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Assessment of nutritional status and academic performance of adolescents in relation to their phytochemical intake

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Abstract

Phytochemicals can be described as chemicals of plant origin. These are certain non-nutritive plant chemicals which have various disease preventive properties. However, the term phytochemical is often used to describe a varied range of bioactive compounds found in plants. These are primary and secondary metabolites which are naturally occurring in the leaves, vegetables and roots that have defence mechanisms and protect from various diseases. Primary metabolites are proteins, carbohydrates, chlorophyll, lipids and common sugars which are synthesised during photosynthesis and these organic compounds are essential for plant life and growth. Secondary metabolites are tannins, flavonoids, phenolic, saponins and alkaloids which are synthesized by the plant during development and are time, tissue and organ specific.

Several epidemiological studies have shown that phytochemical rich fruits and vegetables have considerable health benefits. These benefits include: (i) reducing the risk of several types of cancer, (ii) reducing the risk of heart diseases. The consumption of fruit and vegetable is associated with several health benefits.

The present study was aimed on the assessment of nutritional status and academic performance in relation to phytochemical intake of adolescents. The study was performed on a sample size of 60 school going adolescents (30 girls and 30 boys) between the age group 12-16 years. The adolescents consuming fruits and vegetables in their regular diet reported to have good nutritional status. In the intervention community, the academic output was also increased. The research concluded that the intake of phytochemical rich fruits and vegetables has a positive impact on nutritional status and academic performance of school going adolescents.

Keywords: Phytochemicals, metabolites, adolescents, nutritional status

Introduction

Phytochemicals are naturally occurring, non-nutritive plant chemicals. Each fruit and vegetable may contain hundreds of phytochemicals. In simple words, phytochemicals can be described as any compound found in plant. Phytochemicals are such plant chemicals that are non-nutritive but have many disease preventative properties. Around 200,000 plant chemicals are recognized so far and 20,000 of them have been reported from fruits, vegetables and grains (Kafkas, 2017) [24]. These plant bioactives are not necessary for normal physiological functions but are well recognised for their importance in health-promoting activities such as immunomodulation, cancer preventive and cardiovascular disorders, anti-aging and anti-diabetics (Patra, 2012) [39]. In this way, phytochemicals can be defined as "non-nutrient" chemicals found in plants that have certain biological activities against chronic diseases. Studies show that the consumption of phytochemical rich fruits and vegetables is associated with good nutritional status, particularly among school going adolescents (Husain, 2012) [18] (A S Anderson, 2005) [1]. Anderson *et al.* (2004) analysed the impact of school based nutrition education aimed at increasing the consumption of fruits and vegetables. The intervention programme increased the provision of fruits and vegetables in schools. It was concluded that this approach has a modest but significant effect on fruit consumption and cognitive and attitudinal variables (A S Anderson, 2005) [1].

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Nutritional status is the health necessity of an individual which is persuaded by the diet, the body's nutrient levels and normal metabolic integrity. Standard nutritional status is managed by healthy food intake and proper utilization of nutrients. In the present study the nutritional status has been assessed in the form of:

- Anthropometric Measurements - Weight for age/sex/height.
- Dietary intake of nutrients: Energy, protein, fat and iron

Regular intake of berries, vegetables and whole grains minimise the incidence of oxidative chronic diseases. Although phytochemicals are not essential for sustaining life but these are beneficial to our health. The consumption of fruit and vegetables often tends to guard against coronary heart disease. Approximately 84,000 women were followed for 14 years and 42,000 men were followed for 8 years in a study. It was found that people who consumed more amount of fruits and vegetables had a 20% lower risk for coronary heart disease, and the lowest risks were seen in people who consumed more green leafy vegetables and fruits rich in vitamin C. The high intake of fruit and vegetables may not only inhibit heart disease and cancer, but may also shield from various other diseases. For example a diet rich in fruit and vegetable could help avoid cataracts, diabetes, Alzheimer's disease and asthma. Phytochemicals are often used for a wide range of purposes, including pharmaceuticals, agrochemicals, fragrances, colouring agents, biopesticides and food additives. The phytochemicals exhibit antibacterial, antiviral and antifungal properties against a diverse spectrum of pathogenic and non-pathogenic microorganisms. Phytochemicals are some of the most important natural preservation structures to reduce and inhibit pathogenic microorganism growth and preserve the overall quality of food products. These antimicrobials will preserve food items and increase their shelf life naturally. Food antimicrobials can usually be categorized according to their origin as natural and synthetic. Although many synthetic antimicrobials are found naturally in fruits such as benzoic acid in cranberries, sorbic acid in rowanberries, citric acid in lemons, malic acid in apples, etc.

