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Review

# Digital addiction in children and herbal pharmacotherapy: A scientific review

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**ABSTRACT:**

**Background:** Technology is an integral part of daily life; children overly reliant on digital devices for entertainment, social interaction, and even learning. Besides the ample usefulness in education, opportunities, and access to knowledge the negative consequences include impaired social skills, reduced physical activity, altered sleep, tantrums, anxiety and depression. Other risks include eye strain, refractive errors, headaches, poor attention, concentration and postural defects. **Objective:** To explore herbal pharmacotherapy for digital addiction in children. **Methods: Search strategy:** A comprehensive literature review done through open access, full text publications in English on digital addiction (DA) for last 10 years. Database searched were PubMed, Google Scholar and Science Direct with key words complying with MeSH namely 'Digital Addiction in children and adolescent', 'Internet Addiction', 'Computer Addiction', 'Video Game Addiction', 'Smartphone Addiction' and 'Social media addiction' using Boolean operator ('AND' 'OR' 'NOT'). Duplications, citations, bibliographic index, textbooks, validation studies were excluded. **Results:** Initially 17151 articles identified, subsequently curtailed to 800 through preliminary screening. After applying inclusion and exclusion criteria, 175 publications were identified of which 54 most relevant manuscripts were referenced in this write up. Out of them 40 papers primarily focused on over view of DA, its pathophysiology, underlying brain mechanisms and existing interventions rest 14 explored herbal interventions. Ayurveda concepts were deduced based Samhita and Ayurveda pharmacopeia. However, plant-based interventions specifically targeting digital addiction largely remained unexplored and under researched except for few to treat substance abuse. **Conclusion:** At the outset nootropic medicinal plants from Ayurveda pharmacopeia were promising to treat DA based on preliminary research. Further longitudinal research and controlled studies essential to establish their safety and efficacy.

**KEYWORDS:** *Atatvabhinivesha,* Addictive behavior, children, digital addiction, *Medhya Rasayana, Prajnaparadha,* internet addiction, media addiction, AYUSH

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## 1. INTRODUCTION

The world is in the era of digitalization. Hence, technology has crept in to every walk of life. Recently there is an extensive integration of digital technology into the daily lives of children as well. Smart phones, tablet and computers are present everywhere with children transforming the way they learn, interact, and entertain themselves. These digital devices have even reduced the burden and time involved in dissemination of knowledge, assignments, updates, evaluation, documentation and tracking system. With technology becoming an integral part of daily life, children are overly reliant on these digital devices for entertainment, social interaction, and even learning. Besides the ample usefulness in education, opportunities, access to knowledge, its dependence is leading to negative impact. The negative consequences may include impaired social skills, reduced physical activity, altered sleep, tantrums, anxiety and depression. Other health risks include eye strain, refractive errors, headaches, poor attention, concentration and postural defects. There have been grey areas on to why and how the children behave indifferently with excess attachment to digital media, their mechanism, whether there is any role of environment, gender, socioeconomic status on such digital dependence and long term consequences. The rationale behind the existing intervention strategies and prevention needs to be explored. Thus this narrative review will focus on addressing the above said knowledge gaps and emphasize their importance in the context of modern parenting styles, education and healthcare. This would also aid in designing intervention strategies with an outlook on herbal interventions, future research and policymaking in order to mitigate the adverse effects on child health while ensuring the continued benefits of techno innovations for children.

Digital addiction (DA) is an “addictive behaviours” associated with using digital devices such as mobile phones, computers, the Internet, video games, and social media. [1] It denotes a problematic relation to the technology described by being compulsive, obsessive, impulsive, and hasty. [2] Although a consensus on the definition and diagnostic criteria of DA has not yet been finalized, internet Gaming Disorder is identified within the Diagnostic and Statistical Manual of Mental Disorders, 5th Edition, (DSM-5), [3] and in International Classification of Diseases, 11th edition by World Health Organisation. [4] Thus, certain aspects of DA are identified and categorized for further research. Consequently, intervention strategies for individuals seeking professional help for various types of DA such as Internet Addiction, Gaming Addiction, and Social Media Addiction have been proposed [5–7].

## 2. METHODOLOGY

**Search strategy:** A comprehensive literature review done through open access, full text publications in English on digital addiction (DA) for last 10 years. Database searched were PubMed, Google Scholar and Science direct with key words ‘Digital Addiction in children and adolescent’, ‘Internet Addiction’, ‘Computer Addiction’, ‘Video Game Addiction’, ‘Smartphone Addiction’ and ‘Social media addiction’ using Boolean operator (‘AND’ ‘OR’ ‘NOT’). Duplications, citations, bibliographic index, textbooks, validation studies were excluded.

