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Summary and Conclusion

The present study, "**Digital Technology Assisted Nutrition Support for Children with Attention Deficit Hyperactivity Disorder,"** provided an insight into the significance of intervention programs for eradicating the symptoms of ADHD and enhancing behavioural function in kids between the ages of 4 and 12 years. The basis for growth, health, and development at various periods of life is good nutritional status. India has implemented several intervention measures to enhance children's healthcare throughout the past 40 years. The prevalence and consequences of neurodevelopmental disorders, however, are still present. A multifaceted problem that hinders human growth and has unacceptably adverse effects on attention deficit hyperactivity disorder. Understanding the incidence of ADHD in the Indian population was necessary since the country has a stigma associated with mental disorders, making it difficult for parents and teachers to care for children with the disorder. It also provides insight into the undernutrition burden of the nation. Children's growth and development depend on their ability to consume healthy meals. Even if they have a healthy diet later in life, children who did not develop and expand to their full potential during this critical period will not make up for it (Kamath *et al*., 2017). The best approach to support behaviour development is through a healthy diet, and children who are undernourished and in danger of having their behaviour function decline may benefit from nutritional supplements as the underlying fundamental components in preventing deficits (Lam and Lawlis, 2017).

Because of this, the current study concentrated on developing intervention strategies, such as dietary modifications made from a nutritionally balanced diet, protein- and micronutrient-rich cereals, millets, green leafy vegetables, and legumes, and providing digital technology assisted nutrition education to caregivers of children who were experiencing symptoms of ADHD. Hence the current study entitled “Digital Technology Assisted Nutrition Support for Children with Attention Deficit Hyperactivity Disorder” was carried out with objectives as follows:

- Provide digital technology assisted nutritional support to children with ADHD symptoms.

- ❖ Study the health and nutritional status of children with ADHD symptoms.
- ❖ Formulate micronutrient-rich snacks.
- ❖ Evaluate the impact of digital health intervention and dietary modification in reducing the symptomatology of ADHD.

The present study was conducted in four different phases. In **Phase I** ,A cross-sectional, comparative and intervention study that spanned four years was carried out among 137 children with ADHD symptoms aged between 4 to 12 years in special schools in Chennai City. The study was carried out in four phases. At the start of the study, approval by the Institutional Review Board of Human Ethical Committee, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore (AUW/IHEC/FSN-20-21/XPD-27) and official permissions were obtained from the school authorities. The caregivers were informed about the purpose of the study and written informed consent was obtained from them. In Phase I Based on parental consent, a total of 137 children which included 91 boys and 46 girls with ADHD aged 4 to 12 years from 23 special schools in Chennai city were chosen for this study. The sample's gender ratio was not consistent, as ADHD is more common among boys than in girls. All the children included for the study were diagnosed with ADHD clinically by certified psychologists and with specific inclusion criteria such as the availability of children during the study period and the caregivers as an informant.

The questionnaire used for data collection was adopted from previous studies and pre-tested before its use in this study. Before data collection, the purpose and benefits of this study were explained to the caregivers. The researcher then administered a questionnaire which collected information on the children's socio-economic, demographic, anthropometric, health and diet history. The Modified Kuppuswamy Socio-Economic Status Scale (2019) for assessing the socio-economic status of the children, and the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition, (DSM -V,2013) were used for assessing the behaviour function of the children. The researcher underwent one month training to administer the DSM scale in the Coursera Website. Every child was individually assessed for nutritional status, and behaviour function and their mothers was interviewed individually to collect primary data. Anthropometric measurements such as height, weight, Body Mass Index, head and chest circumference were recorded and calculated by using the ICMR 2020 growth chart. The diet

survey involved the collection of information on the frequency of consumption of various food groups, 24 hour recall survey, and food preferences. Information related to the potential etiological factors causing ADHD among children such as demographic, biological, environmental and health status using the interview method. Further, a comparison of behaviour symptoms, dietary intake and physical activity pattern of children with ADHD were collected. Clinical examination of hair, skin, eyes, mouth, teeth and tongue were assessed based on WHO clinical assessment guidelines. The physician of the respective Special School examined the clinical status of the children. The behaviour function of the children was evaluated by the clinical psychologist administering the DSM-V scale.

In the pretest using a questionnaire, an assessment was conducted for their knowledge of nutrition and to understand the cooking practices followed them. The tool was administered to caregivers before the Nutrition Education Program which was delivered as an intervention for the study. Eight months after the intervention program, the same questionnaire was again administered to caregivers for the post-test results.

In Phase II, on reviewing the literature, the micronutrient-rich snack recipes were formulated by using Ten recipes which included snacks items such as Quinoea Yam Cutlet, Rajkira Crackers, Round Nut Bag, Scopy Urdu Muffins, Amaransu Smoothie, Nut Coated Little Millet Cookie, Curry Stalk Pakodi, Energy Seed Coat, Trevally Nuggets, Checkbox Nuggets were selected for recipes for the nutrition intervention that included macro and micronutrients chosen from five food groups for the nutrition intervention study. The micronutrient-rich snacks were tested organoleptically by a panel of 30 members. Each panel member determined the sensory characteristics including appearance, colour, flavour, texture, taste and overall acceptability, by using five- point hedonic rating scale.