The findings of many scientific trials during the last decade have shown the beneficial impact of phytochemicals on human wellbeing. Antioxidant intake is associated with lower incidence of cardiovascular disorders, cancer, diabetes, hypertension and many other diseases. Phytochemicals of nutraceutical importance are found in majority of foods such as whole grains, fruits, vegetables, beans, etc. These phytochemicals, either alone or in combination, have enormous therapeutic potential in curing various ailments. They have specific pharmacological properties such as anti-inflammatory, anti-allergic, antispasmodic, anti-bacterial, antimicrobial, chemopreventive, hepato-protective, hypolipidemic, hypotensive, anti-aging, analgesic, carminative, etc.

"Fruit and vegetable" intake has been related to low incidences of cancer and heart disease, and mortality rates. The consumption of fruits and vegetables lowers blood pressure, boosts the immune system, detoxifies contaminants and reduces inflammation. Medicines can support our body to recover from illness but in chronic diseases like diabetes, hypertension, cardiovascular diseases, diet plays a very important role and no medicine is the substitute for that. In such diseases phytochemicals can be of great help and they may also help to boost up brain health and immune system.

This gives inner strength to the body which is responsible for our work performance.

Good nutrition in childhood can reinforce lifelong eating habits that contribute to children's over all well-being and enable them to grow up to their full potential and lead a healthier life. Proper nutrition education in childhood helps the children to stay efficient and maintain a healthy lifestyle when they are adults. The education intervention in healthy eating habits and physical activity in the school could contribute to lessen the existing condition of childhood obesity. Habits develop at the beginning of life and later on these are a major determinant of food choice in adulthood.

Researches show that phytochemicals play important role in enhancing the health & nutritional status of children. According to Veugelers P and Heller L (2008) ^[16] "In the academic performances of children, fruit and vegetable intake were found to play an important role". In the background of this, the present study was performed for the assessment of nutritional status and academic performance in relation to phytochemical intake of adolescents.

Material & methods

Selection of Sample: The random purposive sampling method was used for collecting the data. 60 school going adolescents (30 girls and 30 boys) between the age group of 12-16 years were selected from various schools of Sonipat district.

Tools and Techniques

The collection of data was done mainly by following methods:

- 1) **Interview method:** A pre-designed and pre-tested performa was used to collect the information regarding socio-economic background, family history of diseases and dietary characteristics. Interview schedule method was adopted to collect personal information.
- 2) **Anthropometrical Measurements:** The different anthropometric measurements were taken as height and weight. Anthropometric status of the subject was compared against the NCHS/WHO reference standards to determine nutritional status.

Age: Age of the subjects was determined by the school records.

Weight: The weight was measured in kg on a spring weight machine. The subjects were wearing minimum clothing and no shoes. The zero mark of the weighing scale was checked before taking the weight and was corrected as and when required. Standard weight was assessed with the help of I.C.M.R. 2010.

Height: The height was measured with the help of anthropometric rod. In the measurement of height, the subjects were asked to stand erect, looking straight and on a leveled surface without shoes with heels together and toes apart. Standard height was calculated with the help of I.C.M.R. 2010.
- 3) **Diet Survey:** Twenty-four-hour dietary recall was taken with the help of a format in which the meal and meal timings were mention. The phytochemical intake of subjects was assessed by using a food frequency questionnaire in which name of all the fruits and vegetables available in local market were mention. The phytochemical intake assessment was done with the help of a score card, through the card exchanges of fruits and vegetables were counted. The quantities consumed by the samples were converted into exchanges which were then

carefully entered into the sheet. By using the exchange list suggested by ICMR (2010), amount of foods in weight were calculated. The nutrients were calculated by especially designed computer software based on nutritive value of Indian foods by C. Gopalan (1996) and consumed nutrients were checked against recommended dietary allowances (ICMR 2010). The assessment of nutrient intake was done by comparing the nutrient intakes with the RDA of the nutrients.