## 3. RESULTS:

Initially 17151 articles were identified, subsequently curtailed to 800 through preliminary screening. After applying inclusion and exclusion criteria, 175 publications were identified of which 54 most relevant manuscripts

were referenced in this write up. Out of them 40 papers primarily focused on over view of DA, its pathophysiology, underlying brain mechanisms and existing interventions rest 14 explored herbal interventions. For establishing review, conceptual articles focussing on definition, causes, features and management were included. Additionally, articles on pharmacotherapy, cognitive behaviour therapy and medicinal plants to treat DA were referred for getting insights and evidences on current trends. Digital addiction as Ayurveda principles was deduced by referring various Samhita and publications. Ayurveda pharmacopeia was searched gather information on medicinal plants. The information gathered on Digital addiction in children is presented under various headings below.

**Prevalence:**

Recent researches identify DA as a Global Health Problem. Prevalence of global Internet use disorder was estimated to be 6.0% among 12–41 year-olds. [8] yet another study revealed a global internet gaming disorder (IGD) prevalence of 4.6% amongst adolescents aged 10 to 19 years. [9] Invariably these numbers are different for different geographic locations and there could be an increasing trend over the years. In a survey of 11,438 students in grades 7–12 by National Centre for Addiction and Mental Health, 20% of students spent 5 hours or more daily on social media, 23% play video games almost every day, and 30% use various electronic devices. Approximately 5% of them reported signs of addiction. [10] In a cross sectional survey from Saudi Arabia, IGD prevalence was 29.3% in children aged between 12 to 18 years. [11] Brazilian study involving 555 students aged between 14 and 25, IGD prevalence was 38.2%. [12] In an Indian study from Maharashtra IGD was 10.6% among 13–19-year-old students. [13] While it was still higher in a study amongst college students done in the year 2024. [14]

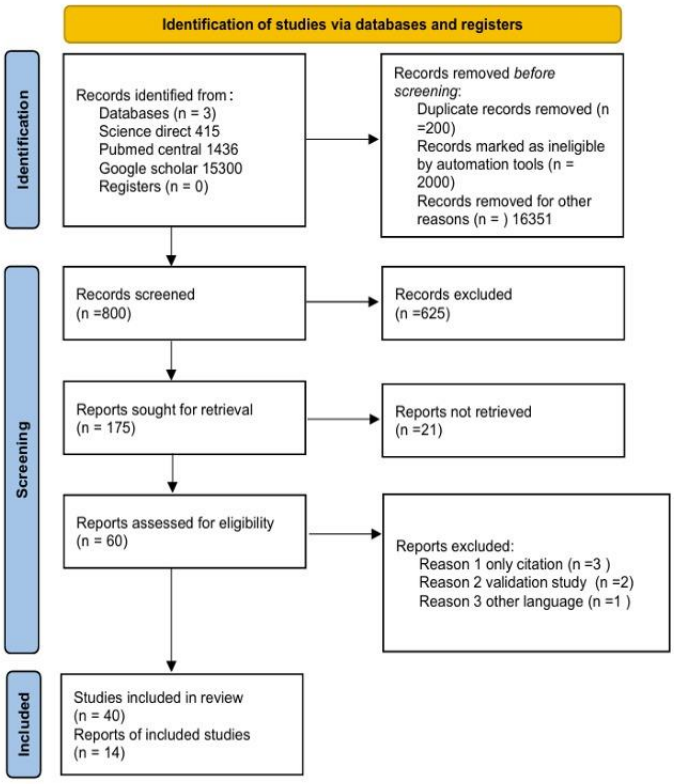


**Figure 1: PRISMA 2020 flow diagram**

**Causes of Digital Addiction**

Overly shy persons who cannot easily relate to their peers are at a higher risk of developing a digital addiction. [15] Persons with lack of emotional support, [16-17] low self-efficacy and stress. [18] Anxiety and depression [19] loneliness, desire to relate to others and childhood trauma can increase screen time in adolescents, thus making it addictive. [20] In a meta-analysis on screen addicts in adolescents by Lozano-Blasco R, [21] personality elements such as introversion, inhibition, submissiveness, self-evaluation, interpersonal sensibility, obsessive–compulsive tendencies, phobic anxiety, hostility, paranoia, borderline personality, and low self-esteem are known to precipitate Internet addiction. [22-25] Other risk factors include dysfunctional families with conflicts, poor communication,

absence of social support and boredom which can lead to development of addiction to new technologies. [16, 22, 25, 26]

