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Panchakarma Detoxification: A Scientific Review of Physiological Changes Before and After Therapy

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Abstract

Panchakarma, a core detoxification therapy of Ayurveda, is traditionally believed to restore dosha balance and eliminate accumulated toxins (âma). This review synthesizes scientific evidence on the physiological changes occurring before and after Panchakarma therapy across multiple biological systems. Historical Ayurvedic concepts of detoxification show notable parallels with modern biomedical parameters, including metabolism, inflammation, neurophysiology, gastrointestinal function, and cardiovascular regulation. Contemporary studies report alterations in metabolic markers such as plasma glucose, lipid profile, cortisol, thyroid hormones, uric acid, and creatinine, suggesting improved metabolic homeostasis. Evidence also indicates modulation of immune responses, enhanced parasympathetic activity, and changes in brainwave patterns following therapies such as Snehapana, Basti, Virechana, and related interventions. Digestive and gut microbiome changes—including variations in bile acids, motility, and short-chain fatty acids—highlight a possible mechanistic link between Panchakarma and microbial metabolite clearance. Cardiovascular findings show improved blood pressure, vascular flexibility, and heart-rate variability, particularly when Panchakarma is complemented with yogic breathing practices. Despite promising outcomes, methodological limitations, nonstandardized protocols, and small sample sizes restrict definitive conclusions. Overall, available evidence suggests that Panchakarma exerts multisystem physiological effects consistent with detoxification processes and warrants rigorous evaluation within integrative healthcare frameworks.

Keywords: Panchakarma, Detoxification, Physiological Changes, Metabolic Regulation, Ayurveda, Inflammation Markers

Introduction

Panchakarma detoxification is associated with a multitude of physiological changes purported to confer health benefits. The scientific literature describing these changes remains largely anecdotal, lacking coordinated study of endpoints and comparison of pre- and posttherapy states. This work seeks to address previously identified systemic targets of Panchakarma and to compile underexplored empirical evidence of corresponding changes. The overarching hypothesis posits that, despite considerable biological diversity across study designs, systematic effects are distinguishable in physical, metabolic, immunological, neurological, digestive, cardiovascular, renal, hepatic, and other systems.

The concept of detoxification evidences an ancient lineage that continues to inform modern practice; physiological targets established by traditional texts correspond with contemporary biomedical parlance. Core observations include the routine elimination of wastes from the body and the Ashud data- a three-dimensional pictorial representation of health illustrating Shudhi, Mudhata, and Teja- suggesting although biological diversity is largely observed in the description of activities, systemic functioning does maintain commonality. A complex systemic integration of detoxification is emphasized, linking Karekls to general Ras, differences previously observed in pure or gross substances, modern physiology correlates well with excreta-based Karekls, transport across Kapha surplus conditions, and Grabhodgars with systematic development of the embryo. Panchakarma aims to reduce poisons linked to broad-spectrum sources including rasayan, food, and stress often referred to as the six substantial Dhatus, a reliable modeling of different activities corresponding well with accumulation and elimination observation of detoxification. Panchakarma is thus hypothesized to possesses a systematic effect in detoxification with modern methodological examination enables research planning (Ranjan & Kumar Sharma, 2012).

Historical Foundations and Conceptual Framework

Panchakarma is a detoxification therapy based on Ayurvedic medicine. Ayurvedic practitioners believe that the human body is made up of three doshas: Vata (air), Pitta (fire), and Kapha (earth). The doshas control different bodily functions, and their balance is necessary for both physical and mental health. Outside factors can perturb the dosha balance and inhibit detoxification processes, leading to the accumulation of toxins (ama). Panchakarma involves five interventions designed to regulate doshas, mobilize, expel ama, and restore tissue healing. All detoxification therapies, alternative and mainstream, are sometimes confounded by a validity paradox. The mechanisms of detoxification therapy have not been decisively established, yet therapies continue to attract researchers and patients. Those pursuing biomedical, physiological, or mechanistic understanding of Panchakarma framework would benefit from clarity on how its essential features can be articulated in modern terms, opening bridges to broader biomedical discourse without denying core principles of the Ayurveda system (Ranjan & Kumar Sharma, 2012) (Swathi et al., 2021).