- 4) **Academic Performance:** Percentage and grades of the subjects of last two years were taken from the school records.
- 5) **Assessment of Phytochemical Intake:** Phytochemical status of all the 60 subjects was assessed from the amount of fruits and vegetables consumed by the samples. A list containing common vegetables and fruits consumed in this region was given to them. The subjects were asked to record consumed food frequency. 84 scores considered as maximum calculated on the basis of NIN/ICMR 2010 recommendations.
 - **Low Phytochemical Intake** less than 28 servings of fruits and vegetables in a week
 - **Moderate Phytochemical Intake** 28-42 servings of fruits and vegetables in a week
 - **High Phytochemical Intake** more than 42 servings of fruits and vegetables in a week

For example, if a subject is taking fruit serving's twice daily and vegetable servings thrice daily then his score will be $2 \times 7 = 14$ for fruits and $3 \times 7 = 21$ for vegetables. Total score will be 35. The student will fall in moderate phyto-intake category.

- 6) **Assessment of Knowledge Attitude Practice:** Knowledge-Attitude-Practice (KAP) assessment was done by using multiple-choice questionnaire specially designed for the subjects. Total 15 questions were given and each student was scored as 1 for a correct response and 0 for an incorrect response. Marks were given to the subjects out of 15 and assessment was done by making three categories good, fair and poor. Subjects who

obtained more than 70% were kept in good category. The ones who obtained between 50-70% were kept in fair category and who got less than 50% were kept in the poor category.

Statistical Analysis of Data: For statistical analysis of data, various methods such as percentage (%) analysis, Mean (M), Standard Deviation (SD) was used. ANOVA and t-test were used in computing significance of difference in mean values. All the statistical work has been done on computer using SPSS software under expert guidance and supervision.

Results

Consuming more fruits and vegetables help adolescents to maintain a healthy weight, feel better and have more energy. Fruits and Vegetables provide phytochemicals and considerable health significance to the human body. These special factors are required for delaying ageing and preventing the processes which leads to diseases such as cataract, cardio-vascular diseases, diabetes and cancer. Keeping these facts in mind, the phytochemical status, nutrient intake and knowledge, attitude, practices of adolescents has been studied in present study.

Table 1: Phytochemical intake status of school going adolescents

| Value | Phytochemical Intake Status | | | F Value |
|-------|-----------------------------|-------------|-------------|-----------|
| | Low (n=25) | Mod. (n=23) | High (n=12) | |
| Mean | 20.68 | 34.521 | 53.833 | 294.064** |
| SD | 2.8095 | 3.5785 | 6.0727 | |

**Significant at 1% level (ANOVA)

The above table indicates that the mean values of the fruits and vegetables servings consumed per week by low, moderate and high phyto-taking groups were found to be 20.68 ± 2.81 , 34.52 ± 3.58 and 53.83 ± 6.07 servings respectively out of total 84 servings suggested weekly. The above table also shows that the obtained F value for the difference in mean values is significant at .01 level.

Table 2: Nutrient intake of school going adolescents in relation to their phytochemical intake

| Nutrient | Phytochemical Intake Status | | | Test Statistic |
|---------------|-----------------------------|----------------|----------------|----------------|
| | Low (n=25) | Mod. (n=23) | High (n=12) | |
| Energy (kcal) | 2116±193.07 | 2271.95±217.58 | 2416.66±214.68 | 2.057 |
| Protein (gm) | 45.6±6.58 | 47.34±3.94 | 50.25±3.95 | 1.226 |
| Fats (gm) | 32.76±4.11 | 35.86±3.49 | 36.33±5.17 | 1.338 |
| Iron (mg) | 21.96±2.68 | 23.73±2.35 | 24.66±2.22 | 1.542 |

The above table shows that the mean values for energy intake were found 2116 ± 193.07 kcal, 2271.95 ± 217.58 kcal and 2416.66 ± 214.68 kcal from low to high phytochemical intake group respectively. In the present study it was found that the mean value for protein intake were 45.6 ± 6.58 gm, 47.34 ± 3.94 gm and 50.25 ± 3.95 gm in adolescents with low, moderate and high phytochemical intake group respectively. The mean values for fat intake were found 32.76 ± 4.11 gm, 35.86 ± 3.49 gm and 36.33 ± 5.17 gm from low to high phytochemical intake group respectively. In the present study it was also

found that the iron levels were 21.96 ± 2.68 mg, 23.73 ± 2.35 mg and 24.66 ± 2.22 mg in adolescents with low, moderate and high phytochemical intake status respectively.

