3

Methodology

The methodology of the research entitled **"Digital Technology Assisted Nutrition Support for Children with Attention Deficit Hyperactivity Disorder"** is presented under the following Phases.

3.1. Phase I - Background information of children with symptoms of Attention Deficit Hyperactivity Disorder (ADHD)

3.1.1. Selection of area and children

3.1.2. Formulation of the assessment tools

3.1.3. Eliciting data on the demographic profile, socio-economic background, lifestyle and dietary pattern

3.1.4. Assessment of the nutritional status and behaviour function of children

3.2. Phase II - Formulation and standardization of micronutrient rich snacks

3.2.1 Identification, selection and processing of foods rich in micronutrients

3.2.2 Organoleptic evaluation of the micronutrients based snacks

3.2.3 Assessment of quality parameters, nutrient content and microbial count of the formulate snacks

3.3 Phase III – Development and Implementation of Intervention strategies

3.3.1. Development of digital health intervention modules

3.3.2. Development of Artificial Intelligence Integrated Dynamic Website

3.3.3. YouTube Videos

3.3.4. Development of Nutrition education Aids for one-to-one telephonic counselling

3.3.5. Dietary Modification

3.3.6. Implementation of Intervention Strategies

3.4 Phase IV – Impact Evaluation

3.4.1. Changes in Anthropometric Measurements of children with ADHD

3.4.2. Changes in Food and Nutrient Intake

3.4.3. Changes in Behaviour Function

3.4.4. Pre and Post – scores on Knowledge, Attitude and Practice (KAP) of caregivers

3.5 Phase V- Statistical analysis

The Research Design is presented in Figure 3

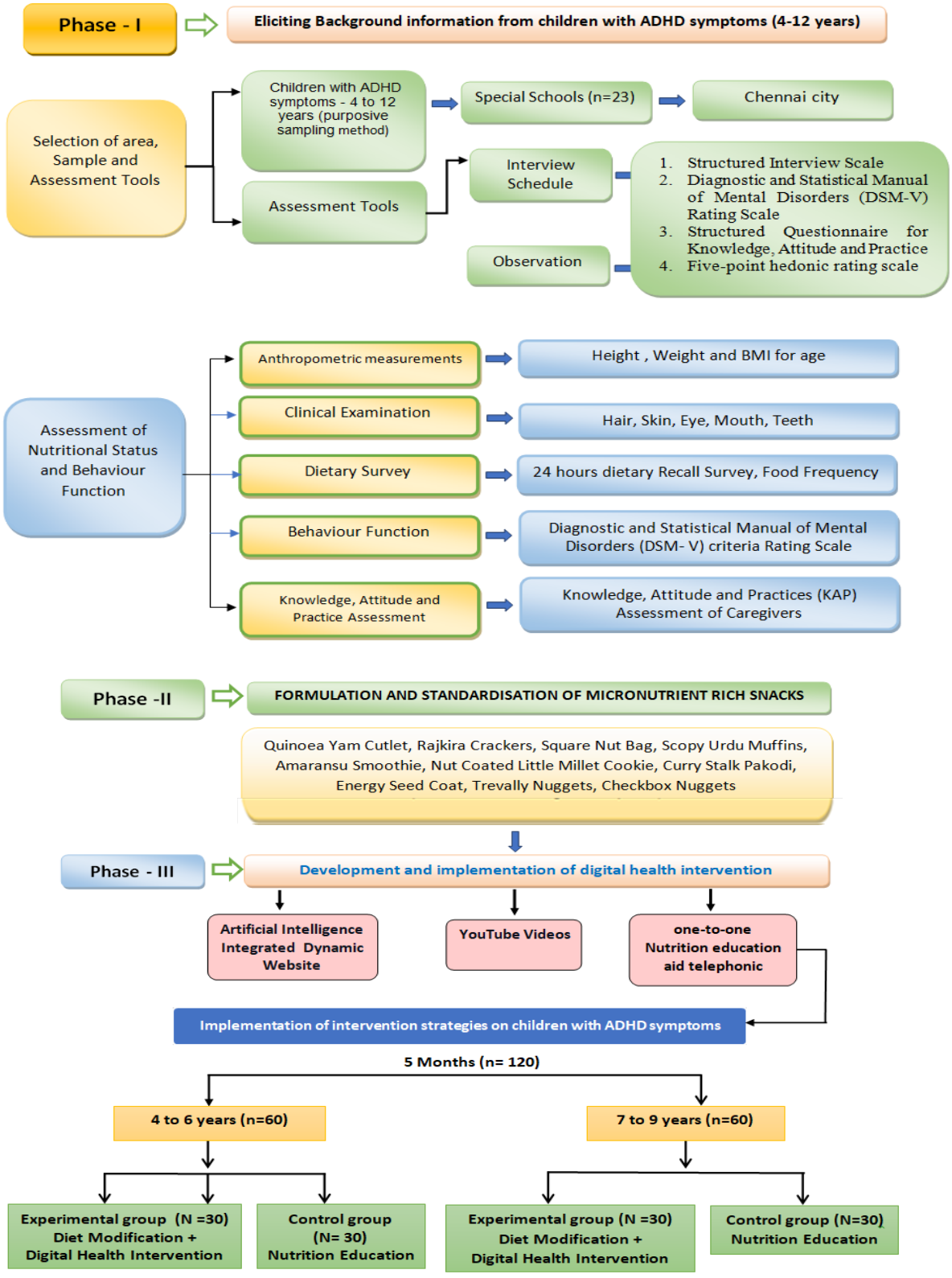


Figure 3

Research Design

3.1. Phase I - Background information of children with ADHD symptoms

3.1.1. Selection of area:

Chennai is a leading city in the country offering various educational opportunities to a wider population and individuals with special needs. Because there are more special needs facilities in Chennai than in the other 31 districts of the Tamil Nadu state, people are more aware of learning difficulties. Given these factors, the current study was conducted in Chennai. Before beginning the study, the researcher sought to identify the children of ADHD symptoms who attended regular school. Parents did not participate in this program because they did not wish their child to be labeled as a "special child," which has serious consequences. Furthermore, school administrators were unwilling to accept it. Because of these considerations, the researcher decided to explore 23 special schools in Chennai, where parents were more supportive of their child's 'special' status in society. Directorate of Medical Services Campus (DMS), Government of Tamil Nadu, Teynampet, Chennai, was contacted to collect the records of the special schools for 2019-2022. The data was obtained from DMS's Department of Welfare for the Differently Abled (Public Welfare Department).