Nutrients such as energy, protein, fat, carbohydrate, ash, moisture, fibre, vitamin B_6, β-carotene, Omega-3 fatty acids, iron, calcium, zinc and magnesium were analysed using AOAC standard procedure. The highly accepted formulated snacks were evaluated quantitatively for secondary metabolites such as fatty acid composition, textural analysis, and colour analysis. The microbiological count provided an essential insight into the snack's preservation quality, as it was made without preservatives.

In Phase III, digital health intervention modules was used for both parents and children comfortable using the applications and digital modes of instruction. Hence, the purpose of the current study was to determine the effectiveness of the web portal which would serve as a platform for caregivers to progress the information they require and increase their general understanding of the topic. The selection of desirable interactive and engaging features was constructed, including YouTube videos that included cookery demonstrations and expert talks including snacks high in micronutrients, nutrition games and quizzes, as well as responses monitoring and tracking programs for diet and activity.

In **Phase IV and V,** nutrition intervention and health education were conducted and evaluated. Among the 137 children initially studied, 120 children and caregivers were willing to participate in the study and fulfilling the inclusion criteria were selected and subdivided into two groups consisting of 30 children each, namely Experimental Group I (EG I) (30), Control Group I (CG I) (30), and Experimental Group II (EG II) (30), and the Control Group I (CG II) (30) in the age group of 4-6 and 7-9 years. The experimental group was provided with Diet Modification and Digital Health intervention (n=60) and one-to-one telephonic counselling and nutrition education (n=60) were provided according to the feasibility of the participants to benefit the control group. The responses before and after intervention on knowledge, practice, attitude and dietary intake were collected and compared to evaluate the impact. The t-test of significance, chi-square, correlation and regression were used to study the relationship between variables and impact was assessed using a paired sample t-test. P values of 1 per cent and 5 per cent were considered to be significant.

The findings of the current study are presented as follows

- Among the 4-6 years of age , 26 percent of the boys were from joint families and 9 percent of girls were from nuclear families and 7-9 years 35 percent of boys were from joint families and 12 percent of girls were from nuclear families. Among 10-12 years 17 percent of boys and 7 percent of girls were from joint families. It showed that all the age category of boys were from joint family type whereas other than 10-12 years of age girls were from the background of nuclear families.
- Findings on the Family members of Children with ADHD symptoms revealed that 2 members in the family for boys and girls were high for the age category 7 to 9 years of age followed by 3 members in the family for boys and girls in the age group of 7 to

9 years of age. 4 members in the family for both the gender respondents among 7 to 9 years was dominant and for 5 family members 7 to 9 years of age was high.

- Order of the Children with ADHD symptoms details showed that for boys the first child in the family the highest age group contribution was found in the age category of 7 to 9 years whereas for girls the age category was from 4 to 6 years. For the 2nd child order in the case of boys highest percentage was found for the age category 7 to 9 years whereas for girls it was seen in the category 4 to 6 years of age and 3rd child was reported high for boys in the age category of 7 to 9 years and for girls it was 10 to 12 years.
- Information related to the religion of the Children with ADHD symptoms showed that the major contribution of Hindu, Muslim and Christian children of both boys and girls gender was observed in the age category 7 to 9 years and Hindu religion was found to be dominant among the selected sample group.
- Fathers of boys aged 4-6 years, had graduate or postgraduate degree, illiterates were 28 percent, 29 percent respectively, age group of 7-9 years professional honour, and illiterate are 45 percent, 50 percent respectively, 10-12 years illiterates are 50 percent.

  Most father's with ADHD symptoms had undergone some kind of primary education irrespective of being illiterate.
- Mothers of boys ages 4-6 years had professional honour, diploma 40 percent, 50 percent, age group of 7-9 years had professional honours, 40 percent aged 10-12 years had middle school certificates 33 percent. Mothers of girls 14 percent, 7-9 years had professional honours, , diploma, primary school certificates 10 and 12.
- Mothers of children with ADHD were found to be educated and a higher percentage of children was seen in the age category 7 to 9 years of age.
- The details pertaining to the occupation of the father of children with ADHD showed that the majority of the fathers were employed in some kind of profession and very few were found to be unemployed.
- Majority of the mothers were found to be employed in some sector where the percentage of unemployed mothers was very less and the higher contribution was seen in the age group of children of 7 to 9 years of age.

- The highest family income earned was reported by boys with ADHD symptoms was Rs 42,875 and for girls it was Rs 16,078 to 21,437.
- Lower class status whereas for upper lower class for the age group of 4 to 6 years 28.6 percent of boys and 7.1 percent of girls were found, for the age category 7 to 9 years of age 35.7 percentage of boys and 7.1 percent of girls were seen and for the age category 10 to 12 years 21.4 percent of boys were observed.
- Middle class of 7 to 9 years 27.9 percent of boys and 16.3 percent of girls upper middle class 7 to 9 years 26.7 percent of boys and 13.3 percent of girls upper class for the age of 7 to 9 years of age 28.6 percent of boys and 14.3 percent of girls. Thus from the study, it can be said that most of the selected children were from upper and middle classes.
- Family history of children with ADHD symptoms showed for the age group of 4 to 6 years about 29 percent of boys and seven percent of girls family members were affected with hyperactivity 7 to 9 years of age about 33 percent of boys and nine percent of girls family members had faced hyperactivity symptoms. In contrast, for attention deficit, about 28 percent of boys and 14 percent of girls family members were affected and for learning disability 36 percent of boys 10 to 12 years old, while 17 percent of boys and about 16 percent of boys were found to have learning disabilities.
- Thus most of the family members of a child with ADHD has been affected with hyperactivity, attention deficit and learning disabilities.
- Fathers of the boys between the ages of 4-6 years had a habit of smoking 26.3 percent, drinking alcohol 28.1 percent, smoking and drinking both 22.5 percent, and 20 percent did not have any habit at all . Fathers of boys aged 7 to 9 years had a habit of smoking 38.4 percent, drinking alcohol was 35.9percent, doing both was 29 percent, or not having any habit at all 40 percent. Fathers of boys between the ages of 10 – 12 years had one of the following habits: smoking 19.2 percent, drinking alcohol 20.5 percent, doing both 14.5 percent, or having none at all 20 percent.
- Among the father's of boys of 4-6 years age group 30 percent consumed more than three times per week, 7 and 9 years, 35.7 percent consumed once per week, 10-12 years 18.8 percent consumed daily.