**Types of digital addiction:**

Young K described five types of online addictions as Computer (games) addiction, Information overload, Net compulsions, Cyber-sexual addiction and Cyber-relationship addiction. [27] The latest Social network addiction may be included in the last category. Various internet addictions identified by Gandolfi include Facebook Addiction Disorder (FAD), YouTube Addiction Disorder (YAD), Google Search Addiction Disorder (GSAD), Widget Addiction Disorder (WAD), Twitter Addiction Disorder (TAD) and Blackberry Addiction Disorder (BAD). [28] Based up on the severity of obsession digital addiction can be classified as mild, moderate and severe. This assessment is based on rating scales to assess the severity of addiction in an individual. Factors such as the amount of time spent online, the degree of impairment in daily life and the presence of withdrawal symptoms are the basis to rate the severity in the scales.

**Factors influencing DA:**

a. **Gender influence:** Digital addiction was seen more in boys and also associated with a longer average gaming time per week. [29-34] The selection of the games, specific risk and behaviors associated with gadgets and gaming are also influenced by gender. Males show DA tendency more frequently and intensely than females. So also, males engage more in riskier games like competitive shooters and massively multiplayer online games as compared to casual story driven games engaged by females. Even the game development shows gender influences as the previous studies report males develop games with features, modes, and esthetics that are usually more appealing to males, specially to adolescents. While female targeted games include social games, story-driven and casual games that are often less time-consuming and less risky. [35]

b. **Age:** Internet gaming addiction was more seen with those individuals who started game play before the age of 6 years. [36-37]

c. **Parental education:** Maternal education significantly influences DA in children. Previous studies did show similar tendency as DA was less in mothers who had university and higher education as compared to mothers of secondary school education and who did not go to school. [30] Similarly the DA was highest in children whose fathers had never attended school, while it was lowest children whose fathers had university and higher education. [29] Handedness is one among the laterality marker. DA didn't show any association with handedness unlike left handedness in substance abuse. [38-39].

d. **Internet connectivity and game type**: Internet connectivity did not show any significant influence in DA due as offline gaming also resulted in DA. However, internet gaming disorder that primarily involves offline, story-driven games, the individual may seek a safe, quiet, and/or uncomplicated escape from the real world. This may be desirable for those with histories of traumatic experiences, social anxiety, and/or abusive or conflict relationships. [40] Most children use smart phones for gaming. As per recent studies problematic gaming can often occur on portable devices and predict gaming problems [41] and smart phone can be used for adjunctive activity in the absence of their preferred device for problematic gamers. [40] Most addictive

game types were strategy, role-playing games (RPG), sports games, and action. RPG may significantly interfere with “real-life” socializing and academic work as well as physical and mental well-being. [42]

**Symptoms of digital addiction:** DA can manifest with both physical and emotional symptoms. [43] Typical emotional features of digital addicts include aggressive behavior, Anxiety, Depression, and Isolation. [44-47] Major physical symptoms are backache, headaches, weight gain or loss, disturbances in sleep, blurred or strained vision. [48] The Carpal Tunnel Syndrome is one of the most significant symptoms. [49] Behavioral symptoms include eating disorders and social withdrawal. At personal sphere, excessive online activity and internet use can lead to poor time management, energy and attention during daytime and disturbed sleep patterns during nighttime. [50] Apart from these tantrums, self-injurious behavior, trouble behavior, refraining from academic activity can also be associated. Video game addiction shown significantly negative correlation with attention, memory and problem-solving skills in children [51].

**Brain mechanisms in Digital addiction:**

A scoping review reported that digital addiction in children and adolescents can lead to structural brain changes, including reduced grey and white matter volume in various regions involved in executive functioning, reward processing and sensorimotor activities. These changes can impair cognitive abilities and contribute to problematic smartphone use, internet gaming disorder, and internet addiction. Affected brain areas include the cortex—specifically the frontal, parietal, temporal, and occipital lobes—along with the cerebellum and subcortical structures like the basal ganglia (comprising the striatum and nucleus accumbens), the thalamus and the hippocampus. Notably, the prefrontal cortex appears to be the most vulnerable region. [52] A cross sectional survey from Bangladesh reported a statistically significant relationship (adjusted OR 0.4, 95% CI 0.3 to 0.7) between gadget addiction and cognitive function. [53]