The above table shows that the obtained test statistic value for the difference in mean values of the nutrient intake of the adolescent taking high, moderate and low levels of phytochemical foods were significant. Energy, Protein, Fat and Iron intake found increasing with increase in phytochemical intake.

Table 3: Distribution of school going adolescents according to their KAP of food and nutrition and phytochemical intake status

| Index | Scores | Phytochemical Intake Status | | |
|-------|---------------|-----------------------------|-------------|-------------|
| | | Low (n=25) | Mod. (n=23) | High (n=12) |
| KAP | Good (>70%) | 12 | 17.39 | 33.33 |
| | Fair (50-70%) | 56 | 56.52 | 41.67 |
| | Poor (<50%) | 32 | 26.09 | 25 |

The table indicates that the KAP score of children regarding food and nutrition was found good among 12%, 17.39 % and 33% students, fair among 56%, 56.52%, and 41.67% students and poor among 32%, 26.09% and 25% students respectively in low, moderate and high phytochemicals intake groups.

Table 4: Academic Performance

| Phytochemical Intake Status | Academic performance |
|-----------------------------|----------------------|
| Low (n=25) | 59.6±15.15 |
| Moderate (n=23) | 63.56±13.83 |
| High (n=12) | 66.16±15.37 |

The above table has shown the academic performance in low, moderate and high phyto-group. In this study, it was found that academic performance was found to be (59.6±15.15), (63.56±13.83), and (66.16±15.37) respectively in low, moderate and high phyto-group.

Discussion

Results of the present study clearly indicate that adolescents are not taking phytochemical rich food like fruits and vegetables. Out of 60 adolescents only 12 found taking high phytochemicals while 25 found taking these pro-health foods in low amounts. Similarly, their nutrient intakes are also found significantly and reciprocally associated with the amount of phytochemical foods. Furthermore, the knowledge, attitude and practices of adolescents towards food and nutrition have also found affecting the fruits and vegetable intakes and the overall nutrition. The study also observed improvement in the academic performance of the adolescents having more fruits and vegetables in their regular diet however, future studies will shed more light on the topic.

For optimum growth and development, a nutritionally adequate diet is important. Childhood and adolescence are periods of continuous growth and development. The healthy diet containing all the food groups in proper amount is necessary for the school going adolescents for their optimum body composition, BMI, reducing risks of diet-related chronic diseases and prevention of vitamin deficiency. Diet rich in fruits, vegetables and legumes may decrease the risk of obesity, diabetes, cardiovascular diseases and some cancers.

A survey found that most teenagers consume less fruit and vegetables than recommended. It was found consistent with the findings of present study. Consuming a variety of fruits and vegetables assures sufficient ingestion of most micronutrients, dietary fiber, phytochemicals and also displaces food high in saturated fat, salt and sugar.

Increased intake of fruits and vegetables among all adolescents is encouraged. Therefore, fruit and vegetable promotions need to be aimed at reaching adolescents, specifically those from low socio-economic families, as they have been identified as consuming the least. Promoting increased availability of fruit and vegetables within schools may have a positive effect on adolescent's food choices.

However, the result of the present study reveals significant association between phyto-intake and Knowledge Attitude Practice of school adolescents and it is indicated that high phyto intake adolescents are having good nutrition practices than the low intake subjects. The proper nutrition in childhood reinforces lifelong eating habits that contribute to adolescent's overall well-being and help them to grow up to their full potential and lead a healthy life. By educating children about healthy eating habits could help them to take proper nutrition and maintain a healthy lifestyle when they are adults.

Conclusion

The study concluded that the consumption of phytochemicals rich fruit and vegetable is associated with the nutritional status of the adolescents and help them to attain good health. The study also observed improvement in the academic performance of the adolescents having more fruits and vegetables in their regular diet however, further studies are required to establish a relationship between both.

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