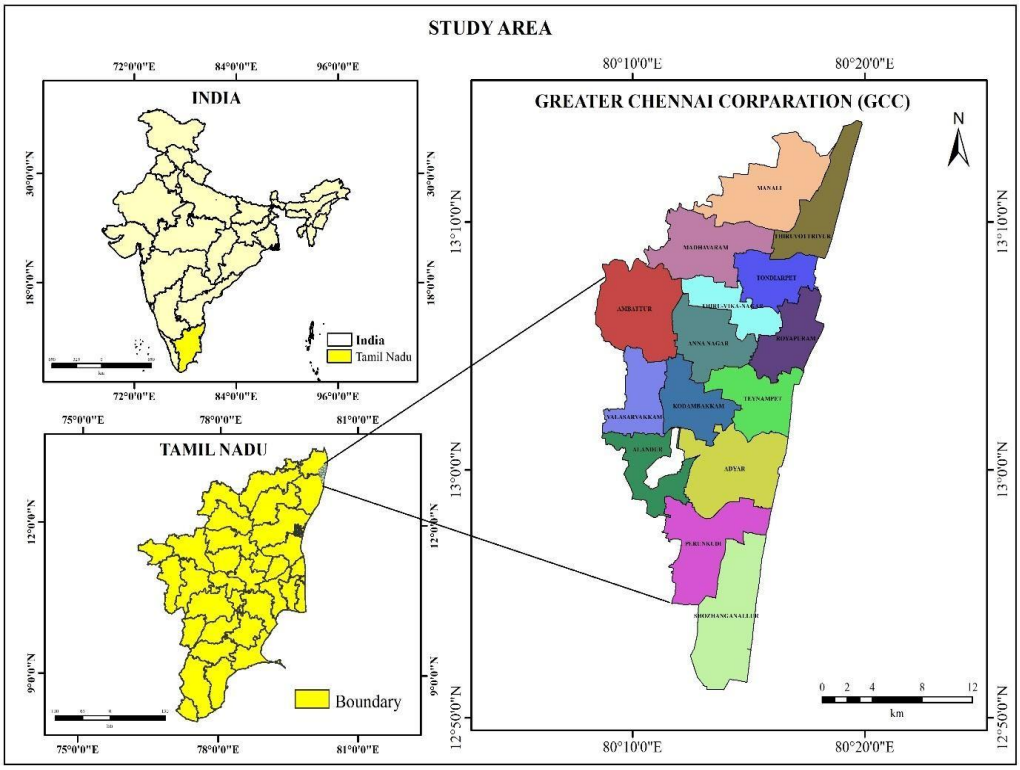


Figure 4

Study Area: Chennai City

i. Study Design

The study design was cross-sectional, comparative, and interventional study to improve the nutritional status and behavioural function of children aged 4 to 12 years in special schools. The study was approved by the Institutional Human Ethical Committee, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore AUW/IHEC/FSN-20-21/XPD-27, and official permissions for the special schools to conduct this study were obtained from the School Principals. (Appendice I, II, and III)

ii. Sampling:

Children with ADHD symptoms were chosen using purposive sampling, commonly known as the judgemental method. Purposive sampling refers to a certain person chosen as a subject for the study because they exhibit some unique traits required for the study.

iii. Selection of the children:

Based on the 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. Most of the children had comorbid conditions such as moderate autism (autism spectrum disorders), specific learning disabilities (SpLD) namely dyslexia or dysgraphia, conduct disorder and bipolar illness. These children were undergoing various treatments for their ailments. The inclusion and exclusion criteria are as follows

Inclusion Criteria	Exclusion Criteria
1. Children from special schools of Chennai city.	1. Children with ADHD symptoms studying in mainstream schools.
2. Children between 4-12 years of age.	2. Preschool children and adolescents with ADHD.
3. Children with a clinical psychologists unambiguous diagnosis of ADHD symptoms and related comorbid disorders.	3. Children with severe learning disabilities, severe autism, and mental retardation from special needs schools in Chennai.
4. Caregivers' willingness to participate in studies.	4. Children with physical disabilities.
	5. Stigmata of mental retardation.

The age group of 4-12 years (school-age) was purposefully selected to investigate the early causes and to provide timely intervention of ADHD. The researcher wanted to maintain consistency in the characteristics of the chosen sample of exclusively school-aged children. Because there is a considerable difference in the features of preschool and adolescent children when compared to school-aged children, very young preschoolers (less than 4 years) and adolescents (more than 12 years) were eliminated from the sample. The sample of 137 children was then classified into 4-6 years, 7-9 years, and 10-12 years as three groups. This age-group distribution of children was based on the Recommended Dietary Allowances for Indians (RDA-ICMR, 2020) as nutritional intervention is a major part of this study.

3.1.2. Formulation of the assessment tools

The following assessment tools were used to collect information on the children's socioeconomic and demographic profile, health and nutritional status, behaviour functions, and nutritional Knowledge, Attitude, and Practices (KAP).

i. Structured interview schedule for nutrition survey

Given the nature of the research and the number of participants, an interview schedule was chosen as the data gathering instrument. With objectives and interview strategies in mind, an organised interview schedule was created. (Appendix IV) Questions on socioeconomic status, health status, parental health status, morbidity pattern, physical activity pattern, and nutritional status of the children were drawn from a previously validated questionnaire framed in accordance with the literature review and purpose of the study. Before being used in this study, the reliability and validity of the interview schedule were evaluated by a clinical psychologist and a nutrition specialist, who were also administered a pre-test. Prior to data collection, the indicated improvements were implemented.

ii. Behavioural assessment of children with ADHD using DSM-V criteria

This section was amended from the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition, 2013, published by the American Psychiatric Association (APA) (Appendix IV). The DSM- V criteria is the guidebook used by psychologists and academics to diagnose and describe the symptoms of attention deficit hyperactivity disorder. The DSM manual can also be used to categorize patients for research purposes

utilizing diagnostic criteria. It is useful across communities in assessing how many children have ADHD, the severity of ADHD, and how this disorder affects paediatric health. The DSM contains the criteria for the three subtypes of attention deficit hyperactivity disorder. They are inattention, hyperactivity/impulsivity, and combination type, each with its own level of severity, which can be low, moderate, or severe. These types were identified using a total of 18 symptoms-based questions which were divided into two categories (Attention Deficit and Hyperactivity/Impulsivity), with a minimal of six signs in one or both categories required to be diagnosed. The symptoms must be present for at least six months if the child is under the age of seven. The DSM also recommends ruling out other associated ailments that could be the source of the displayed symptoms.

iii. **Structured questionnaire for Knowledge, Attitude and Practice (KAP) regarding child nutrition**

The caregivers were mothers or any person who took care of the children with ADHD for the KAP survey were given a predefined close-ended questionnaire. It had 20 questions covering Knowledge, Attitude, and Practices in Child Nutrition. Questions were derived from the FAO manual (2014) and revised based on the title and relevance to the study, as shown in (Appendix V) . The questions addressed a wide range of issues, including child nutrition, cooking methods, and the relevance of nutrients. This questionnaire was administered before and after the eight months of conduct of the nutrition education programme.

iv. Five-point hedonic rating scale for formulated snack evaluation

The scientific discipline of sensory assessment has been described as being used to elicit, estimate, evaluate, and interpret responses to products as perceived through the senses of vision, smelling, touching, tasting, and hearing (Edgar Chambers IV, 2019). To evaluate the formulated snacks included in (Appendix VI) , a self-designed score card was created utilizing a 5-point hedonic rating scale. The five point hedonic scale, which evaluates the degree of like or disliking for the organoleptic properties of food, is the most widely used category scale in sensory testing. This scales are useful for panel members because of their simplicity. Moreover, as they are simpler to tabulate than line markers or the more variable magnitude calculations, they provide some benefits in coding the data

and computation for both accuracy and speed. The score card includes factors such as appearance, colour, taste, texture, flavour, and total acceptability, with scores ranging from 1 to 5 (1 = dislike very much, 2 = dislike slightly, 3 = neither like nor dislike, 4 = like slightly, 5 = like very much). (Pimentel and Deliza ,2016).