- Fathers of girls 4 and 6 years, 9.5 percent consumed once per week, of 7-9 years 16.0 percent consumed alcohol twice a month. 10-12 years 7.1 percent drank once a week. The frequency of consumption of alcohol or smoking among the father of the respondents showed that most of them were found to be consuming either daily or once a week
- Fathers of boys (4-6 years), 27.2 percent have diabetes, 27.5 percent have respiratory complications, 29.4 percent have B.P, 28.5 percent have a nervous disorder,7 and 9 years 37.5 percent have cardiovascular disease, 45.4 percent have diabetes, 42.8 percent have nervous disorders, and 33.3 percent are healthy 10-12 years affected.
- Twenty five percent have CVD, 28.5 percent have nervous disorders, fathers of girls 4 and 6 years 9 percent have kidney disease or advanced kidney disease, of 7-9 years: 15.1 percent have kidney disease 10 and 12 12.5 percent have cardiovascular disease (CVD)
- Twenty three percent of father's of boys between the ages of 4-6 were very calm while 17 percent of the father's were described as aggressive. For 7-9 years, 35.2 percent very calm personality, 32.5 percent aggressive 10-12 years, and 13.7 percent aggressive.
- Fathers of girls 7-9 years 16.2 percent aggressive 10 to 12 years: 6.2 percent aggressive. Mothers of boys 4-6 years 7-9 years 33.7 percent, 14.1 percent 10-12 years, while 9.7 percent of mothers of girls aged 4 to 6 years were married to blood relatives, 7-9 years 16.3 percent, aged 10 to 12 years, 8.8 percent were married to a blood relative.
- 30.7 percent of the mothers of boys 4-6 years were born when they were above 30 years old. Of 7-9 years, 38.4 Percent had conceived above the age of 30 years. boys of 4-6 years 20 Percent of mothers of boys ages 4-6 years of 7-9 years, 16 Percent were between the age of 20 and 30 years, 10 and 12 years, 16.2 Percent were born before the age of 20 years.
- 22.3 Percent of mothers of boys between the ages of 4-6 years, 7–9-year-old 35.2 Percent 15.2 Percent of mothers of 10-12 years old boys experienced significant complications, 8.2 Percent of mothers of boys between the ages of 4-6 years suffered

a severe pregnancy problem, of 7-9-year-old did not have a severe pregnancy issue made up 35.2 Percent of the population. 4.7 Percent of mothers of boys between the ages of 10 and 12 years.

- The percentage of pregnant women who encountered serious complications of 4 – 12 years old children experienced anaemia 37.5 Percent, hypertension 33.3 Percent, diabetes complications was 50 Percent , problems caused by bleeding 50 Percent, excessive vomiting 35.2 Percent.
- Epilepsy (33.3 Percent) hypothyroidism 50 Percent of mothers suffered from hyperthyroidism, 50 Percent of mothers suffered from other hormonal problems and maximum C-sections was 27.3 Percent, the full-term baby was 36.5 Percent.
- Mothers aged between 4 -12 who breastfed their children was 31 Percent, mothers who breastfed their children for four months 34.5 Percent For six months, 28.5 Percent (7-9 years of boys). For one year, 30.7 Percent (7-9 years of boys). For four-six months, most of the mothers who just fed their babies were 34.8 and 28.5 (4-6 and 7-9 years).
- Children between the ages of 4 to 12 years used the highest percentage of special supplements while pregnant, which was 29.6 Percent.
- The mother of the children had the highest rate of CVD health issues at 42.8 Percent. (7–9-year-old boys), mothers who had diabetes at the highest percentage of 41.6 Percent (7-9 years of boys), Mother's highest percentages for respiratory problems, kidney/CKD problems, high blood pressure, and nervous disorders were 50 Percent, 37.5 Percent, 38.2 Percent, and 40.63 Percent, (7-9 years of boys) respectively. The majority of mothers, 33.3 Percent (boys aged 7-9), are unaffected by any severe health problems.
- Personality of the mothers of the children described them as being, at most 37.1 Percent (7-9 years of boys), extremely calm, a Maximum of 36.5 Percent (7-9 years of boys) of them were regarded as aggressive people, while 33.3 Percent (7-9 years of boys) of them were described as stable people.
- The frequencies of O and A genes were higher than that of B gene in ADHD children. There was a correlation between ABO blood type gene and ADHD in children. The

risk of ADHD is increased in the presence of alleles O and A, but the risk is reduced in the presence of allele B.