**Assessment of Digital Addiction:**

Frequently used standardized scales to assess digital addiction include the Digital Addiction Scale for Children (DASC) developed by Nazir S. Hawi, [54] Problematic Internet Use (PIU) criteria [55]. Compulsive Internet Use criteria [56] and Negative Consequences criteria. [57] Other widely recognized tools include the Internet Addiction Test (IAT), [58] the Compulsive Internet Use Scale (CIUS), [59] Young's Diagnostic Questionnaire (YDQ), Young’s Internet Addiction Test, and the Depression Anxiety Stress Scale (DASS). [60] These tools help evaluate the severity, patterns and psychological impacts of digital addiction across different age groups.

**Treatment options:**

Psychotherapeutic interventions are mostly adapted in DA management. Cognitive Behaviour Therapy (CBT) is widely used and remains to be corner stone in the management of DA. CBT helps individuals identify maladaptive thought patterns and behaviours related to excessive internet use. It aids in challenging and changing negative thought patterns and impulsive behaviours through cognitive restructuring and modification. Also supports with coping strategies and self-regulation skills so as to gain better control over their online behaviour. [61] Dialectical behaviour therapy (DBT) combines mindfulness and acceptance strategies. It is particularly effective for individuals who struggle with emotional dysregulation and impulsive behaviour. [62] Mindfulness-based interventions include meditation and mindfulness-based cognitive

therapy which aid in controlling impulsive online behaviours and promoting self-regulation. [63] Family and group therapy offers supportive and educational environment for both the individual with addiction and family members to aid in the recovery process.

**Technology-Based Interventions:**

Technology-based interventions such as internet blocking and filtering software, [57] along with smartphone applications designed for self-control [64] enable individuals to restrict access to websites or apps that may trigger problematic behaviours. Smart devices also offer features like screen time tracking, usage limits, digital history monitoring, real-time feedback, and notifications to promote self-regulation and encourage healthier internet use. Additionally, digital detox programs, [65] which involve temporary abstinence from digital devices, support the development of mindful technology habits through a gradual reintegration process. However, these interventions are most effective when combined with other therapeutic approaches.

**Pharmacological Interventions (PI)**

Specific medications to treat digital addiction have not yet been approved.

Researchers are exploring on certain medications that can reduce cravings and compulsive behaviours associated with digital addiction. Most of the prescriptions are to regulate the emotional distress and address comorbidities such as attention deficit hyperactivity disorder, anxiety and depression. [66] Further research in this area is essential to target the specific dis-regulation and provide additional therapeutic options.

**Holistic and Integrative treatment approach:**

Holistic and integrative treatment approaches recognize multiple interconnected factors that contribute to addiction such as behavioural patterns, emotional triggers, family dynamics and technological influences. They incorporate combination of various interventions such as cognitive behavioural therapy (CBT) for behaviour modification, family therapy to address interpersonal issues, and internet-blocking software for practical management. This approach offers a comprehensive solution. [67] It enables clinicians to address all underlying factors affecting addiction and facilitates more effective treatment. Treatment plans can be tailored to each individual's unique circumstances so as to enhance the overall efficacy of care. [68-69] These therapies can be offered in outpatient settings, intensive inpatient care during crises, or through online or chat-based formats, these therapies adapt to the needs of the patient. In addition, self-help resources, support groups, and online communities provide crucial encouragement, helping individuals with digital addiction to regain self-control and develop deeper awareness of their behavior. These therapies also extend support to families and social networks, helping them understand addiction, create a nurturing environment and establish healthy boundaries. [70]

**Prevention:**

Educational workshops for school children, parents and the general public on digital literacy, online safety and recognizing signs of internet addiction can facilitate awareness. Open discussions on the challenges and benefits of technology, healthy online behavior, and balanced technology use contribute to fostering a mindful community. These initiatives do promote responsible internet usage and enable early intervention.

**Herbal pharmaco-therapeutics in DA:**

DA presents with brain mechanisms that are similar to substance use disorders (SUDs). Both affect dopamine levels in the brain and result in similar structural and functional variations. [71-73] There may be executive dysfunction, affecting higher-order cognitive processes required for goal pursuit. [74-75] Apart from this the associated comorbidities like anxiety, depression, attention deficit hyperactivity disorders, memory dysfunction, tantrums and sleep issues can contribute to the persistent behavioural abnormalities. Thus the aim of herbal pharmaco-therapeutics should be to reverse these chemical imbalances in the brain and to aid in stimulating the executive functions, memory and sleep. Anxiolytics and anti-depressant herbs can be useful in improve affect and stabilize mood. Some of the herbs that are proposed to be useful are Ginseng, Nigella sativa and passion flower.