3.1.3. Eliciting data on the demographic profile, socio-economic background, lifestyle and dietary pattern

Caregivers of children with ADHD were informed about the study's goal and advantages prior to data collection. The investigator administered and gathered the questionnaire, which required information on the children's demographic profile, socioeconomic background, lifestyle, and food pattern. Under the guidance of a clinical psychologist from the Department of Psychology, the Coursera Website the researcher received one month online course of training to administer the ADHD elementary strategies and DSM scale. (Appendices VII and VIII). The investigator also conducted a pilot study to become acquainted with the DSM -V criteria technique.

After establishing rapport with the headmasters, head mistresses, class instructors, and caregivers of each child the information and objectives of the study were explained. A formal informed consent was also acquired in both English and Tamil. Mothers were questioned to gather primary data on their background information, socioeconomic profile, family history of ADHD symptoms, parental health profile, lifestyle pattern, health history, and dietary consumption. Each child's nutritional health and behavioural function were tested independently.

3.1.4. Assessment of the nutritional status and behaviour function of children with ADHD symptoms

i. Anthropometric measurements

Anthropometric assessments are a group of quantitative measurements of muscle, bone, and adipose tissue that aid in determining body composition (Casadei and Kiel., 2020). Individual measurements are taken into consideration in comparison to reference standards. The children's anthropometric measurements for the study were height and weight. For greater precision, the values were recorded in triplicates. The tools used for this phase of the study were a stadiometer, weighing scale, ICMR growth charts.

A. Height

Height is regarded as a significant indicator of a child's nutritional condition. The children's height was measured from the floor to the vertex of the head using a stadiometer. The children with ADHD symptoms were taught to stand erect with heels flat, feet close to one another, buttocks and back of the head touching the wall, shoulders loose, and hands hanging straight (NHANES,2016). By bringing the head piece down to the highest point of the head and compressing the hair, the measurement was taken as close to 0.1 cm in triplicates.

B. Weight

Weight is also a sensitive sign of current nutritional condition and growth failure. A portable weighing balance was used to calculate total body mass. Before weighing each child, the scale was reset to zero. On the balance, the children were asked to stand without socks or shoes. They were ordered to stand tall, heads straight, and stare forward, with arms at their sides, and their weight was recorded to the nearest 0.1 kg (NHANES,2016).

C. Body Mass Index (BMI)

BMI has become the key indicator of relative weight. It is based on reference curves that represent BMI values as a function of age. BMI is a simple index defined as weight in kilograms divided by height in metres squared (WHO, 2007). BMI was computed from the given formula:

$$\text{Body Mass index} = \text{Weight (kilogram)}/\text{Height (metre)}^2$$

After calculating the BMI for the children, the BMI value obtained was plotted on the WHO BMI-for-age growth charts (for either girls or boys) to obtain a percentile score (Kummer *et al.*, 2016).

Percentiles are the most often used indicator to measure the size and growth trends of individual children, and they represent the child's BMI value's relative position among children of the same age and gender.

Table IV depicts the BMI-for-age weight status categories, as well as the related percentiles and the number of children classified according to these percentiles in the current study.

Percentile Range*	Weight Category
(< 5th Percentile)	**Under Weight**
(5th and < 85th Percentile)	**Healthy Weight**
(≥ 85th and < 95th Percentile)	**Over Weight**
(≥ 95th Percentile)	**Obesity**

*WHO (2007)

ICMR 2020 standards were utilised to assess the children's height and weight, and WHO growth charts were used to calculate stature for age, BMI for age, and height based on BMI percentiles of the children with ADHD symptoms.

ii. Clinical Examination

Clinical examination is the most basic and practical method for determining nutritional status. Hair, skin, eyes, mouth, teeth, and tongue of the children were checked using the World Health Organization, 2013 examination protocol. A clinical examination was performed on the children with the assistance of a physician in order to assess their clinical status.

iii. Assessment of dietary pattern of the children

A dietary survey collects data on children's food intake, nutrient intake, and eating habits, which reflect on their nutritional status (Omage,2018). Data on food frequency intake, a 24-hour meal recall survey, food preferences, food inclusion and exclusion, junk food choice, and food habits and attitudes are all collected as part of the dietary pattern evaluation. The intake data was collected using a standard three-day recall questionnaire, which the children completed over three randomly chosen days (two regular days and one weekend). (Appendix IV) (FAO, 2018). Caregivers were requested to provide information about the child's dietary profile as well as an estimate of the portion size consumed by the child in order to calculate the quantity. Measurement of foods using spoons, measuring cups, and plates were taught to the caregivers (Plate 1). The nutrient intake was calculated using the Indian Food Composition Table (Longvah *et al.*, 2017) and compared to the ICMR's Recommended dietary allowances (2020).

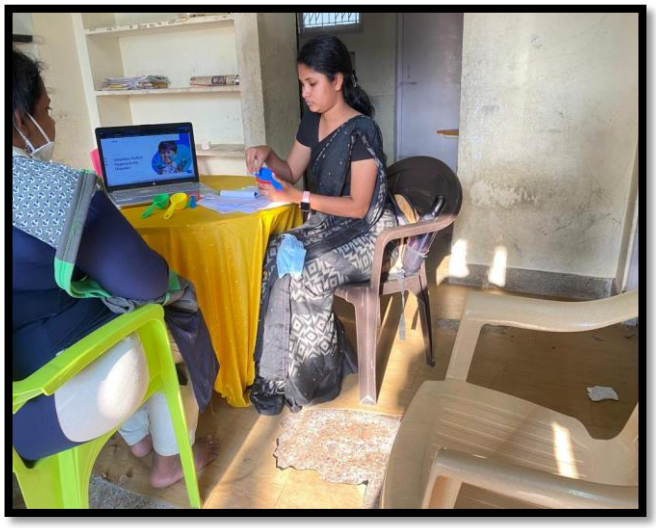


Plate 1: Diet Survey

iv. Assessment of behaviour function

The behaviour function of the children was assessed using the DSM-V symptoms criteria (Annexure IV). It is a table based on a 4-point Likert scale that includes 19 prevalent ADHD symptoms and is graded with four columns for symptom presence as numbers (1- no symptom, 2-mild symptom, 3-moderate symptom, 4 –severe symptom). The checklist was used to identify and classify the symptoms of attention deficit hyperactivity disorder in children with ADHD symptoms, with the assistance of a clinical psychologist. The average score of all symptoms defined only in hyperactivity, inattention, and combination type was called ADHD symptoms.

v. Assessment of Caregivers Knowledge, Attitude and Practices (KAP) regarding child nutrition

The impact of caregivers knowledge, attitude, and practice (KAP) in the area of nutrition on their children's dietary behaviour was evaluated (El-Nmer *et al.,* 2014). The nature and quality of care provided to the child is significantly influenced by the caregivers' understanding of child nutrition (Harun *et al.,* 2021). Thirty multiple-choice questions from the FAO handbook (2009) that were adjusted based on the study's topic and relevance were included in the pre- and post-testing questionnaire throughout the study of eight months. The questionnaire's contents, focused on the value of nutrients, the nutritional needs of children, the consequences of snack intake, childhood growth and development, and a balanced diet. Each question was given a score.(Appendix VI)

