Research Article

Scientific Research on Pediatric Health Promotion Addressing Adolescent Nutrition Deficiencies and Preventive Lifestyle Education Across Schools

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Abstract

Nutrition deficiency in adolescents has continued to be a significant societal issue as it has the potential of compromising physical development, cognitive development, academic success and future health outcomes. Schools offer a valuable environment in which pediatric health promotion can be promoted through organized preventive lifestyle education and nutritional prevention efforts among the adolescents. The purpose of this research was to determine how school-based pediatric health promotion programs can work to reduce the problem of adolescent nutrition deficiencies and enhancing preventive lifestyle behaviors in schools. The school based quantitative research design with pre and post interventions was applied in a sample of 300 adolescents aged 1218 years old in the selected schools. A structured questionnaire was designed to collect data that measured the Nutrition Deficiency Reduction Score (NDRS) as the main outcome measure, and secondary outcomes such as the Nutrition Awareness Score (NAS), Healthy Eating Behavior Index (HEBI) and Preventive Lifestyle Practice Score (PLPS). Multiple linear regression, descriptive statistics, and correlation analysis were used to note the outcomes of interventions and their related factors. The results showed that there was a marked decrease in NDRS after the pediatric health promotion activities which showed that there was a lowered risk in adolescent nutrition deficiency. An increased understanding of nutrition, healthier dietary habits, and more robust preventive lifestyle choices were correlated with improved NDRS. The research concludes that the concept of school-based pediatric health promotion programs may be very important in alleviating the problem of nutrition deficiencies in adolescence and reinforcing preventive lifestyle practices which in turn can lead to sustainable adolescent health, healthy school attendance and overall long-term health outcomes.

Keywords

Adolescent health; Pediatric health promotion; Nutrition deficiency; School health education; Preventive lifestyle education; Healthy eating behavior; Nutrition awareness

1. Introduction

Adolescence is a crucial transition period characterized by accelerated body growth, hormonal development, psychological transformation and formation of lifetime health habits. The nutritional adequacy at this age is vital since its direct impact can be seen in the physical development, immune system, cognitive functions, emotional stability, and academic performance. Nevertheless, teenagers are also susceptible to poor eating habits like not eating breakfast, eating insufficient fruits and vegetables, eating too much processed snacks and high fructose beverages, eating out of schedule, and eating inadequate foods rich in iron and protein. Such habits may cause deficiencies of micronutrients, fatigue, lack of concentration, weaker immunity, decreased school attendance and school-related health problems. Consequently, adolescent nutrition deficiencies are still considered an important public health issue that has to be addressed with preventive care in time.

Pediatric health promotion has gained popularity in the past few years as a strategy of combating the risks associated with nutrition in adolescence, via education, counseling, and school-based preventive measures. Schools represent a notably good place to target health promotion since it offers a long-lasting access to adolescents in a developmental stage of life and which provides a chance of taking organized health education, peer communication and establishes the habit of instilling healthier daily practices. The pediatric health promotion programs in schools may include nutrition awareness, balanced diet education, hydration education, healthy meal planning and counseling to decrease junk-food intake and promote preventive lifestyle behaviors. Connecting learning with daily behavioral reinforcement, these interventions can enhance health literacy in adolescents and alleviate the burden of the deficiencies associated with nutrition.

Even though past research has investigated adolescent dietary behavior, nutrition awareness and school health education individually, a relative number of them have combined pediatric health promotion, nutrition deficiency reduction and preventive lifestyle education into a single analytical framework based on school settings. There is a plethora of available literature on individual outcomes (e.g. obesity prevention, physical activity, or general nutrition knowledge) and fewer that assess the impact of structured health promotion programs on nutrition-related risk using a composite health outcome measure. Moreover, the correlation between nutrition awareness, healthy eating behavior, preventive lifestyle and reduction of symptoms due to deficiency among adolescents is understudied in the school context. This gap has demonstrated the necessity of a more comprehensive research model that should evaluate behavioral and health outcomes of pediatric nutrition interventions.

Hence, the current research was intended to be investigative of whether school-based pediatric health promotion programs are effective in solving the problem of nutrition deficiencies among adolescents and in enhancing the outcomes of preventive lifestyle education at school level. To this end, it employed the Nutrition Deficiency Reduction Score (NDRS) as the main measure of the changes in the health risk regarding nutrition in adolescents as well as the secondary measures of the Nutrition Awareness Score (NAS), Healthy Eating Behavior Index (HEBI), and Preventive Lifestyle Practice Score (PLPS). The main discoveries of the research are fourfold: firstly, the proposed school-based pediatric health promotion model is specifically designed to tackle the problem of nutritional deficiency in adolescents; secondly, the proposed NDRS is a composite outcome measure that can be used to monitor changes in nutrition-related health risk; thirdly, the study explores the relationships between nutrition awareness, healthy diet, prevention of lifestyle changes, and outcomes of nutritional deficiency reduction; and fourthly, the research presents the supporting evidence of the practicality of incorporating pediatric nutrition education and preventive lifestyle interventions into school health systems to enhance the well-being of adolescents and long-term population health.