Methodologies in Panchakarma: Procedures and Classifications

Panchakarma therapy consists of a series of procedures that are traditionally organized into the five cleansing therapies of Vamana, Virechana, Basti, Nasya, and Raktamokshana. Various intervention durations are prescribed depending on the selection and sequence of procedures; five to 30 consecutive days is a common range, accommodating a broad diversity of protocols and practice styles (Swathi et al., 2021). Despite extensive contemporary documentation and research, considerable variation exists among both practitioners and academic sources regarding the specific procedures included within the Panchakarma framework, the recommended number and combination of therapies, and the suitability and even designation of individual techniques as Panchakarma at all (Kumar Dass et al., 2012). The relatively narrow set of procedures examined in published clinical studies is summarized.

Physiological Systems Affected by Panchakarma

Panchakarma preparations are expected to modulate a diverse array of physiological systems on numerous biomarkers. One potential systemic target is metabolism and energy regulation, which is associated with a greater variety of candidate biomarkers. Modern practitioners and researchers frequently invoke the notion of detoxification. Changes in exposure and in bodily stores are expected to affect a variety of parameters associated with detoxification and cleansing. Similarly, practitioners frequently invoke the notion of reducing inflammation. Inflammation has come to be recognised as a generalised process involving changes in many

systems, linked in both classical and modern notions to the elimination of toxins, and represents a large space of candidate physiological endpoints. The importance of maintenance of homeostasis is elevated, with restoration of balance considered a fundamental need to support the general process of healing. A wide range of parameters related to homeostasis is available for measurement. The gastrointestinal tract is highlighted, with the prevention of potential toxins entering the body via food considered a potential priority. A wide variety of parameters measured in contemporary work map directly on to the functions of the gastrointestinal tract, and the microbiome is increasingly viewed as a central piece of modernity, with attention devoted both to the composition of the microbiome itself and to metabolites such as short-chain fatty acids. These targets stand on their own technical merit, with attention afforded to bioenergetic balance (Ranjan & Kumar Sharma, 2012).

Metabolic and Endocrine Alterations: Panchakarma therapy is said to promote the elimination of toxic metabolic residues (âma) and to restore the normal supply of nutrients (rasa) through the application of purifying (úodhana) treatment. This detoxification process is expected to bring broad-spectrum physiological changes. Changes in basal metabolic rate have been posited to increase wastage of toxic residues (âma) and restoration of normal functions of the body, which has direct correlation with the parameters listed under the standard metabolic rates. The following parameters were selected for which there is solid literature support that they can be modified by the scheduled interventions. These include plasma glucose, lipid profile (Rais & Bhatted, 2013) , lipid peroxidation, cortisol, total cholesterol, uric acid, creatinine, BUN, T3, T4, ketogenesis, insulin levels, weight, and water intake.

Immunological and Inflammatory Responses: Clinical applications of Panchakarma are thought to support detoxification, rejuvenation, and restore homeostasis through physiological rebalancing. Guidelines describe ailments targeted by intervention or indicate therapeutic objectives aligned with ayurvedic health concepts. Recharge and restore nourishments, for instance, favour rejuvenation or depletion recovery. Similarly noted is eligibility for revival of depleted or obstructed dhatus, strictly evidenced by macro items (e.g. lustre, flexibility, urge satisfaction). Such concepts lack direct contemporary scientific correspondence (B Prakash et al., 2024). The pivotal physiological determinants identified for theragnostic specification thus concern metabolic and endocrine processes. Evidence points to improved insulin sensitivity, reduced glucose and lipid dysregulation, normalised trajectories for blood glucose and cortisol, and adjustment of the thyroid axis to prevailing conditions. Dependent mechanisms of action potentially include elevated autophagy in absence of feed, augmented lipolysis and ketogenesis under energy deficit, enhanced intramyocellular fat mobilization, modulation of the gut–brain axis, and shift towards expanded single-day energy capacity.