PHASE II

3.2 FORMULATION AND STANDARDIZATION OF MICRONUTRIENTS RICH SNACKS

3.2.1 Identification, selection and processing of foods rich in calcium, iron, zinc, omega-3 fatty acid and magnesium

i. Need for food formulation

A balanced diet should include foods with a high nutritional content, be acceptable, easily accessible, affordable, and well-known in the community in order to avoid and rectify nutritional deficiencies. The formulation of supplements utilizing inexpensive, readily accessible native foods that are popular in the community is one of the methods that has been proven to be effective in enhancing the health condition of the common people. Micronutrient-rich food combinations that include vitamins, minerals, and polyunsaturated fats are recommended as supportive therapies for ADHD symptoms (Handel *et al.*, 2021). Additionally, there is a link between children with ADHD symptoms and changed levels of key elements (iron, zinc, calcium, omega-3 fatty acids, and magnesium) (Robberecht,2020). Having all of these factors in mind, the researcher made the decision to formulate snacks using South Indian recipes that are often eaten. 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.

ii. **Selection of the ingredients and formulation of the micronutrients-rich snacks recipes**

All of the recipes chosen were cooked in their normal form as well as the three variants. The highest quality ingredients were selected, acquired, cleaned, and prepared uniquely for each recipe. All recipes were prepared using exact weights, equal proportions of components, temperature control, and timing restrictions. During recipe preparation, vessels were cleaned and standardized in size and shape. To formulate healthy snacks for dietary intervention, a list of micronutrient-rich food products were selected (Appendix 9)

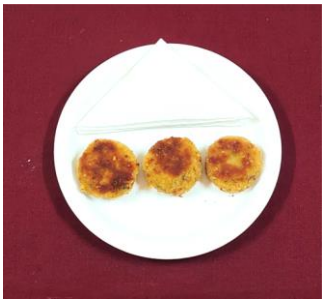
Amaransu Smoothie

Scopy Urdu Muffins

Checkbox Nuggets

Nut Coated Little Millet Cookie

Trevally Nuggets



Quinoae Cutlet

Curry Stalk

Energy Seed Coat

Round Nut Bag

Rajkira Crackers

Plate 2

Formulated and Standardized Micronutrient rich Snacks

3.2.2. Organoleptic evaluation of the micronutrients-based snacks recipes

The formulated samples were intended for feeding children with ADHD symptoms to improve their nutritional status and behaviour function. Sensory assessment is a scientific methodology that examines the qualities of a product using human senses of smell, sight, taste, touch, and hearing. (Singh-Ackbarali, 2014). A five-point scale was developed to analyse the acceptability of the recipe in terms of appearance, colour, flavour, texture, and taste, and a score card was developed to evaluate the grades based on the degree of acceptance. Thirty semi-trained panel members were chosen based on their health, cooperation, willingness, and understanding of quality attributes and sensory analysis of snacks. All ten snacks formulated with three alternative forms were provided to the panel members for sensory evaluation at different points of time (Plate 3) Recipes were assessed immediately after preparation to avoid any variations in quality caused by storage, temperature fluctuations, and reheating. All of the recipes' portion sizes were kept consistent and uniform. The panel members' sensory evaluation scores of the products were recorded, and the mean scores for each recipe were calculated. The prepared score card is given in Appendix VI.

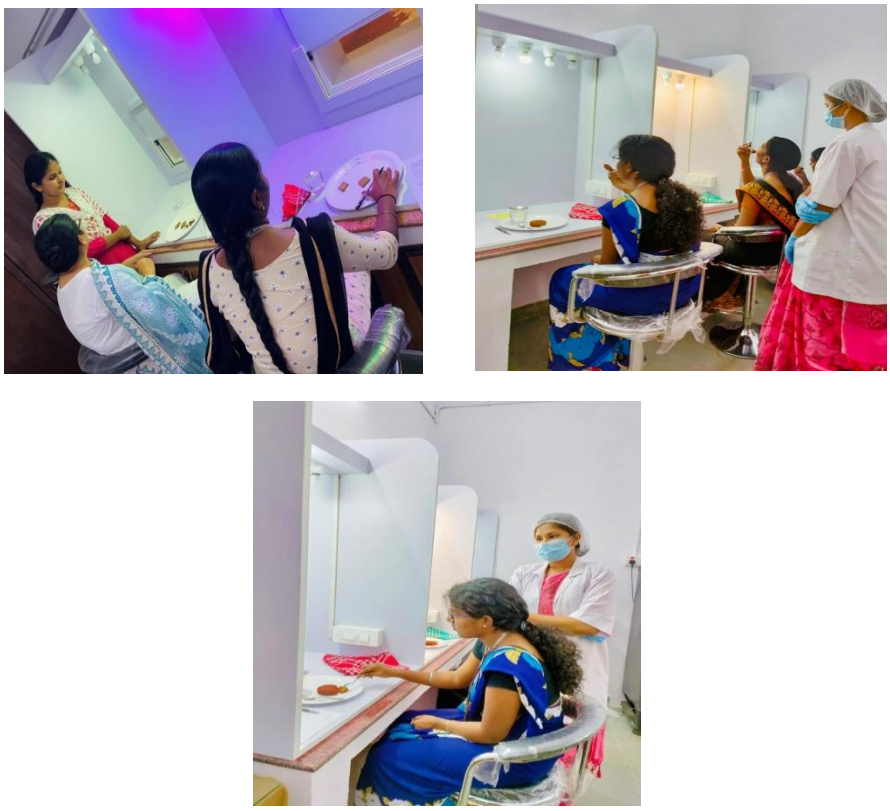


Plate 3

Organoleptic Evaluation for Micronutrient-rich Snacks

3.2.3. Assessment of quality parameters, nutrient content and microbial count of the formulate snacks

i. Physical analysis:

The physical characteristics such as weight, width, diameter, thickness and spread factor were determined. The physical characteristics were measured according to the methods described by (AACC, 2000).

i. Weight (W): Weight was determined using an electronic weighing balance.
ii. Diameter (D): Diameter was measured by placing the developed snacks horizontally edge to edge and rotated at 90-degree angle for duplicated reading.
iii. Thickness (T): The thickness of cookies was measured by stacking them one on top of the other and recording the duplicate reading.
iv. Spread ‘ratio (SR): The spread ratio is defined as a diameter/thickness ratio and was derived using the formula SR= (Diameter/Thickness x CF) x 10

ii. Texture analysis

Texture Analyzer was used to do textural analysis on each recipe (TA-XT2). The hardness of products is defined as the maximum force (gm, kg, N) which a product can bear before breaking. The hardness of product was measured using (HDP/BSK blade set with a knife) probe. The texture analyser was switched to _ON', and then settings given for hardness measurement of sample was adjusted, which was mentioned in the application guide of texture analyser. A calibration was performed on the probe, and then the sample was placed on the texture analyser platform by (Li,2020).

iii. Colour analysis

The colour was read as L*, a* and b* using Hunter Lab Colorimeter (D-25, Hunter Associated Laboratory, USA). The Hunter lab colorimeter was calibrated by Hunter colour standard prior to the reading of each samples as described by (Kuchtova ,2018) .