2. Literature Review

Adolescent nutrition is a key factor in current and future health as such is the time of rapid physical growth, cognitive development and higher nutritional demands. Poor dietary habits in adolescence may result in iron deficiency, low energy, stunted growth, poor academic achievement and greater susceptibility to sickness. Mass media nutrition surveys, school-level nutritional examinations have demonstrated that a good number of youngsters are still confronted with inadequate diet quality, no sufficient intake of nutrients, and developmental nutritional issues [1], [4]. The iron deficiency is especially significant since it may adversely influence the learning process, memory, and concentration and thus interconnects nutrition and educational achievements [5].

Poor eating habits and lifestyle are some of the key causes of food deficiencies in adolescents. The most prevalent types of breakfast, poor intake of fruit and vegetable, inadequate hydration, and frequent intake of processed food are widely reported among school-aged adolescents [6]. Studies on diet quality in children and adolescents have also demonstrated that poor diet patterns are related to negative health-related consequences, and therefore, it is necessary to consider nutrition in more detail than individual foods or unique nutrient deficiencies [7].

Pediatric health promotion in schools has been noted to be one of the best ways through which the nutrition knowledge, healthy eating behavior and preventive lifestyle measures among adolescents can be enhanced. Schools offer a handy

setting to organize interventions like nutrition education, healthy meal instructions, promotion of hydration, and general health behavioral counseling. Past studies indicate a possibility that school health and nutrition programs may enhance dietary awareness, healthier behaviors, and help improve nutritional outcomes among children and adolescents [8], [9].

In spite of these findings, much of the available literature has centered on the individual outcome (quality of diet, physical activity, obesity or nutritional status) instead of the investigation of nutrition deficiency reduction using a coordinated pediatric health promotion model. Very little has been done on studies that measure all the three (nutrition awareness, healthy eating behavior and preventive lifestyle practices) along with deficiency related risk using a composite measure. Thus, this gap in the current research will be filled with the help of the Nutrition Deficiency Reduction Score (NDRS) to determine the combined impact of school-based pediatric health promotion and preventive lifestyle education on the selected outcomes of nutrition deficiency in adolescents.

3. Materials and Methods

3.1 Study Design and Setting.

The school-based quantitative research design based on interventions was selected to determine whether pediatric health promotion could be effective in reducing the nutritional deficiency in the adolescent population and enhancing the effects of preventive lifestyle education. The research design employed a pre- and post-intervention study design to test the differences in the primary and secondary variables due to the implementation of a structured health promotion program. The study was done in some middle and secondary schools among the adolescents of age 12-18 years. Schools were selected as the site of study due to the opportunity they offer in terms of providing a structured environment in which nutrition education, behavioral counseling and encouragement of healthy lifestyle practices are repeated among adolescents.

3.2 Study Population, Sample Size and Sampling.

The sample comprised of 300 teenagers selected in schools. The stratified method of sampling was used in sampling the participants in the classes in the middle and secondary schools to provide a reflection of the age groups, gender and academic grades. Only adolescents who were regularly attending school and who were ready to take part in the study were included in the study, and incomplete responses were not analysed. Table 1 shows the demographic makeup of the participants, such as the age group, gender, and grade-level profile, which is a baseline participant profile of the study population.

Table 1. Participant Distribution / Demographic Profile (N = 300)

Variable	Category	n	%
Age Group	12–14 years	102	34.0
	15–16 years	118	39.3
	17–18 years	80	26.7
Gender	Male	144	48.0
	Female	156	52.0
School Level	Middle School	128	42.7
	Secondary School	172	57.3

3.3 Pediatric Health Promotion Intervention

The implemented intervention was applied during 8 weeks, based on the structured school-based pediatric health promotion program, aimed at mitigating the deficiencies of adolescent nutrition by means of preventive lifestyle education. The program involved nutrition education of balanced diets, healthy food, and micronutrient significance, counseling of hydration, regularity of breakfast, habitual snacking, and minimization of junk-food intake. Preventive lifestyle education also focused on healthy lifestyles and school health involvement. Figure 1 shows the key elements and delivery framework of the intervention.

