pivotal role in the pathogenesis of numerous diseases.

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Given its central role in maintaining metabolic equilibrium, a comprehensive understanding of *Agni* may contribute significantly to reducing the burden of metabolic disorders. The concept of basal metabolic rate (BMR), defined as the minimum energy expenditure required to sustain vital physiological functions at rest, shows conceptual similarity to *Agnibala* (5). Although review studies have discussed the role of *Agni* in metabolic processes, empirical evidence establishing a relationship between *Agnibala* and objectively measurable parameters such as BMR remains limited. For Ayurveda to effectively contribute to the prevention and management of metabolic diseases, *Agni* must be validated through standardized assessment tools and correlated with contemporary metabolic markers (6)(7).

Material and methods

This cross-sectional analytical study, conducted and reported in accordance with STROBE guidelines. The study was carried out at Shri Ayurved Mahavidyalaya, Nagpur where recruitment, assessment, and data collection were completed. Individuals aged 19–25 years who had not engaged in gym activities or structured exercise for at least one month were included, while those with diagnosed thyroid disorders, on hormone replacement therapy, or experiencing sleep disturbances for at least three nights per week over the past three months were excluded. Quota sampling was used to ensure equal numbers of males and females in each *Agnibala* category. 356 individuals screened, 160 healthy participants (20 males and 20 females in each of the *Manda*, *Sama*, *Tikshna*, and *Vishama* groups) were selected after applying inclusion and exclusion criteria and assessing *Agnibala*. *Agnibala* was assessed using a validated self-assessment tool developed in the study Development, validation and verification of a self-assessment tool to estimate *Agnibala*, and classification was based on predefined scoring criteria(8). Anthropometric measurements included height using a Health Tech 2m staturimeter and weight using a Dr. Trust USA digital weighing scale, recorded in light clothing without footwear. BMR was estimated using the Harris-Benedict equation for males and females and categorized as normal (1200–1400 kcal/day), below normal (<1200 kcal/day), or above normal (>1400 kcal/day). Bias minimization included strict eligibility criteria and quota sampling to reduce selection bias; validated tools and uniform measurement protocols to minimize information bias; and use of the Harris-Benedict equation, which accounts for age, height, and weight, to reduce confounding (9). Data were entered into Microsoft Excel, cleaned, and analyzed using STATA 14.0. Descriptive statistics summarized participant characteristics; one-way ANOVA compared mean BMR across *Agnibala* groups; Pearson's Chi-square test assessed categorical distributions such as BMR categories across *Agnibala* groups and gender; and Student's t-test compared male-female differences within each *Agnibala* group. A significance level of $p < 0.05$ was used, and findings were presented through tables and graphs as appropriate.

Observations and Results

The study demonstrated clear variation in BMR across *Agnibala* groups in both sexes. Among males, mean BMR increased from *Manda* (1466.53 ± 87.56 kcal/day) to *Sama* (1523.59 ± 123.21), *Vishama* (1622.64 ± 150.09), and was highest in *Tikshna* (1708.58 ± 145.96). Females showed a similar pattern, with BMR lowest in *Manda* (1339.70 ± 108.43) and highest in *Tikshna* (1459.35 ± 90.77). These differences were significant ($p = 0.0001$) (shown in graph 1). After adjusting for body weight, BMR/kg continued to

vary across groups. In males, the mean values were *Sama* (27.17 ± 2.06), *Manda* (26.91 ± 1.72), *Vishama* (26.43 ± 1.79), and *Tikshna* (25.69 ± 1.39) ($p = 0.0489$). Among females, BMR/kg ranged from *Vishama* (27.12 ± 2.35), *Manda* (26.81 ± 2.24), *Sama* (26.69 ± 3.12) to the lowest in *Tikshna* (23.41 ± 2.06) ($p = 0.0001$) (shown in table 1). BMR category-wise distribution also showed significant associations. In males, below-normal BMR was most common in *Manda* (65%) and *Sama* (55%), while 70% of *Tikshna* participants had above-normal BMR ($\chi^2 = 26.23$, $p = 0.000$). Females showed a similar trend, with below-normal BMR predominating in *Manda* (80%) and *Sama* (75%), and 80% of *Tikshna* falling in the above-normal range ($\chi^2 = 29.38$, $p = 0.000$) (Shown in graph 2 & 3).