iv. Nutrient Analysis

The developed snack was analysed for its nutrient content following the procedures suggested by AOAC (2019). Moisture content of the formulated snack was determined using a digital moisture balance. The carbohydrate content was estimated by anthrone method, protein content was assessed through macrokjeldahl method. Fat content of the developed snack was estimated by soxhlet method and the energy value was

calculated from these proximate principles. The iron content of the formulated snack was estimated colorimetrically and calcium content was estimated using the titrimetric method. Crude fibre and dietary fibre of the formulated snack were also estimated using standard procedures. To measure ash content, weighing the samples was done in a 550°C furnace until a constant weight was obtained. In an oven at 105°C, the samples were dried until they reached a constant weight, at which point the moisture content was calculated using the gravimetric method. To determine the pH meter measure the potential difference at both the electrodes and calculate the pH as per the Nernst equation. The carbohydrate was assessed using the anthrone method. To calculate protein from total nitrogen, the Kjeldahl method was applied. A conversion factor of 6.25% was applied to calculate the total nitrogen to crude protein. Crude fat was extracted with petroleum ether, using Socs Plus, and for Crude fibre, acid and alkali washing was given in Fibra Plus Apparatus .Total dietary fibre was measured by Method 985.29 plus low molecular weight resistant maltodextrin (AOAC) and the energy value was calculated from these proximate principles. Omega-3 Fatty acid was analysed by Gas Chromatography Mass Spectrometry (GC-MS). Vitamin B_6 , β-carotene were assessed by UV-Vis spectrophotometric method, Vitamin C and calcium and magnesium were estimated by titrimetric method and Vitamin B_{12} , Iron and phosphorus content by colorimetric method, and zinc was analysed by atomic absorption spectrophotometer. Nutrients were analysed for all the variations to choose the best combination for possessing high nutrient content.

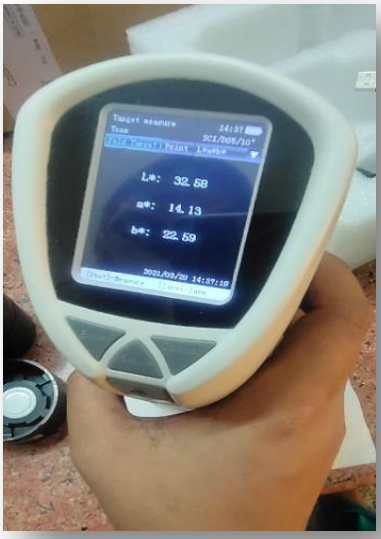
V. **Microbial count**

The safety and shelf life of the snacks depends upon the interaction of chemicals, physical and microbial factors. The microbial count of the formulated snacks were assessed by total bacterial count method (APHA ,2015). The scores were tabulated. The microbiological count provided an important insight into the snack's preservation quality, as it was made without preservatives.

The Assessment of quality parameters, nutrient content and microbial count of the formulated snacks is depicted in Plate 4

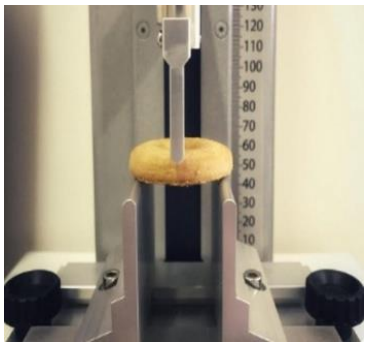
Fat extraction

Microbial analysis



Colour analysis

Diameter and Thickness ratio



Texture analysis

Plate 4

Analysis of Formulated Snacks

Phase III

3.2 Development and Implementation of Intervention strategies

3.3.1 Development of digital health intervention modules

With the onset of the Covid – 19 pandemic, there had been a change in the education system shifted to online learning; with time, the children, as well as the parents, became well acquainted with the usage of digital modes of education and the use of mobile applications. (Dhawan, 2020). Further, the cheap availability of the internet with high bandwidth on cell phones has opened the doors for digital learning to reach inaccessible sectors of the population in the developing world. (Milakovich and Wise, 2019). Nutrition education is a process of conveying the scientific findings of benefit to a particular community using education methods to promote better feeding habits and behaviour to enhance their standard of living (Contento, 2010). Hence, in the present study, appropriate modules and portals were selected to know the effectiveness of a different form of educational intervention. Since children with ADHD symptoms follow the significance of macro and micronutrients with particular reference to omega-3 fatty acids, protein, vitamin B_6 and $B_{12,}$ iron, calcium, and zinc-rich in food items was required behaviour modifications in the symptoms of brain function and helps in neurotransmitter level was promoted in the content of the educational materials. Materials for two different intervention strategies, digital health intervention and dietary modification using telephonic counselling, were developed. The materials were assorted across digital health intervention modules such as AI-integrated dynamic websites, YouTube Videos, Expert talks and nutrition games to avoid monotony.

3.3.2. Development of Artificial Intelligence Integrated Dynamic Website

As a result of the COVID19 pandemic, the educational system changed to emphasise online learning. Both parents and children were comfortable using web application and usin g digital modes of instruction (Dhawan,2020). Web-based programmes and apps are relatively inexpensive and have the potential for broad reach; yet, continuous engagement is a crucial factor limiting efficacy. The user-desired combination of approved information, interactivity, personalization, and tailored feedback needs to be included in digital nutrition promotion aimed at parents in order to address this issue (Grady, 2018). Consequently, 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.

In this stage, the content of the website was gathered from different sources, such as Center for Disease Control and Prevention, World Health Organisation, ICMR-NIN and from psychologists and nutritionists. At the same time, the process of searching and selecting the possible web hosting to develop the website was also carried out. A selection of desirable interactive and engaging features was constructed, including YouTube videos such as those that included cooking 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. Parents were willing to connect and communicate with other users through conversation sites and social media to exchange the information, perspectives, experiences, and issues. Some other features that was desired was the potential to communicate with medical experts, ask queries, make goals, and to get opinion on development.

The steps of web design are:

Content framing for the website

Causes and symptoms of ADHD, risk factors of ADHD, and treating and preventing ADHD symptoms were among the themes chosen for the content targeted at instilling awareness about ADHD symptoms among children. The steps of content framing were **Website Development**: The website was built with the assistance and experience of a web programmer and a web designer. The web programmer built the navigational web architecture and selected screens, while the web designer produced the displays and interactive features.

- **Content-only Site Framework**: A navigation map was created to represent the overall structure of the web project, including all pages and linkages inside the site.
- **Templates:** Templates for common pages were produced at all levels of the website.
- **Client-side Programming (CSP):** For client-side development, the nutrition website included style sheets and Java scripts.
- **Server-side programming:** Jquery and JavaScript programmes were utilised for form processing on the ADHD-based nutrition Questionnaire website.
- **Typography:** Typography is an important part of Web design. For the nutrition page, Cambria typefaces were used.
- **Images**: By utilising the visual effects of shape, colour, and contrast, websites can be aesthetically appealing and inspire visitors to examine their contents. Some licensing keys

and free stock photos were purchased. Graphics, when used correctly, may improve practically any web page.