**Pathophysiological understanding of digital addiction based on Ayurveda principles:**

Digital addiction in view of basic principles of Ayurveda could be regarded as *Prjnaparadhajanya vyadhi.* [76] Excessive and long hours' exposure to digital devices can be considered as improper and unwholesome conjunction between senses and their objects (*Asatmyendriyartha Samyoga*) of *chakshu (eyes), karna* (ears) and *manas* (mind) specifically which can further impact up on *manasika dosha* namely rajas and *tamas* (the stimulating and controlling mechanisms). They further disturb the equilibrium of the mind (*satva*) in other words the person gets attracted to this fairy world. In this state the person tends to engage in similar activities repeatedly in such a way that it further disturbs *tridosha* namely *vata, pitta* and *kapha* along with *Agni dushti*. This further influences *rasa dushti*, impacting *hridaya* (disturbed neuro humoral mechanisms that are comparable to changes in neurotransmitters like Serotonine, Melatonin Dopamine, Endorphin and Cortisol and Adrenaline) resulting in behavioral deviations. This disturbs the discrimination (*dhee*), self-control (*dhriti*) and orientation towards routine disciplined activities (*smriti*) resulting in *Prajnaparadha* (a status of dependency with loss of locus of control, mindfulness and discrimination are lost). In this stage it manifests as functional dependence and over use disorder as *Anidra* (Insomnia), *Chinta* (Anxiety), *Daurbalya* (Fatigue), *Drishti Dosha* (Visual strain) and *Rahaskamata* (Social withdrawal). However, at this stage with efforts, counseling, reinforcements and medications one can try to keep the triggers away, bring back confidence and self-control with restoration of *satva* (neuro-transmitters) and rehabilitate the person. When these efforts fail, and a person develops craving for digital devices, gaming disorder, gambling, if not given harmful tendency, obsessions, compulsive behavior and suicidal thoughts, it becomes worse and called as addiction. Addiction can make a person sink in to a non-real world and to go to any extent to get the pleasure. If unavailable ends up in negative consequence or harmful impact on self and others. This stage psychologically driven and is beyond control and called as *atatvabhinivesha*. [77]

The first line of management for such manifestations could be staged based up on the extent of the pathology and manifestation. In initial stages psychological interventions to enhance *dhee, dhriti* and *smriti* by avoidance to triggers, mindfulness events, support and indulgence in calming activities like *yoga*, meditation, outdoor activities with friends and social gatherings. In the event of dependency these needs to be potentiated by use of certain therapies like *shirodhara* (rhythmic pouring of medicated liquids on

head), massages and nootropic and anti-craving herbal medicines or compound medicinal formulations would be useful. In the event of digital addictions, the treatment further should involve *Shodhana* (therapeutic cleansing) followed by *Unmada chikitsa* clubbed with mindfulness activities to improve awareness and self-control. [78] Some of the herbs from Ayurveda pharmacopeia that are used to treat various substance abuse but that can also have an impact on features of digital addiction are explored below.

**Potential herbs for digital de-addiction and their pharmacological actions**

***Mandukaparni* (*Centella asiatica Linn*.)**, a nootropic herb [79] with chemical constituents namely saponin (medacoside, asiaticoside, medacassoside, asiatic acid, a new triterpenic acid. they regulate behavior besides being neuro-protective [80] and brain growth promoter. [81] Improvement in executive functions like learning and memory could be ascribed to dendritic arborization, free radical scavenging activity. Triterpenes from *Centella asiatica* exhibit anti-depressant activity. [82]

***Aindri (Bacopa monnieri(L.) Pennell*)** is a most researched nootropic herb for sedative action, [83, 84] besides being cognitive enhancer, [85] hepato-protective, [86] memory enhancer [87] and antioxidant [88-90] Neuro-protective nature could be attributed to reactive oxygen species scavenging activity. [91] It acts on cholinergic system by modulating neurotransmitter acetylcholine that coordinates memory formation. [92] CDRI-08, a Special BM extract ameliorates amnesic effect of scopolamine by reducing acetyl cholinesterase activity and drastically up regulating the mRNA and protein expression of BDNF, Arc, and GFAP in mouse cerebrum. Thus providing molecular evidence for anti-amnesic potential of CDRI-08 via enhancement of CREB mediated basal transcriptional machinery of memory linked both neuronal and glial plasticity markers. [93] It inhibits acetylcholinesterase, reduces beta-amyloid, activates choline acetyltransferase, and aids in monoamine potentiation and increased cerebral blood flow. [94] *Bacopa* support GABA production, by enhancing the gamma-aminobutyric acid (GABA) A receptor subunit and up-regulating glutamate decarboxylase, [95] which further reduces neuron excitability and hence improving rapid response decision-making. [96] Additionally, it has a calming effect on the brain.