Neurological and Autonomic Nervous System Modulations: In traditional Ayurveda, the constitution of an individual is based on Saptadhatu or Seven Dhatus: Rasa (lymph), Rakta (blood), Mamsa (muscle), Meda (fat), Asthi (bone), Majja (marrow), and Shukra (reproductive). The process of Panchakarma begins with Snehapana which not only nourishes Shuktadhatu but also increases the quantity of brain tissue, prevents degeneration, and maintains mental health (Sitaram Jaideep et al., 2014). The process of Panchakarma therapy provided for 21 days was analyzed for its effect on brain waves and parameters of neurological function before and after the therapy. Results indicated an increase in parasympathetic activity and higher activity in the alpha, beta, and gamma frequency ranges. Ayurveda has evolved into a widely practiced science. There is a growing interest in scientific studies of Panchakarma therapy and literature review (Malhotra et al., 2022). Before and after Panchakarma therapy developed in India. Brain wave patterns and neurological parameters in subjects of 20 to 60 years of age, before and after Panchakarma therapy were analyzed and statistically analyzed for the subjects of both genders and the significance of therapy.

Digestive System and Microbiota Impacts: Gastric and Small Intestinal Motility: Gastric

emptying time (GET), small intestinal transit time (SITT), gastric acid and bile secretion, and intestinal digestive enzyme activity played pivotal roles in every therapeutic session. The effectiveness of decoctions, foods, and other products of digestion depended on the timely arrival at the site of action. A delay would result in ineffectiveness or adverse effects (Vishwas Ranade et al., 2020). Bile Acids: Every therapy session exhibited a specific effect on the bile acid pool and metabolic symptoms such as energy, craving, appetite, and activity. Microbiome and Short-Chain Fatty Acids (SCFAs): Panchakarma therapy, especially Virechana and Basti, induced significant changes in the human gut microbiome. The classical schools of thought in Ayurvedic physiology already correlated the functions of the gut microbiome and closely related concepts, such as the absence of lethargy and the movement of Prana throughout the body (Rew et al., 2022).

Cardiovascular and Hemodynamic Changes: The first line of defence of the body against pathogens is the immune system. Immune system is governed by hormones which also controls metabolism through Feedback mechanism and regulates nutrients supply to the organ. The study of Virechanakarma (therapeutic purgation) with special reference to serum electrolytes. The procedure was preceded and followed by administration of Trivrit (Operculina turpethum) deobstruent powder and no adverse events were reported. All the subjects' serum electrolytes were within normal range at all measurements and significant statistical difference was not obtained between pre- and post procedure readings. A treatment protocol of panchakarma should be welcome by the scientific community for smooth conduction of clinical research (Rais & Bhatted, 2013). Kapalbhati (KB) is a popular pranayama which results in unidirectional, forceful expulsion of air through the nose without any inhalation. Immediate hemodynamic effects of KB, with or without relaxation, on cardiovascular parameters of healthy subjects were evaluated. None of the measurements of heart rate, stroke volume, and cardiac output changed significantly after practice, either immediately or after 10 minutes of relaxation. After 10 minutes of Savasana rest, however, significant changes in cardiovascular parameters were observed leading to the conclusion that KB practice, when followed by a period of relaxation, promotes parasympathetic dominance and decreases sympathetic activity, which could be beneficial in stress-related conditions, without altering cardiac output (Malathi, 2018).

(i)Blood Pressure and Vascular Function

Panchakarma detoxification is associated with significant changes in blood pressure and vascular function. Several studies assessing outpatient Ayurveda treatment have reported decreases in systolic and diastolic blood pressure (Mashyal et al., 2014). Changes in vascular function include decreased arterial stiffness as measured by pulse wave velocity and enhanced endothelium-dependent flow-mediated dilation, pointing to improved vascular function. The mechanisms by which these interventions exert their effects remain undetermined, but they present an intriguing opportunity for further research on the physiological basis of detoxification. The measurement of blood pressure (BP) is essential in clinical practice. BP tells the practitioner about the patient's cardiovascular and metabolic health and is a good predictor of future cardiovascular events. It is particularly important in patients with lifestyle-related ailments. Elevated BP, especially the systolic component, is associated with increased cardiovascular risk. Global estimates suggest that over 1 billion people worldwide suffer from hypertension. Health-care providers measure BP through physical means, such as a sphygmomanometer, or by using ambulatory BP monitoring devices. Standard practice involves measuring BP at a clinical setting, which is called clinic BP reading. It has been observed that clinic BP readings do not behave in the same way as ambulatory BP. BP pattern, which is the trend of rise and fall of BP during 24 hours, is different among different types of patients.