- The highest percentage of the children with a symptom of daytime inattention was 34.6per cent, with 37.5 per cent of them having the symptoms of rhinitis, 50 per cent having cold, 50 per cent having irritability, and 100 per cent of them having hyperactivity. Children with ADHD showed slower reaction times and higher detection threshold, likely driven by IQ and inattention, because reaction time and detection thresholds correlated with IQ and subtle motor signs. Children with ADHD showed a pattern of altered tactile processing on specific tasks, suggesting that higher cognitive function and cortical mechanisms related to adaptation are affected in ADHD
- The majority of children were sensitive to specific smells, including perfume (50 per cent), hairspray (44.4 per cent), detergents (33.3 per cent), and noises (26.5 per cent). The findings related to ADHD children's attitude when he or she becomes hungry showed that their nature's gets changed. The maximum age group affected by having headaches when he/she becomes hungry was 7-9 years old boys at 50 per cent, 66.6 per cent of them became moody when he/she becomes hungry.
- A maximum of 33.3 per cent of children were having difficulty in going to bed. Reasons were found to be that too much screen time before bed or a lack of time set out in the night-time routine for relaxing, peaceful activities.
- In the age of 4 to 6 years about 22.2 per cent of boys were suffering with epilepsy whereas in girls it as 18.5 per cent. Among 7 to 9 years 50 per cent of boys were suffering from insomnia and 43 per cent of girls were affected with asthma and in 10 to 14 years 16.7 per cent of boys showed seizures and 28.6 per cent of girls had asthma,showing the majority of them were suffering from asthma and insomnia.
- In the age 4 to 6 years about 24 per cent and 7 to 9 years 34.5 per cent of boys underwent some injury in the neck. While the ages 10 to 14 years 17.2 per cent of girls stated that they had neck injury.
- A maximum of 36.3 per cent of children between the ages of 7-9 years were diagnosed with attention-deficit/hyperactivity disorder within two years of age. While

41.6 per cent were recognized within 6 years. This showed that most of them were diagnosed to be affected with ADHD between the age of 2 to 6 years .

- Among the selected respondents about 29 per cent of boys suffered with learning disability along with their ADHD. Whereas in age of7 to 9 years about 80 per cent of were affected with oppositional and conduct disorder among boys, in girls 10 per cent suffered from autism along with ADHD and 10 to 14 years 20 per cent of boys were affected with anxiety and 40 per cent of girls were affected with oppositional and conduct disorder.
- The study identified that most of the selected respondents experienced special education and occupational therapy for their intervention. In the age of 4 to 6 years about 31.3 per cent of boys undergo special education and among 7 to 9 years 36.1 per cent of boys undergo occupational therapy. In the age of 10 to 14 years about 21.9 per cent girls under went special education.
- R-value and R^2 value shows that 71.2 % of behavioural changes occur through demographic variables in boys and 612% of the changes occur in girls for children in the age group of 4 – 6. In 7 – 9 years 74.5% and 60.3% of behavioural changes occur through demographic variables for boys and girls and 10 -12years 60.1% and 60.3% of behavioural changes occur due to the demographic variables.
- In the age group of 4 – 6 years relationship between birth order, marrying with blood relatives, the mode of delivery and behavioural symptoms was significant at 1% level. Personality of the father and mother, Blood group of the child and income of the family were also related to the behavioural pattern of the child at 5% level. Among girls (4 – 6 years) Birth order, blood relation marriage, personality of father and mother related with the behavioural pattern at 5 % level.
- Demographic variables like family income, birth order of the child, marrying within blood relation, personality of father and mother, blood group of the child and mode of delivery have an impact on the behavioural pattern of ADHD children. Mainly among boys in the age group of 7 – 9 years
- Clinical symptoms showed the maximum percentage of Loss of appetite (33.33 per cent),Muscle wasting/Apathy/Irritability (28.13 per cent), Hair changes- Loss of

lustre/discoloured/Dandruff (36.36 per cent), Skin changes dry and rough /Hyperkeratosis (50 per cent), Eyes-pale/dull (33.33 per cent), Bleeding gums (100 per cent), Night blindness/Bitot"s spots/Conjunctival xerosis (33.33 per cent)of boys between the ages of 7-9 years having significant clinical symptoms.

- Physical activity patterns showed among 7 -years 30.1 per cent of the boys and 17.2per cent of the girls participated in physical activity and 36.3per cent of boys participated in Focus & Concentration skills Therapy. Whereas 38.8 percentage of boys Watched Tv. Computer games/mobile were played by 31.2 per cent and 12.5per cent of the boys and girls. This showed that most children in the study had taken up some kind of physical activity in focus and concentration therapy.
- Duration of physical activity showed that the selected children with ADHD were engaged in physical activity for about 6 to 7 days in a week.
- The study has found that among the children taken for the study majority of them are non-vegetarian. The maximum non-vegetarian percentage for boys and girls between the ages of 4-12 years is 30.4 per cent and 9.7 per cent.
- In the study the majority of the respondents were found to be having either 3 meals or 4 meals in a day. The maximum three meals/day percentage of boys and girls among 4-12 years was 28.9 per cent and 13.1 per cent. while 4 meals/day was observed in 34.6per cent and 13.4 per cent. Most of the selected children were found to be consuming snacks often which is either 2 (35.2%)or three times(36.3%) in a day.
- Most of the children in the study are found to be preferring either meal(34%) or snacks(32.9%) for their needs. A maximum of 29.7 per cent and 15.3 per cent of the boys and girls between the ages of 4-12 years skip their meals. 39.1 per cent of boys skip their breakfast frequently, 34.2 per cent of boys and 12.5 per cent of girls skip their lunch.
- In the age of 4 to 6 years about 33.3 per cent of boys avoided chocolate and 11.5 per cent of girls avoided wheat. Among 7 to 8 years 50 per cent of the boys avoided corns and 12.9 per cent of girls avoided wheat and in10 to 12 years about 50 per cent of boys avoided corn and 8 per cent of girls avoided wheat showing the majority of them to be avoiding corn and wheat.