***Guduchi (Tinospora cordifolia (Wild) Miers)*,** Menispermaceae family: *Guduchi* is a most regarded and widely used drug in Ayurveda pharmacopeia. [97] Root of this climbing shrub is known for anti-stress, anti-leprotic anti-malarial and cardio-protective properties. [98-100] Juice of whole plant is M*edhya* (cognitive enhancer). [79] Active chemical components include alkaloids, glycosides, polysaccharides, steroids, diterpenoid lactones, sesquiterpenoid, aliphatic and phenolics compounds. [101] Antioxidant and trace element contents (Zinc and Copper) in the plant contribute to the neuroprotective and ameliorative properties. [102-03] It possess learning and memory boosting, [104] anti-stress activity, [105] antioxidant, [106-07] anti-anxiety [108] and cognitive enhancing action. [109] Cognitive enhancement is through immune-stimulation and modulating the synthesis and supply of acetylcholine. [110] Significant antidepressant activity is attributed to the up regulation of brain monoamines, [104] inhibition of amines reuptake in the brain, increased norepinephrine (NE), serotonin (5hydroxytryptamine or 5HT), and dopamine (DA), and reduced GABA. [111] aqueous extracts of TC either alone

or in combination reduced chronic alcohol induced disorders. [112]

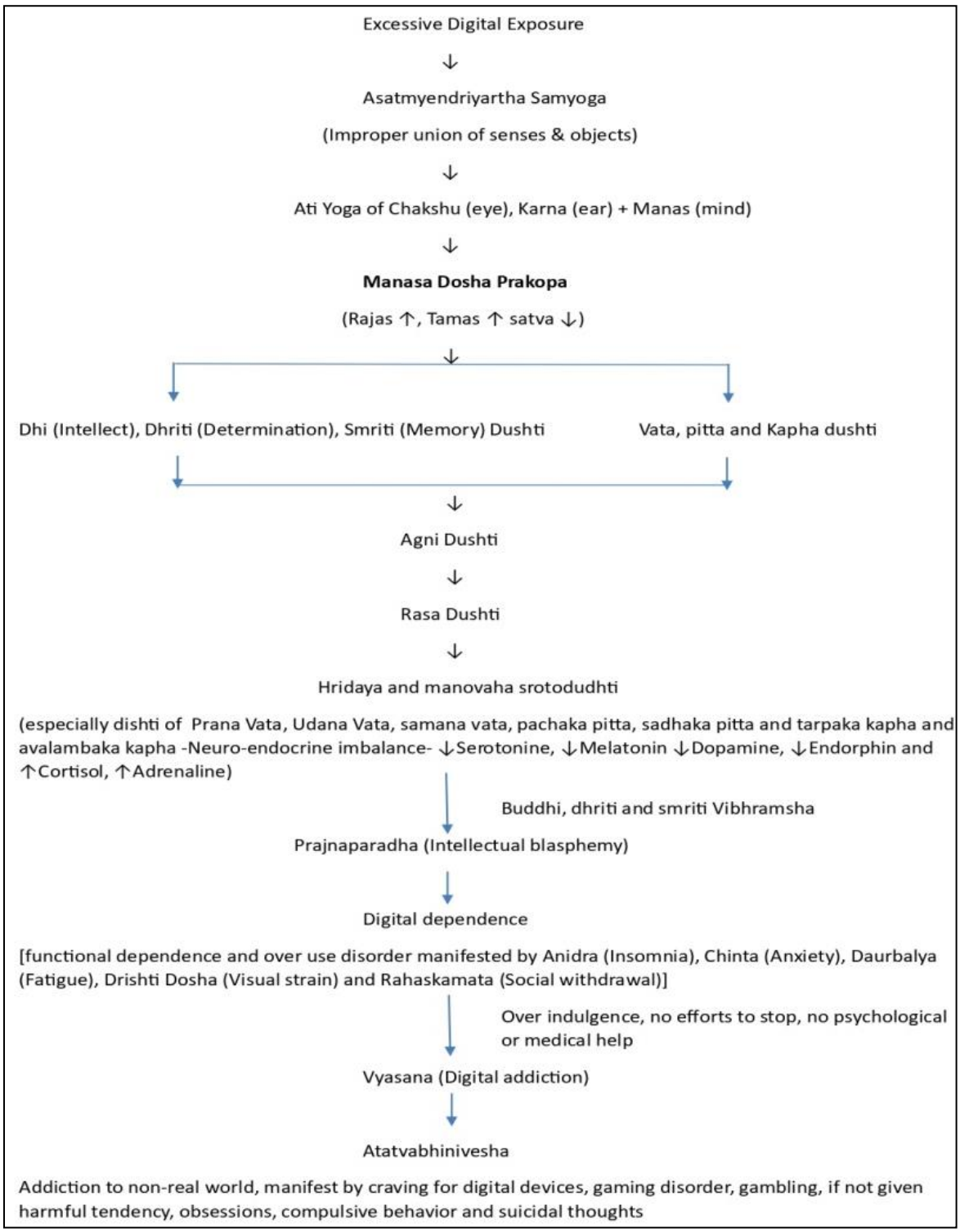


**Figure 2: Flow chart on patho-physiology of digital addiction based on Ayurveda principles**

***Jatamamsi (Nardostachys jatamamsi (D.Don) DC)*:** It is an erect perennial aromatic rhizomatous herb with a hairy tail like rootstock. [113] It is a wild endangered herb whose rhizome decoction is used to treat insomnia, and disorders of cardiovascular nervous system. It exhibits antidepressant, anticonvulsant and antiarrhythmic activities as well as antioxidant and lipid peroxidation activities. [114-16] The important chemical constituents include in roots sesquiterpenes (jatamansic acid, jatamansone), lignans, and neolignans. Nardostachysin a terpenoid ester present in Rhizome. [117-18] It is Antioxidant, Neuroprotective and Stress Relieving, [119-20] Antidepressant, [114] Anti-insomniac, [121] tranquilizing besides being Anticonvulsant. [122] Additionally, it shows Anticancer Activity, [123] Hepatoprotective Activity, [124] Cardio Protective Activity [125] and Hypolipidemic Activity. [126] Molecular