(ii)Heart Rate Variability

Meditation-based stress reduction programs, including yoga, can enhance heart rate

variability (Zou et al., 2018) and reduce perceived stress, thus balancing the autonomic nervous system and fostering relaxation . Specific mind-body practices, such as qigong, tai chi, and evocative (chanting) meditation may have advantageous effects on heart rate variability (HRV) in clinical populations while evoking different longitudinal patterns. Interventions of varying intensity have been observed to elicit an initially greater increase in HRV but ultimately a lower final change than low-intensity methods. Heart Rate Variability is a critical physiological marker influencing stress reactivity, mood, and health. Stress induces a rapid reduction of parasympathetic vagal tone, increasing risk for several diseases. Regular physical exercise enhances vagal tone, decreasing stress reactivity. Mind-body workouts, such as yoga, tai chi, and qi gong, have demonstrated positive effects on HRV and health, promoting exercise-friendly interventions offering additional benefits.

Safety, Adverse Events, and Risk Assessment

Health professionals acknowledge the need for evidence supporting the safety of detoxification methods, such as the Ayurvedic Panchakarma regimen. Clinical safety research of Panchakarma remains limited, and available studies present a diverse collection of information. For example, one Ayurvedic institution conducted an observational study assessing safety on patients recruited to a Virechanakarma program, an intervention involving therapeutic purgation. Electrolytes remained within normal ranges and no adverse events were recorded. Nevertheless, the small sample generated low confidence in the findings, indicating the necessity of investigating safety in larger cohorts and examining other Panchakarma procedures (Rais & Bhatted, 2013).

Evidence Synthesis: Clinical Trials and Observational Studies

Research articles in which Panchakarma is the principal intervention have been conducted at the National Institute of Ayurveda in Jaipur and the I.P.G.T.R.A. in Jamnagar. Experiments have focused on Manovaha Srotas and a range of assessment techniques employed to gauge effects (Ranjan & Kumar Sharma, 2012). The Ayurvedic treatment for chronic liver disease corresponds well with contemporaneous pathology (Tubaki et al., 2022). Positive results were observed after several months of intervention, even though disturbances of physiological and biochemical parameters persisted, indicating the severity of the underlying disruption. Interventions included administration of Shodhana, Shamana, and Chedana therapies; significant changes were recorded in one of the three groups. Investigations of Shatkarma demonstrate enhancements to respiratory function, digestive health, cognition, and relaxation, along with meditational and overall health benefits (Swathi et al., 2021). Although the literature does not provide a clear answer to the relevance of these findings, the studies indicate that positive changes are associated with Ayurveda practices. This evidence warrants the formal evaluation of Ayurvedic procedures through recognized scientific criteria. Different physiological parameters have been conjectured to be affected, both directly and indirectly.

Methodological Considerations and Gaps in Current Research

Numerous methodological issues, measurement gaps, and standardization challenges impede the accurate characterization of physiologically relevant changes associated with Panchakarma. Most studies employ subjective outcomes, instructor assessments, or unverified questionnaires, while only a few quantify the individual elements of the intervention, control for concomitant practices, or clarify their regulatory status. The uncertainties surrounding dosage, duration, and timing further complicate the interpretation of findings. Few scholars address these constraints or offer specific suggestions for systematic improvements. More than half of the clinical investigations lack sufficient detail, hindering reproducibility and even basic comprehension of the intervention (Gupta & Dhawan, 2022). Credible evidence of the physiological effects of Panchakarma emerges predominantly from low-quality nonrandomized

studies that report only aggregate alterations without specifying—let alone controlling for—potential confounding factors. Subjective evaluations and nonvalidated instruments dominate the outcome measures. Consequently, discerning the specific systems that might exhibit biologically significant changes before and after treatment remains a challenge (Swathi et al., 2021). Studies addressing these concerns typically focus instead on the effects of Yoga or its auxiliary components, inhibiting the generalization of such investigations to other scenarios.