- Between the ages of 4-12 years 30.3 per cent, 35 per cent, 37.5 per cent, 40 per cent, 40 per cent, and 36.3 per cent of boys had a specific liking for sweets, chips, biriyani, burger, pizza, and chocolate. Girls had particular preferences for sweets, chips, biriyani, and chocolate was 12.1 per cent, 10 per cent, 12.5 per cent, 40 per cent, and 4.5 per cent.
- Awareness regarding the Feingold diet, sugar-free/low-sugar diets, casein-free diets, and gluten-free diets was 29.7 per cent, 36.3 per cent, 50 per cent, and 32.2per cent among boys and 13.6per cent, 10.8 per cent, and 9.6 per cent among girls. Between the ages of 4 and 12 years 33.3 per cent and 12.5 per cent of the boys and girls follow a restricted diet
- Inattention symptoms among boys under 4-6 years 28.5 per cent showed moderate and 33.3 per cent showed severe symptoms. While, in 7–9-year- 100 per cent showed mild, 42.8 per cent Moderate, and 44.4 per cent severe symptoms . Also, Girls under 10-12 years showed 28.5 per cent of Moderate and 22.2 per cent of Severe symptoms.
- Hyperactivity symptoms among 4- 6 years boys was 40 per cent Mild, 28.5 per cent Severe and 25 per cent .Moderate Symptoms and girls was 6.2 per cent moderate 4 and 4.7 per cent of Severe symptoms. 7–9-year-old boys 40 per cent mild, 37.5 per cent moderate and 38.1 per cent severe symptoms and girls 12.5 per cent moderate and 4.7 per cent severe symptoms. Among 10-12 years boys 4.7 per cent had Severe symptoms.
- Both Hyperactivity and Inattention symptoms were present in 4–6-year-old boys showing 33.3 per cent , Mild, 28.5 per cent Severe and 20 per cent Moderate Symptoms and in girls 10 per cent moderate and 6.12 per cent severe symptoms. In 7–9-year-old boys show 44.4 per cent mild, 35 per cent moderate and 34.6per cent severe symptoms and Girls 15 per cent moderate and 8.1 per cent severe symptoms. Boys between 10-12 years exhibited 22.2 per cent Severe, 15 per cent moderate and 18.3 per cent Severe symptoms.
- The mean height of boys (103.7 cm) was found to be more than girls(98.6 cm) in the age category of 4 to 6 years. The mean height of boys (118.2 cm) was found to be more than girls(112.8 cm) in the age category of 7 to 9 years. On the other hand, girls (147.8 cm) were marginally taller than boys in the age 10 to 12 years, which may be

dueto the pubertal growth spurt. Overall, this study population was shorter than the 50thper centile ICMR reference cut-off value, and a significant difference exists at less than 1%(P=0.0001)

- The boy's mean weight was 14.4 kg in 4 to 6 years, 7 to 9 years they were in 20.8 kg, and they were 37.9 kg in 10 to 12years, respectively. Similarly, the girl's mean weight was 16.3 kg in 4 to 6 years, in 7 to 9 years they were in 23.5 and 43.6 kg in 10 to 12 years. For the mean weight of the children, a significant P value of < 0.001 was derived.

- The mean Body Mass Index in the age category of 4 to 6yearswasfoundtobe 11.8 for boys and 12.6 for girls, respectively. In the age category of 7 to 9 years mean BMI for boys was found to be 13.6 and for girls it is 13.7. The mean BMI was almost similar in the lower age group of 4 to 9 years between genders. In contrast, the mean BMI of boys (20.3) was lower than that of girls (22.4) in the upper age category of 10 to 12 years, respectively. A significant difference was noted between the schools at less than 1 per cent level among boys and girls regardless of age. BMI percentiles classification found the boys who were in the age group of 4 – 6 years were mostly underweight and normal weight and for girls most of them were in normal weight. In the age group of 7 – 9 years most of the boys and girls were found to be underweight and obese.

- The consumption patterns of various food groups by different age groups of children were almost similar. The green leafy vegetables (52.1%) and other vegetables (64.6%) were consumed more among 6 – 9 years than 10 – 12 years to the suggested allowances of the ICMR (2020). Milk intake was observed very low among children in all the age groups compared to the recommended allowances.

- The nutrient consumption of children was below the recommended allowances (ICMR, 2020) The per cent adequacy of many nutrients was higher among 10 – 12 years old children when compared to 7 to 9 years and 4 to 6 years and the nutrient intake was found to be higher in girls than boys in all age groups.