Graph 1 Comparison of mean BMR among *Agnibala* groups in Males and Females

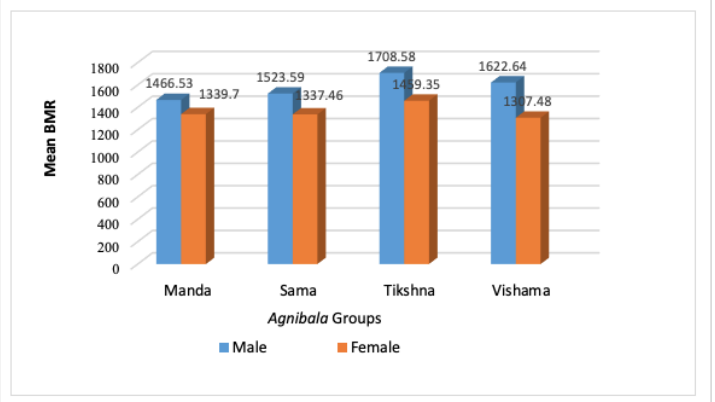
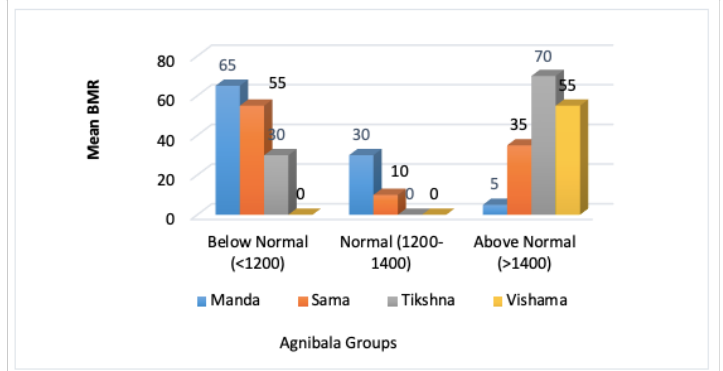
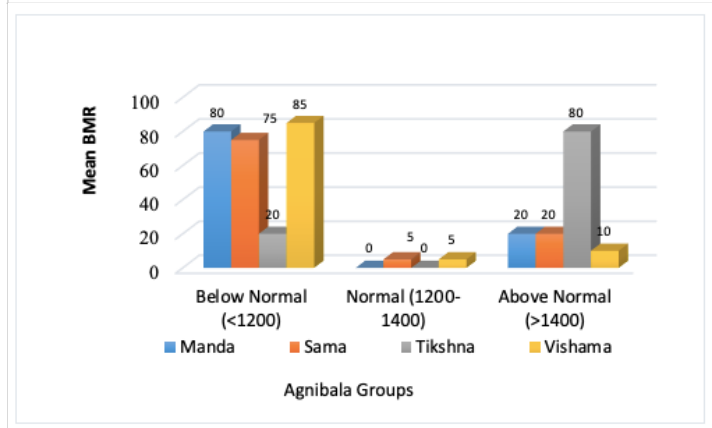


Table 1: Comparison of Mean BMR/kg among four *Agnibala* groups in Males and Females

Dominant <i>Agnibala</i> Groups	Male		Female	
	Mean BMR/kg	SD	Mean BMR/kg	SD
<i>Manda</i>	26.91	1.72	26.81	2.24
<i>Sama</i>	27.17	2.06	26.69	3.12
<i>Tikshna</i>	25.69	1.39	23.41	2.06
<i>Vishama</i>	26.43	1.79	27.12	2.35
P value ANOVA	0.0489 Borderline Significant		0.0001 Significant	

Graph 2: Distribution of *Agnibala* across BMR categories in males



Graph 3 Distribution of *Agnibala* across BMR Categories in Females

Discussion

The findings of the present study demonstrate a clear physiological reflection of classical Ayurvedic descriptions of *Agni*. Ayurveda describes four functional states of digestive fire, namely *Sama*, *Tikshna*, *Vishama*, and *Manda*, each governed by *doshic* predominance and associated with distinct metabolic characteristics. The absolute BMR values observed in these groups correspond closely with these traditional concepts (10) (11). Participants with *Sama Agni*, representing a balanced *doshic* state, showed moderate BMR values consistent with the steady digestive capacity described in classical literature. Individuals with *Tikshna Agni* displayed the highest metabolic output, which aligns with its classical portrayal as intense and rapid in function. *Manda Agni* showed the lowest BMR values, reflecting the sluggish digestive capacity attributed to *Kapha* predominance, while *Vishama Agni* displayed comparatively higher but variable BMR values paralleling its classical description as irregular in function (shown in figure 1) (12) (13) (14). Together, these observations provide empirical support for the Ayurvedic framework of *Agni* by demonstrating measurable variation in basal metabolic activity that corresponds to the four *Agni* types.