Mechanistic Hypotheses and Biological Plausibility

Panchakarma therapy entails a series of interventions that aim to induce detoxification. Autologous excretions of metabolites of microbiota origin accumulate in the body over time and are postulated to impede physiological function, leading to a range of disorders. Consequently, the gut microbiome and faecal metabolites are regarded as potential factors underpinning health. Dietary and lifestyle changes together with Panchakarma therapy, which adheres to the Ayurvedic principles of Ahara (diet), Vihara (lifestyle), and Aushadha (medicinal therapies), aim to harmonise gut microbiota and reduce toxic accumulation. Savalya Ayurveda, a chain of Panchakarma clinics based in Kerala, India, highlights the importance of dietary and lifestyle adjustments accompanying the therapy. Panchakarma strategies are designed to prioritise Mamsa meda shodhana, the detoxification of muscles and fat, and the excretion of lipopolysaccharides and â-glucuronidase-rich metabolites that are thought to inhibit Amino Acid Decarboxylase (AA-D), a pathway linked to intestinal and systemic disorders. The detailed changes that the protocols and interventions incorporated to the detoxification regimen impose upon humans remain, nevertheless, poorly characterized and thus are examined as part of this review. The following four pathways that connect the set of interventions to the changes highlighted in preceding sections are subsequently proposed: hormonal modulation, autonomic nervous system control, gut microbiome manipulation, and microbial metabolite excretion. (Mondal, 2024)

Practical Implications for Integrative Healthcare

The findings of this review offer an evidence-based foundation for the selection of Ayurvedic Panchakarma detoxification in integrated healthcare settings. The therapy encompasses a set of standardized physical and material interventions, implemented simultaneously or sequentially for multiple days, targeting a range of physiological systems. The direction of change in key physiological parameters consistently aligns with effects sought by processes classified as detoxification in diverse cultural and historical settings.

Panchakarma is versatile enough to address concerns associated with direct chemical exposure—here termed "contaminants"—as well as metabolic toxins linked to the evolution of modern lifestyles—termed "inconveniences." Contaminants can originate from multiple exogenous sources. In Indian contexts, statutory limits for drinking-water contaminants are periodically revised downward (D Lennox & Cecchini-Sternquist, 2018) , while the health record of the Ganges basin illustrates the burden of unregulated chemicals. The spirit of Panchakarma also encompasses Sanskrit terms for detoxification not restricted to particular substances, emphasizing the beneficial elevation of complex urban and digital exposures by these procedures. Applied to selected aspects of urban metabolism, the detoxification profile engendered by Panchakarma likewise resonates with an evidence-based description of modern toxins. Wide-ranging physiological effects in humans are produced by interventions designated in Ayurveda as detoxification and supported by biomedical literature, providing a mechanistic basis for plausibility.

Conclusion

Given the extensive period of evolution and adaptation of the Ayurvedic therapy of "Panchakarma", it is not easy to find scientific reference points to establish reproducible and

clear protocols. Nevertheless, PK applications have been shaped into a consistent set of detoxification therapies that more than a hundred years ago were scientifically introduced as repositioning a disturbed "vital force" (dosha). Since then, many further attempts have been made to connect PK with modern science, e.g. through the use of botanical preparations in connection with Ayurveda "prescriptions". Such attempts provided some links with the recent field of epigenomics but did not make any less clear the link to modern scientific protocols as established by Albert Hoffmann and others. As a consequence, the present review is intended to gather available evidence from publications on physiological and biological parameters about normal states before and after PK applications in humans and in animals. Brought together across disciplinary boundaries, it illustrates the extent and the type of effects of PK applications. Biological effects can be shown for four medical systems, covering metabolism, the immune system, the nervous system, and behaviour. Selected comments are made primarily around metabolism, which is the medical system with most robust data and constitutes a classical key edge of toxicological literature. Results collected across four medical systems also allow a measure of alignment and characterisation of the level and class of the biological information generated. Finally, links and trajectories are proposed to professional detoxification approaches based on the work of earlier investigators such as Albert Hoffman.

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