- The sensory evaluation for curry stalk pakodi, Rajkira crackers, Amaransu smoothie, Checkbox Nuggets, Scopy Urdu Muffins, Nut coated little millet cookie, Quinoea Yam cutlet, Trevally Nuggets, Round Nut Bag and Energy Seed Coat snack showed.

variation II of Rajkira Crackers had high acceptability in appearance, colour, flavour, taste, and texture with a mean value of 4.60. this shows that variation II to be highly accepted variation in the preparation of rajkira crackers while compared to the standard value, variation I and variation III

- Variation III of Amaransu Smoothie had higher acceptability of the recipe on the basis of its appearance, colour, flavour, taste and texture as the mean score was 4.86. This showed that while formulating the amaransu smoothie variation III is highly considered and it was found to be having high acceptability. Curry stalk pakodi variation II had sensory evaluation mean value 4.96 showing variation II to have good appearance, colour, flavour, taste and texture, when compared to other variations.
- The check box nuggets variation II had a good appearance, colour, flavour, taste, texture showing the mean value of 4.70, which was high while compared to other variations taken for the study. The variation II, the nut coated little millet cookies had good appearance, colour, flavour, taste and texture while compared to other variations as the mean value was 4.53.
- The sensory evaluation of scopy Urdu muffins showed that variation II had a high level of acceptability with the mean value being 4.90. This showed that in variation II, the scopy Urdu muffins had the acceptable appearance, colour, flavour, taste and texture while compared to other variations. Quinoa Yam cutlet variation III had good sensory evaluation as the mean score was high while compared to other variations as the mean value was 4.33 and Trevally nuggets variation II has high acceptability as the mean value was 4.83 which was high compared to other variations. The result for Round Nut Bag showed that variation I had a high acceptability as the mean score was 4.56 which was high while compared to other variation in the study
- Physical analysis of the snack muffin showed the weight, diameter, thickness and the spread ratio to be 45.11gm ,70.49mm ,62.55mm and 1.13 respectively. Smoothie showed that weight was 68.37gm, diameter was 0.85 mm with thickness about 2.07mm and spread ratio of 0.41. For the cutlet the weight was 52.65gm, diameter was 2.23mm, thickness was 11.15mm and spread ratio was 0.16. In the case of pakoda, weight was 13.26gm, diameter was 1.94mm, thickness was 22.10mm and spread ratio was 0.08. Veg nuggets showed weight of 71.27gm, diameter of 1.20mm,

thickness of 6.55mm and spread ratio was 0.21. Crackers weight was 13.27gm, diameter of 69.16mm, thickness of 4.97mm and spread ratio was 13 91. In the case of cookies the weight was observed to be 18.13gm, diameter was 53.54mm, thickness of 8.13mm and spread ratio 6.59. For the seed bar the weight was 55.75gm, diameter was 3.17mm, thickness was 12.55mm and spread ratio 0.25 and for nut bar the weight was 50.85gm, diameter was 2.25mm, thickness was 10.56 and spread ratio was 0.21.

- The Total plate count for muffin was 24×10^1 cfu/g, veg nuggets was 16×10^1 cfu/g, energy seed 17×10^1 cfu/g, fish nuggets count was estimated to 18×10^1 cfu/g, horse gram cookies count was 21×10^1 cfu/g, for pakoda the count 6.0×10^1 cfu/g, crackers had count of 3.0×10^1 cfu/g, cutlet 9.0×10^1 cfu/g, smoothie microbial count 2×10^1 cfu/g and nut bar 23×10^1 cfu/g. the microbial count was found to be high in muffin
- The ash content was found to be high in energy seed recipes formulated whereas the moisture content was found to be high in smoothie and pH level was found to be high in muffin and crackers. This in the current chemical analysis of the recipes formulated by the investigator is found to be having higher content of ash, moisture and pH level was energy seed, smoothie, muffins and horse gram cookies.
- Textural analysis for the selected recipes were carried out and the mean scores of the muffin was 838.31 in case of veg nuggets the mean was 1.93 followed by energy seed value being 1101.42 whereas for fish nuggets the mean value was 1.50 for horse gram cookies the hardness was found to be 1.7 the recipe pakoda had the mean value 100.90, crackers had 1.27 mean score, cutlet had mean value of 319.157± 0.04 and amaransu smoothie had a mean value of 2.37±0.01 and nut bar had value as 109.9. This showed that energy seed had a high mean value that was in the recipes formulated in the study.
- The colour analysis of the formulated recipes showed that horse gram cookies have a mean value to dominate all the other recipes with the mean value of 78.392 in 'L'. The mean value of Pakodi showed the best in all recopied in terms of 'a' and the mean value of Veg Nuggets shows as the best in all recipe in terms of 'b'
- The crackers have a high mean score value 521.36 Kcal compared to other recipes. The carbohydrates showed a mean value of 65.94 Kcal. The protein content was 16.83 g and fat content was 27.02 g. The crude fibre content in the recipes showed

that crackers mean value was high (4.31 g) when compared to other recipes. The dietary fibre content in the recipes showed that crackers had high mean score of 12.82 g