- **Page Layout:** In graphic design, page layout is concerned with how content is organised and styled on a page. An appealing layout encourages visitors to interact with the content on the page and allows them to access the most important information more quickly.
- **Colour**: The primary backdrop was blue, the contents were white, and the typefaces in the contents were green.

6. Programmes and Tools

- The abbreviation for **Hypertext Markup Language (HTML)** is Hypertext Markup Language. Dreamweaver was the software package used to produce the HTML for the Nutrition ADHD website. It is a mobile-friendly website that can be seen on a range of devices such as computer displays, tablets, and mobile phones.
- **PHP** is an acronym that stands for Hypertext Preprocessor. Understand your BMI and dietary status. The Nutrition ADHD website's computations were performed using core PHP.
- J**avaScrip**t is a computer language that lets you add movement, interaction, and dynamic visual effects to your HTML sites. On the client side, JavaScript programmes were used to validate data entered in the Questionnaire, Nutrition ADHD Indicator Calculation, and Calculate Your BMI forms.
- **CSS (Cascading Style Sheets):** CSS allows the designer to customise the design of the website. CSS was used to create everything from precise margins to pixel-perfect spacing to fonts and type faces.
- **Adobe Photoshop:** In Photoshop, the backgrounds of the images were rendered translucent so that they could be integrated into the Nutrition ADHD webpage.
- **Python:** The usage of an integrated "chatbot" with Artificial Intelligence (AI) made it possible to ask users follow-up questions to help them become feasible to the web application created. These bots can be made using the Artificial Intelligence Markup Language language (AIML). The developer can create the rules that the bot will adhere to using a language that is based on XML. Furthermore, with the help of python, it was developed by Google Analytics to archive the data, that could be accessed from any

location in the world. It has various ways to analyse the tracking data and create custom reports on this website.

- **Nutrition games-** Nutrition games can facilitate learning and behaviour modification since they can be made to be entertaining, enjoyable, or engaging, thereby integrating nutrition education and minimising the screen time. It strengthens the focus of attention, concentration, and the memory game by requiring the matching of pair-wise food images. To supply a digital timer and a time bar. When a children makes a matched pair, a pleasant sound is produced, whereas an unpleasant sound is produced when the pair does not match. The games are Word Search, Quiz, Sudoku, Puzzle ,Magic food , Food painting were designed using CSS, HTML, and Python.

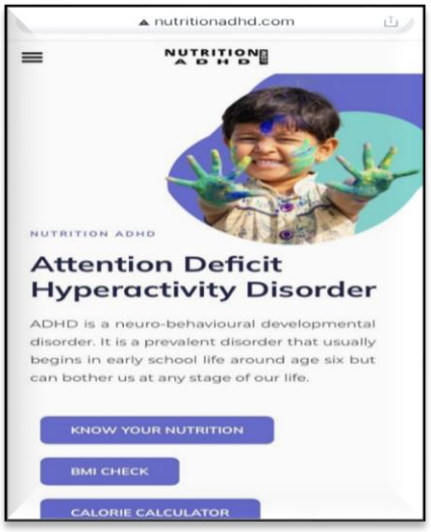
- **Examining and Testing the Website**

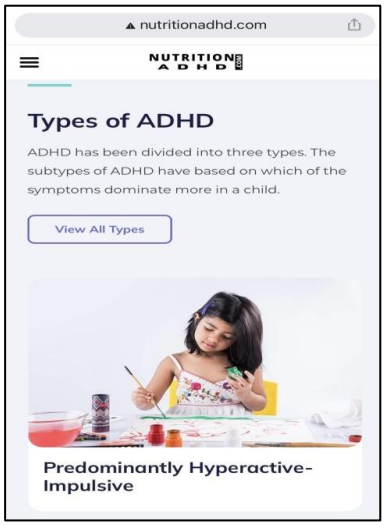
  The webpage was reviewed for spelling and/or grammatical problems. The website's layout was scrutinised for uniformity. For accuracy, the written programming was double-checked. Before it was launched, the complete website was reviewed and evaluated for acceptability and satisfaction with the interface and navigation, tone, colour, and substance, and spelling concerns.

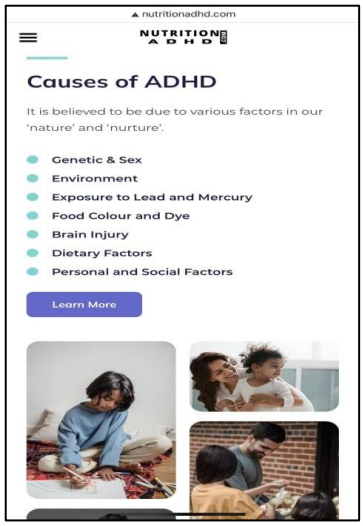
Launching the Website:

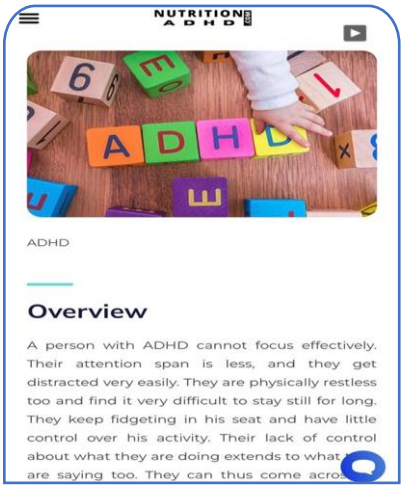
The process of making a website available to users is known as publishing. It is necessary to physically upload the web page to a server. An IP address or a domain name is used to access a website. A domain name should be simple to remember, pronounce, and spell. It must also be relevant to the website's content. The website's domain name was **www.nutritionadhd.com**.

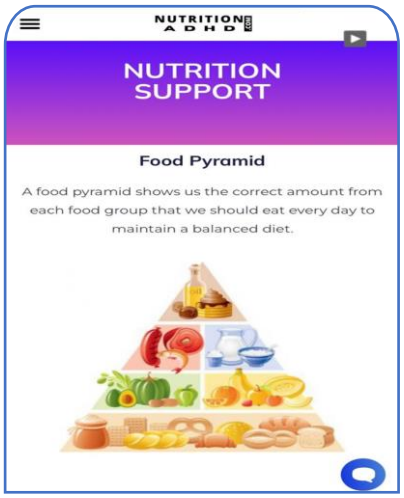
- **Uploading the Website:** To upload files containing each unique web page to the server, a File Transfer Protocol (FTP) application was utilised. Those stage-by-stage design plans were implemented on the website once it had been uploaded to the web server.