Within Ayurvedic physiology, *Agni* serves as the central regulator of digestion, assimilation, and metabolic transformation. *Jatharagni* governs the primary breakdown of food and the formation of *Ahara Rasa*, a process comparable to gastrointestinal digestion (15). *Bhutagni* transforms this nutritive essence in a manner similar to hepatic metabolism, and *Dhatvagni* operates at the tissue level where it parallels cellular enzymatic activity and mitochondrial oxidative processes (16) (17) (18). *Tikshna Agni* corresponds to heightened metabolic capacity reflected in efficient enzymatic function and increased thermogenesis, whereas *Manda Agni* corresponds to reduced digestive and metabolic activity similar to hypo-metabolic physiological states. These parallels indicate that both Ayurvedic and contemporary biomedical models describe the same fundamental processes related to the conversion of food into energy for homeostasis and physiological maintenance (19).

The analysis of BMR per kilogram of body weight was undertaken to reduce the confounding influence of body size and to evaluate whether metabolic differences persisted independent of weight. Although the pattern differed from absolute BMR values, BMR per kilogram continued to show statistically significant variation across all four *Agnibala* groups (shown in table 1). This indicates that the observed metabolic differences are not solely due to variations in body mass but reflect inherent

physiological distinctions linked to *Agnibala*. The persistence of significance after adjustment strengthens the robustness of the study outcomes (20). The distribution of *Agnibala* across different BMR categories further demonstrated clear variation in metabolic activity. Individuals with *Tikshna Agni* were predominantly represented in the above normal BMR category, whereas those with *Manda Agni* were mostly present in the below normal category. A considerable proportion of *Sama Agni* individuals appeared within the below normal BMR category when interpreted according to current biomedical reference values, despite exhibiting a balanced metabolic profile within their group (shown in figure 2 & 3). This observation highlights an important distinction between Ayurvedic interpretation and modern biomedical classification. Contemporary BMR reference ranges are largely based on Western population data, which may not accurately represent Indian physiological norms (21). Lower average BMR among Indian populations has been attributed to differences in body composition, climate, dietary habits, and levels of habitual physical activity (22). Therefore, individuals with *Sama Agni* may still possess a functionally efficient metabolism within the Indian context even if classified as below normal by Western standards. The broader literature supports the metabolic patterns observed in the present study. Research in subclinical hypothyroidism demonstrates reduced resting energy expenditure, increased leptin levels, and adverse lipid profiles, mirroring the features of *Agnimandya* described in Ayurveda (23). Similarly, individuals with obesity and type two diabetes often exhibit reduced metabolic rate and diminished thermogenic response, which parallel the Ayurvedic understanding of *Kaphaja* conditions marked by chronic *Agnimandya* and metabolic stagnation (24) (25) (26). In contrast, conditions such as Graves' disease are associated with markedly elevated BMR and increased heat production, which correspond to the characteristics of *Tikshnagni* described in Ayurvedic texts (27). The present findings show a similar pattern: participants with *Mandagni* demonstrated lower BMR consistent with hypometabolic states, while those with *Tikshnagni* displayed higher BMR consistent with hypermetabolic physiology. These parallels reinforce that *Agnibala* represents a physiologically meaningful indicator of metabolic function and offer a valuable bridge between classical Ayurvedic theory and contemporary metabolic science (28) (29).

Conclusion

The present study establishes a significant positive association between *Agnibala* and basal metabolic rate, affirming that individuals with stronger *Agnibala* demonstrate higher absolute BMR values. The analysis of BMR per kilogram further confirmed that these metabolic differences persist even after adjusting for body weight, indicating that *Agnibala* reflects an inherent physiological characteristic rather than a mere effect of body size. The distribution of participants across BMR categories also aligned with classical Ayurvedic descriptions, with *Tikshna Agni* individuals predominantly falling in higher BMR categories and *Manda Agni* individuals clustering in lower ones, while *Sama Agni* maintained a balanced metabolic profile. These findings collectively validate *Agnibala* as a meaningful indicator of metabolic efficiency and energy utilization. The study thus provides scientific support for the Ayurvedic concept of *Agni* and highlights its relevance as an important parameter in assessing metabolic health in young adults.

Conflict of interest: None

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