- Energy seed had high calcium content with the mean score 67.5 mg whereas iron content was found to be high same with energy seed as the mean score value was 12.2 mg while compared to other recipes incorporated in the study. In case of phosphorus the recipe crackers was dominating other recipes with the mean score 268.73 mg whereas magnesium the mean value was high in the recipe pakoda incorporated in the study as the value was 130.33 mg and zinc content was high in the recipe muffin with value 20.83 mg. Thus from the mineral content examination it can be identified that energy seed, crackers, muffins to be having high level of mineral content when compared to other recipes in the study and it can be very beneficial in the consumption of children to develop their health by providing proper minerals needed
- Vitamin B_6 was high in fish nuggets with the mean value of 1.30 mg whereas Vitamin C was high in the recipe energy seed with the mean score 6.53 mg in case of Vitamin B_{12} the content was found to be high in energy seed with mean value 1.43 (µg)and **β** - carotene was high in smoothie with mean score 332.33 (µg)
- Quinoa cutlet had à-Linolenic acid (octadeca-9,12,15-trienoic acid)- $C_{18}H_{30}O_2$ and its peak percentage was 14.49. despite not being an oilseed crop, the oil composition of quinoa seeds is remarkable due to its profile, which shows a high proportion of polyunsaturated fatty acids (PUFAs), particularly in essential fatty acids such as linoleic (ω-6) and α-linolenic (ω-3)
- Rajkira crackers were found to be high in à-Linolenic acid (octadeca-9,12,15-trienoic acid)- $C_{18}H_{30}O_2$ with a peak percentage of 13.48. Nut coated little millet cookie showed that it had a higher peak for à-Linolenic acid (octadeca-9,12,15-trienoic acid) - $C_{18}H_{30}O_2$ with the peak percentage 11.56. Amaransu smoothie showed that it had peak for à-Linolenic acid (octadeca-9,12,15-trienoic acid)- $C_{18}H_{30}O_{2-}$ with molecular weight 278 and peak percentage 12.99
- Scopy Urdu Muffins by GC-MS showed that it had a peak in à-Linolenic acid (octadeca-9, 12, 15-trienoic acid)- $C_{18}H_{30}O_2$ with molecular weight 278 and the peak

percentage estimated was 6.43. Nuggets by GC-MS showed a peak for à-Linolenic acid (octadeca-9,12,15-trienoic acid)- $C_{18}H_{30}O_2$ with molecular weight 278 with the peak percentage 12.96. the Trevally Nuggets by GC-MS found to have peak in à-Linolenic acid (octadeca-9,12,15-trienoic acid)- $C_{18}H_{30}O_2$ with molecular weight 278 with peak percentage 15.03

- Round Nut Bag by GC-MS showed a peak in à-Linolenic acid (octadeca-9,12,15-trienoic acid)- $C_{18}H_{30}O_2$ with moelecular weight 278 and peak percentage was 16.97. thecurry stalk pakodi showed to have peak in à-Linolenic acid (octadeca-9,12,15-trienoic acid)- $C_{18}H_{30}O_2$ with molecular weight 278 with peak percentage 19.49
- In Phase III, Responders from several nations, particularly India, preferred pictorial shots on the web page, nutrient calculators, and documentaries for kids. Recipes and YouTube Videos on cooking demonstrations and meal planning were liked by 100% of psychologists and 82% of nutrition experts. The website's information was 80% instructive regarding how diet plays a part in Attention Deficit Hyperactivity Disorder, according to 1000 caregivers and nutrition specialists who gave it a 63.2% informative rating for parents and society. Nearly 93.3% of respondents think the website's dietary information is helpful. Most respondents—between 60 and 80 per cent—liked the website's colour and snapshots
- 16.9 per cent and 24.5 per cent strongly agreed with the website's ability to identify ADHD symptoms, Continuous monitoring of work via the website was strongly endorsed by 20.7 per cent, 28.3 per cent, and 30.1 per cent. 15 per cent and 28 per cent strongly agreed that using the website will increase academic performance. The percentage of those who strongly agreed with the expression "brain break" was 22.6 per cent. A strong agreement with the assertion that knowledge can be improved through the website was expressed by 24.5 per cent. In the case of statement involvement via audio-video, 26.4 per cent highly agreed.
- The website content in the output of paired sample t-tests for attributes of the caregivers before and after usage of the website. Changes in the scores of Knowledge, Attitude, Relationship with ADHD Children, and Organization Skills (P=0.000, 0.003, 0.004, 0.000) are statistically significant at 1% level of significance, and Academic Performance (p=0.006) is statistically significant at 5% level of

significance. The results found effective changes in the attributes of the caregivers' Children with ADHD symptoms before and after using the website. 93.3% of parents of children with ADHD were satisfied with the website's Indian-inspired design.

- The anthropometric measurement in the age group of 4 – 6 years revealed an increase in body weight from 13.7 kg to 17.8kg in the experimental group in terms of height from 103 cm to 116.8cm and for BMI it increased from 11.6 to 15.3. The experimental group of 7 – 9 years of children, in terms of weight is increased from 19.9kg to 24.2 kg in the post, as in terms of height 113.8cm to 122.1cm and in terms of BMI it is 13.5 in the pre and 15.1 in the post intervention group.
- The changes in the behavioural function showed that the mean value decreased from 8.8 to 8.1 among 4 – 6 years and 7.0 to 6.7 among 7 – 9 years in the experimental group. As in the control group without the supplementation and education there is an increase in the behavioural pattern from 5.9 to 7.4 in the 4 – 6 age group and 6.8 to 7.7 in the 7 – 9 age group.
- The cereal intake of children in the Experimental Group (4 to 6 years) increased from 173.4g to 204.1g. Similarly, the consumption pattern of cereals in the Experimental Group (7 – – 9 years) increased from 221.6g to 266.8g and the cereals intake increased slightly among children in the control group from 185.9g in Pre and 193.4g in Post (4 – 6 years of age) and 233.1g to 254.4g (7 – 9 years of age) the intake of pulses in age group of 4 to 6 years increased from 36.0g to 43.7g and from 45.9g to 52.3g in the experimental group of 7 to 9 years. After nutrition intervention, the consumption patterns of green leafy vegetables, other vegetables, fruits, milk and milk products, and oils increased in the experimental groups of children aged 4 to 6 and 7 to 9 years.
- Mean energy intake increased from 1152kcal to 1328kcal in the Experimental Group (4 – 6 years of age) and from 1482 kcal to 1728 kcal in the Experimental Group (7 – 9 years of age). The average intake of Fats, Protein, carbohydrate, calcium, magnesium, iron, zinc, vitamin B6, vitamin B12, vitamin C, vitamin A, and vitamin D in the experiment group of 4 – 6 year olds increased from 17.3g, 10.1g, 77.5g, 307.0mg, 94.1mg, 3.11mg, 0.83mg, 0.19mg, 0.08g, 16.4mg, 130.1g, and 400 mcg