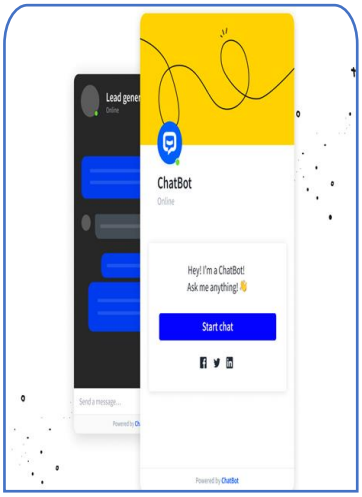


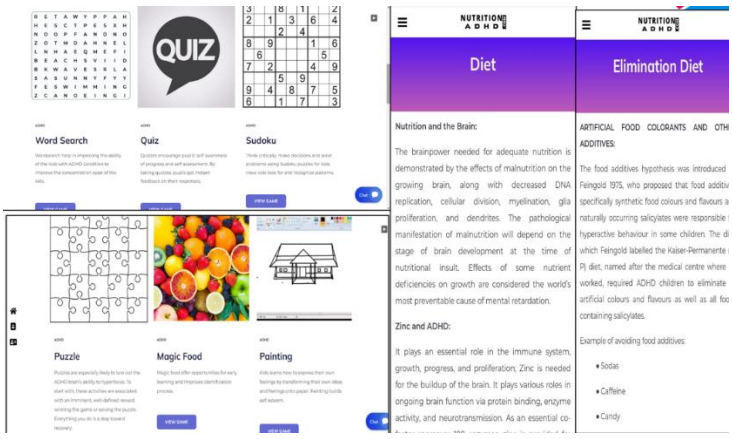












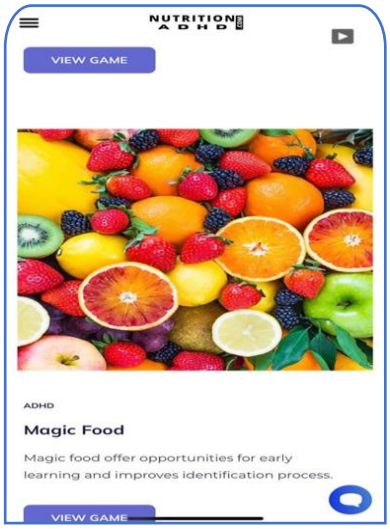


Plate 5

Development of the Website

3.3.3. YouTube videos

The YouTube platform has gained importance in recent years. An increase in usage of this platform from 48 per cent in 2016 to 68 per cent in 2021 has been apparent with every 2 out of 3 people and also less age gap among users compared to other social media platforms displaying its potential to be used as an educational tool (https://www.marketingcharts.com/digital/video-106574)In the present study YouTube videos developed were in the form of lectures for 10 – 15 minutes(Plate). The content of which was collected from book references and a literature review. These lectures were recorded using a mobile phone and camera with edited professionally before implementation. The videos developed were as follows:

1. The first part of the Video on the topic "Introduction to the website on Attention Deficit Hyperactivity Disorder An overview" included the basics, symptoms, diagnosis, benefits and consequences of the neurobehavioural disorder.
2. The second part of the video on expert talks from professionals namely psychologists, nutritionists, therapists, and academicians involved treatment consultation and research on symptoms with ADHD children. The guidelines on effective behaviour modification and a particular emphasis were made on changes in the behaviour function. It was helpful for caregivers to handle the children and digitally connect with the experts. It also reduced the symptomatology for children and easily monitored the behaviour at their homes and wherever the child is comfortable.
3. The third part of the video "Dietary modification" focused on Micronutrient-rich based snack formulated and standardised snack recipes. Cooking demonstration videos were shot and included in the YouTube channel to help the caregivers to learn and prepare the snacks for the children.

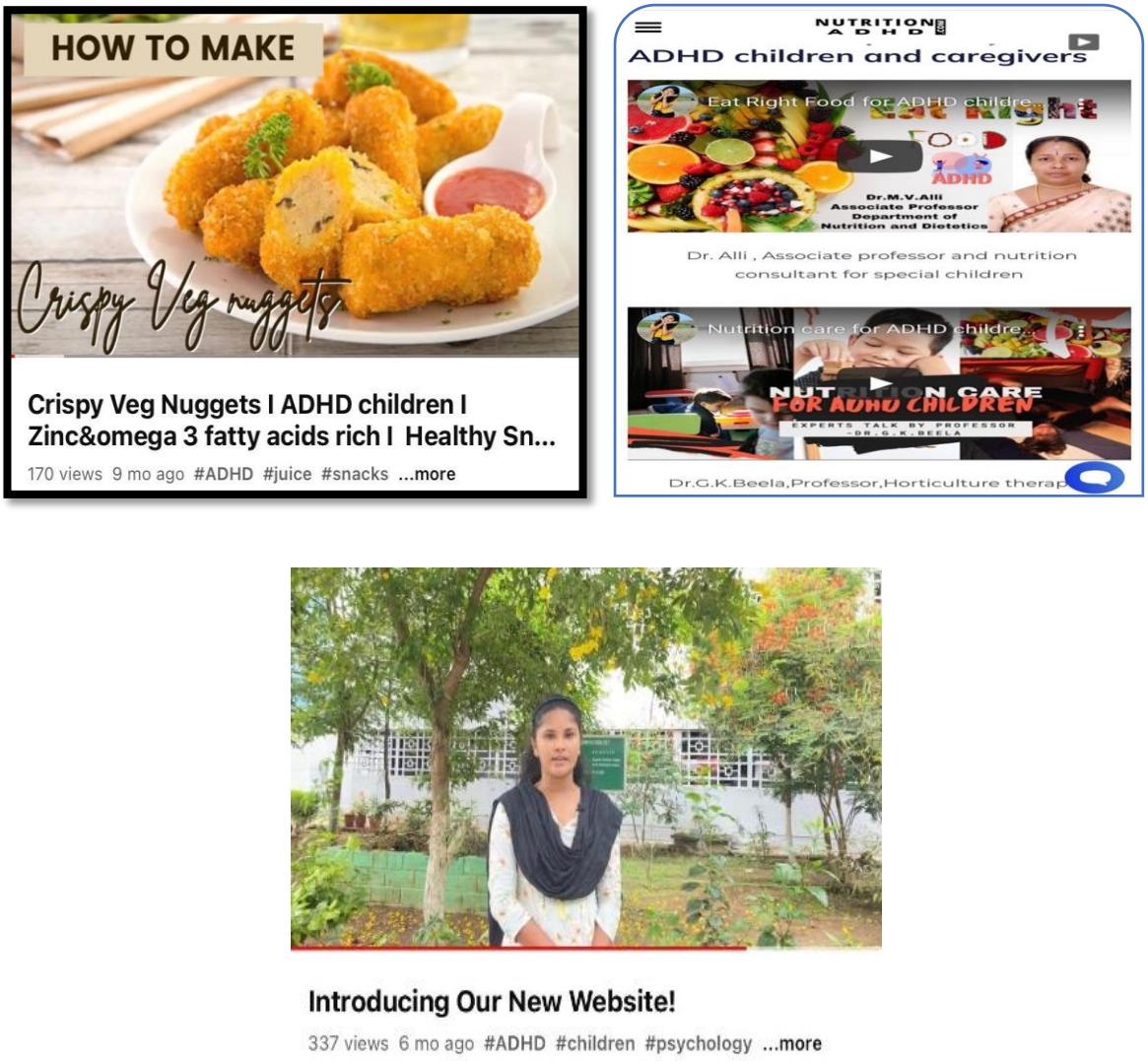


Plate 6

Development of the YouTube Videos

3.3.4. Development of Nutrition education Aids for one-to-one telephonic counselling

Personalised nutrition counselling was given to the caregivers of children with ADHD symptoms. The researcher provided one-to-one telephonic nutrition counselling based on the child's requirements during the specified time for five months. The causes of the child's undernutrition and nutritional deficiencies were identified through individual discussions with the caregivers. It was prepared in a simple and easily understandable manner. Based on the KAP survey findings, the nutrition education package was created with content on introduction to ADHD, causes of ADHD, and consequences of ADHD, why nutrition is important, classification of food, recommended dietary allowances for children aged 4 to 12 years, healthy food plate, healthy food

pyramid, healthy foods vs junk foods, and the significance of macro and micronutrients with particular reference to omega-3 fatty acids, protein, vitamin B_6 and B_{12} iron, calcium, and zinc. The researcher observed that this person-to-person telephonic counselling is a more efficient technique of nutrition education programmes than other approaches. **Plate 7** depicts telephone counselling that is conducted person-to-person with the caregivers.