Mechanics/Generalized Born Surface Area (MM-GBSA) analysis confirm that dihydro-jatamansin inhibits acetylcholinesterase, (*AChE*) and jatamansinol inhibits butyryl-cholinesterase, (*BuChE*) glycogen synthase kinase 3β *(GSK3β*), and kelch-like ECH-associating protein 1 (*Keap1*) AD therapeutic targets. [127]

***Ashvagandha (Withania somnifera* (L.) Dunal):** Commonly known as Indian winter cherry or Indian ginseng, is most used rasayana herb in Indian system of medicine. Chemical constituents include alkaloids (isopelletierine, anaferine, cuseohygrine, anahygrine, etc.), steroidal lactones (withanolides, withaferins) and saponins. [128] Withania sitoindosides and acylsteryl glucosides in Ashwagandha are anti-stress agents. It also exhibits an antidepressant effect, comparable with that induced by imipramine, in the forced swim induced 'behavioral despair' and 'learned helplessness' tests. [129] In a systematic review on *W. somnifera* successful inhibition of neuro-behavioral abnormalities produced by different physical and chemical stimuli on oxidative stress in rodent brain have been discussed. A significant decrease in the increased lipid per oxidation (LPO), protein carbonyl, AchE and nitrite levels noted in different parts of rodent brain. The natural cellular antioxidants (SOD, catalase and GPx) and the non-enzymatic antioxidant like GSH, ChAT and Ach alteration in the neuropathological environment were also considerably restored to normal by *W. somnifera*. [130]

***Tagara* (*Valeriana wallichii DC*.):** Yet another neuroprotective herbal medicine effective in treatment of migraine [131-23] insomnia and anxiety [134] It is known for its antioxidant [135] and chelating effect [136] A two-month regular oral administration reduced stress, attenuated anxiety, depression and enhanced adjustment without altering memory, attention, and concentration in humans indicating a potential regulation of the hypothalamic-hypophyseal-adrenocortical axis (HHA axis), especially during stress-related disorders. [137] Valerian in higher doses may be effective in the treatment of tension and Muscle spasm**.** Its extracts namely Valerenic acid and valerenol, allosterically modulate GABA-A receptors resulting in anxiolytic activity which is primarily attributed to valerenic acid. [138]