- The average intake of Fats, Protein, carbohydrate, calcium, magnesium, iron, zinc, vitamin B6, vitamin B12, vitamin C, vitamin A, and vitamin D in the experiment group of 7 to 9-year-olds increased from 23.5g, g, 15.1g, 87.4mg, 354.0mg, 130.4mg, 5.48mg, 1.93mg, 0.69mg, 0.77g, 23.0mg, 156.2g The control group exhibited no significant difference in nutrient consumption and a lower mean intake in the final evaluation.
- The mean scores of EG I and EG II increased from 3.3 to 6.5 and 3.5 to 8.1 in terms of nutritional knowledge, In EG II and EG II before and after intervention, statistical significance at less than 1% level of difference was obtained. The greatest mean difference was discovered among EG II, demonstrating the impact of dietary supplements as well as nutrition and health education.
- After receiving nutrition education and intervention, the mother's attitude increased from its initial mean scores in EG I, EG II, and CG I of 3.1, 2.9, and 3.6 to 6.3, 8.4, and 5.0, respectively. According to statistical significance, there was a 5% level difference for EG I before nutrition and a 1% level difference for EG II before nutrition.
- The mean practice score among the selected caregivers in EG I increased from 1.7 to 7.2 and the mean practice score of EG II increased from 2.7 to 8.9. The control group showed no alterations after the research period.
- Micronutrient and Omega-3 fatty acids -based digital technology assisted nutrition support for caregivers led to a significant improvement in children's nutritional status, according to a cluster-randomized intervention study in Southern Indian. This finding raised the possibility that nutrition education for caregivers may be an effective method for enhancing the health and nutritional status of children from Indian communities.

Conclusion:

The current study concluded that consanguinity in marriage, which was prevalent in many Indian cultures, significantly contributed to the development of ADHD in children. The gender, family income, family type, and order of child were all connected with subtypes of ADHD. Further investigation highlighted the necessity to establish a connection between

subtypes and children's blood groups, which was crucial for that study. Personality of father and lifestyles of father and mother are significant to symptoms of children with ADHD. Mothers' prenatal and postnatal histories were linked to the development of children with ADHD symptoms. Age of the mother and a protracted labour were two key factors in the etiology.

It was discovered that the children's food habits and illness episodes had an impact on their anthropometric indices, highlighting the significance of routine clinical and nutritional evaluations for children with ADHD. The association between behaviour symptoms and food intake of fat, carbohydrate, and micronutrients such calcium, phosphorus, magnesium, zinc, vitamin A, and vitamin C suggested a link between micronutrients and immune functions.

Overall study findings showed that children with ADHD are malnourished to varying degrees. Even though the children with ADHD had nutritional consumption levels that were significantly lower than the RDA, anthropometry, and symptoms all pointed to changed intake, poor absorption, and metabolic dysregulation. The children's dietary intake was a reflection of factors like the caregivers poor calorie-laden dietary decisions, their lack of knowledge about healthy cooking and eating habits, and their inconsistent use of nutrient supplements, all of which had the potential to significantly exacerbate the symptoms of ADHD. Therefore, there was a pressing need to identify the nutritional and metabolic components that contribute to the development and severity of ADHD symptoms in the early period. The study also stresses how important it is for all healthcare professionals, not only caregivers, to understand the importance of nutrition together with other interventions. Digital health intervention showed a significant impact on Knowledge, attitude and practices for caregivers and there was statistically significant difference in nutrient intake in both the Experimental groups suggesting one to one dietary modification to have better effect in improving the intake. Hence a holistic approach of digital technology assisted nutrition support and dietary modification may be effective strategy to improve the KAP and dietary intake. Further the sustainability of these changes should to improve and maintain the behaviour function among children with ADHD symptoms. Also, more Micronutrient rich snacks would support in improving the nutrient intake and reducing the symptoms of children with ADHD. Since the digital technology assisted nutrition support and feedback for the study-developed Artificial Intelligence based integrated dynamic website were both highly

successful, such initiatives can be seen as a crucial component of the special needs education system.

Limitations:

The study could suggest strategies to overcome neuro behavioural disorder among the children with ADHD symptoms in Chennai city through improvement in knowledge and bringing about a difference in attitude, practices for caregivers and nutritional intake for children, but owing to Covid - 19 pandemic conditions, biochemical estimations were not feasible during the study.

Recommendations:

- Children with ADHD who were enrolled in special education programs and regular schools may be compared.
- A cross-cultural study on children with ADHD can be carried out.
- As the study demonstrates a strong influence of digital health intervention , this may be recommended as one of the intervention strategies for studies on Special children.