Plate 7
Telephonic Counselling for Dietary Modification

3.3.5. Dietary modification

Dietary modification was suggested in the form of adjustment of micronutrient and macronutrient intake especially omega-3fatty acids, with the exclusion of food additives, gluten, milk and dairy products, chocolates, junk foods and highly containing salicylate and sulfite foods and following health education tips (regular sleep, limit TV time) improved symptoms and behaviour of ADHD patients as documented by decrease in scores of Conner's parent rating (Abd El Baaki *et al*., 2021). A 3 day 24 hour recall questionnaire developed for the dietary survey was used to evaluate pre and post-dietary modification changes and the data was collected through telephonic interview.

3.3.6 Implementation of intervention strategies:

The selected caregivers from experimental groups were encouraged to participate and openly share their thoughts with the investigator to make the intervention study more effective. The criteria for selecting 120 children with ADHD symptoms between 4-6 and 7-9 years in both genders were established. Purposive sampling was used to select the experimental group (n= 60) and control group (n= 60) for the investigation. A written

consent was collected from the selected participants of the experimental group. 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) was provided according to the feasibility of the participants to benefit the control group. Participants were able to interact with the investigators, asking questions and receiving responses on matters important to improving total health status. The grouping of the children for the intervention study is depicted in Figure 5.

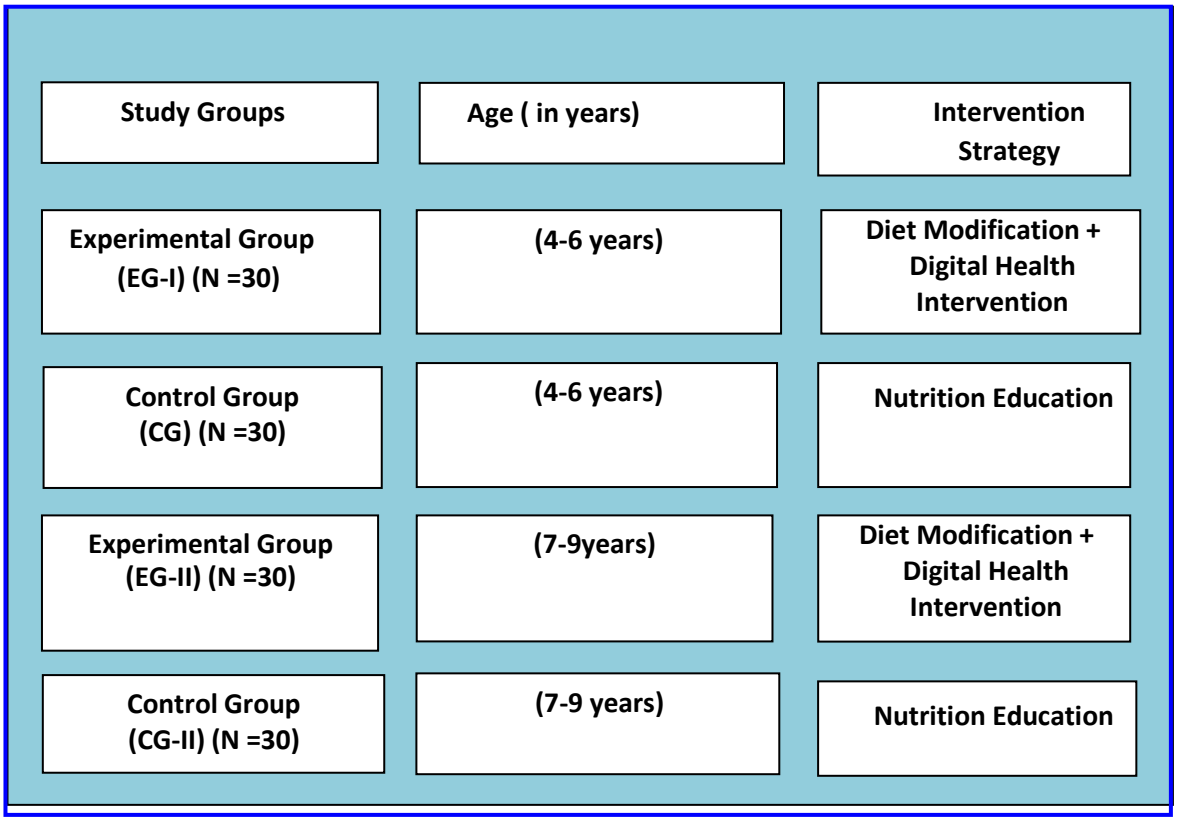


Figure 5

Grouping of the children for the Nutrition intervention

Digital health intervention and nutrition education were provided to the caregivers and Diet modification to the children through the caregivers

3.4. Impact Evaluation:

The impact can be denoted as change or an effect of a particular service of an initiative on a person or a group (Markless, 2017). The selected children with ADHD symptoms in EG and CG, were monitored closely and the impact of intervention strategies evaluated before and after intervention for five months.

3.4.1. Changes in Anthropometric Measurements of children with ADHD

Height, Weight, Body Mass Index, were recorded using standard procedures and nutritional status of the selected children was assessed with the help of the ICMR growth chart (2020) before and after intervention.

3.4.2. Changes in Food and Nutrient Intake

The dietary pattern of the selected children was assessed through 24 hours recall survey. The food and nutrient intake of the children were calculated using the ICMR recommended dietary allowances procedures.

3.4.3. Changes in Behaviour Function

The behaviour function of the selected children was elicited using the DSM-V Criteria Rating scales.

3.4.4. Pre and Post – scores on Knowledge, Attitude and Practice (KAP) of caregivers

Caregivers of selected children were invited to participate in telephonic counselling for evaluation. The mothers completed pre- and post-test questionnaires on Knowledge, Attitude, and Practice before and after the eight-month nutrition education programme.

3.5. Statistical analysis

The data collected from different surveys were recorded in the respective instrument constructed for collection. This data was consolidated using Microsoft excel so that it can be easily read and subjected to further analysis and interpretation. Research statistics' is an important tool in designing, analysing to draw to a conclusion from the collected data (Wilson, 2016). The statistical analysis was done using the two advanced graphical and Statistical Softwares Sigma Plot 14.5 and Systat 13.2. Data was expressed in terms of number and percentage regarding qualitative variables with the mean standard deviation for quantitative variables. Statistical methods such as chi-square, and independent paired test were used for linear relationship and association within the groups.