**4. DISCUSSION:**

Digital addiction in Ayurveda can initially manifest as *Prajnaparadha* (digital dependence) which in later stage can turn in to a stage of *Atatvabhinivesha* (Digital addiction) if proper measure is not taken. These can have varied manifestations from simple irritability, restlessness, loss of sleep to as severe as harmful tendencies, obsessions, compulsive behavior and even suicidal thoughts. This could reflect imbalances in *Vata, pitta* and

*Kapha* as well as *rajas* and *tamas.* As a result, the person loses self-control through neuro endocrinal dysregulation and develops addictive behaviors. Thus, *chikitsa* (management) should encompass both *satvavajaya* principles and *yuktivyapashraya* based on necessity. [139] *Satvavajaya* is all about psychological interventions done to aid and enhance dhee (discriminative knowledge), dhriti (locus of control), dhairya (self-resilience), *atma jnana* (self-awareness and conviction about pros and cons) and based on these modulating behaviours (*sadvritta*). [140] *Yuktivyapashraya* encompasses various therapeutic approaches and dietary interventions [139] specially to tackle *tridosha* namely vata, pitta and kapha and ultimately to achieve balance of *satva* (mind). These could be medicinal interventions or therapeutic procedures to pacify *tridosha (shamana chikitsa)* or *shodhana* therapy. Yoga therapy has been used effectively based on severity of the clinical condition. [141-43] Yoga practices, Pranayama and mind subtraction meditation [144] can aid in improving mindfulness, emotional regulation, resilience through neuro endocrinal mechanisms. [145-46] However, oral administered medicinal therapy to regulate addictive behavior and to reduce related clinical features are sparse. *Medhya rasayana* (Nootropic herbs) have been effectively used treat addictive behaviours with substance abuse. [147-149] Considering this fact and similar pathological mechanics in digital addiction, potential of oral administration of *medhya rasayana* is explored by means of a thorough review. *Medhya rasayana* have specific action on modulating neuro endocrinal mechanisms and neuro-transmitters. These would aid in curbing addictive behaviors, enhancing attention, memory, mood and affect in individuals with tendency of addiction and thus restores the balance. However, the selection of these *Medhya Rasayana*, the form in which they need to be administered, specific adjuvant to be used for synergistic effect and the duration of therapy all are subjected to *Prakriti* and *vikriti* (pathological stage) [150] based individualistic prescriptions that needs to be done by the concerned Ayurveda experts.

**5. CONCLUSION:**

Digital addiction in children is a burning issue in recent years owing to digitalization of life style. Pathophysiological description of digital addiction discussed here with possible herbal pharmacological intervention and their mode of action. Despite frequent prescriptions of these medicaments in office practice for effective management of substance abuse none of them are exclusively validated clinically on digital de- addiction. Thus, scientific validations through experimental and randomized clinical trials are essential on *Medhya Rasayana* in the context of digital de-addiction. Additionally digital addiction in children should be declared as priority area by AYUSH to enhance research and evidence generation in this field. Precise experimental and randomized clinical trials are essential to carry forward the heritage of herbal pharmacotherapeutics.

**Abbreviations:**

DA- Digital addiction, DSM-Diagnostic and Statistical Manual of Mental Disorders, internet gaming disorder (IGD), FAD-Facebook Addiction Disorder, YAD-YouTube Addiction Disorder, GSAD -Google Search Addiction Disorder, WAD-Widget Addiction Disorder, Twitter Addiction Disorder (TAD), BAD-Blackberry Addiction Disorder, OR-Odd's ratio, DASC -Digital Addiction Scale for Children, PIU-Problematic Internet Use, IAT-Internet Addiction Test, CIUS-Compulsive Internet Use Scale, YDQ-Young's Diagnostic Questionnaire, DASS-Depression Anxiety Stress Scale,CBT- Cognitive Behaviour Therapy, DBT- Dialectical behaviour therapy,PI-Pharmacological Interventions, SUD- substance use disorders, GABA-

Gama amino byuteric acid, MM-GBS- Molecular Mechanics/Generalized Born Surface Area, *AChE* - acetylcholinesterase, *BuChE*-butyryl-cholinesterase, *GSK3β*- glycogen synthase kinase 3β, LPO-lipid per oxidation, SOD- Super oxide dismutase, HHA axis-hypothalamic-hypophyseal-adrenocortical axis, AYUSH-Ayurveda, Yunani, Siddha, Homeopathy

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