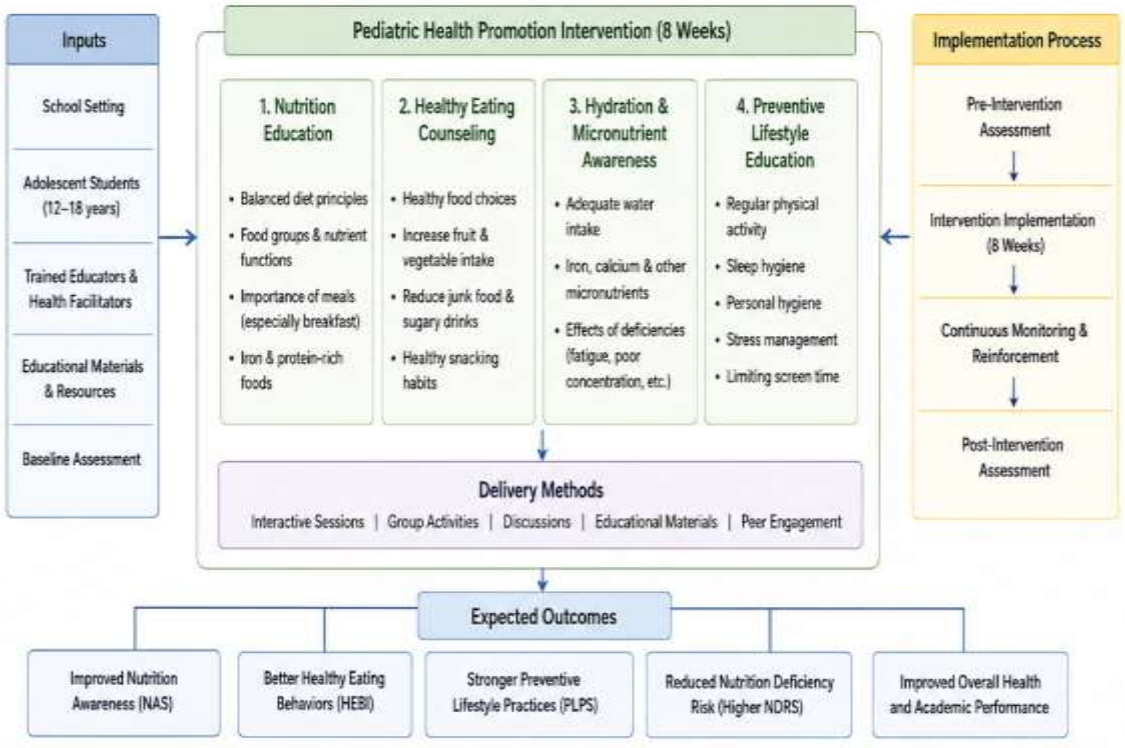

Figure 1. Pediatric Health Promotion Intervention Framework

3.4 Outcome Variables and Measurement Tools

The Nutrition Deficiency Reduction Score (NDRS) was the main outcome variable of the study and used to address the improvement of nutrition-related health risk among adolescents after the intervention. NDRS has been created as a composite score which includes breakfast regularity, sufficiency of fruits and vegetables intake, the decrease in the consumption of junk-food, hydration behavior, consumption of iron- and protein-rich food, dietary diversity, and the decrease in the deficiency-related symptoms (fatigue, dizziness, poor concentration). Three secondary variables were measured as well: Nutrition Awareness Score (NAS), Healthy Eating Behavior Index (HEBI), and Preventive Lifestyle Practice Score (PLPS). Table 2 summarizes the list of study variables and their measurement scheme.

Table 2. Study Variables and Measurement Metrics

Variable	Metric	Purpose / Measurement Focus
Primary Outcome	Nutrition Deficiency Reduction Score (NDRS)	Assesses reduction in adolescent nutrition-related health risk through breakfast regularity, fruit and vegetable intake, junk-food reduction, hydration, iron/protein-rich food intake, dietary diversity, and deficiency-related symptoms
Secondary Outcome	Nutrition Awareness Score (NAS)	Measures adolescents' knowledge of balanced diet, nutrient importance, and deficiency prevention
Secondary Outcome	Healthy Eating Behavior Index (HEBI)	Assesses healthy eating practices such as meal regularity, healthy food choices, and reduced junk-food intake
Secondary Outcome	Preventive Lifestyle Practice Score (PLPS)	Measures preventive health practices including hydration, healthy daily routines, and school health participation

3.5 Data Collection and Statistical Analysis

A structured questionnaire was used to collect data and included sociodemographic variables, nutrition awareness, diet, preventive lifestyle, and nutrition related symptoms. The questionnaire was given at baseline to acquire baseline data and omission to receive the post-intervention changes after the 8-week program. Descriptive and inferential statistical analysis was performed to analyze the data. Continuous variables were represented by mean and standard deviation and categorical variables by frequency and percent. NDRS and the secondary variables were compared both before and after the interventions. Associations between NDRS and NAS, HEBI and PLPS were determined by Pearson correlation analysis and multiple linear regression analysis was used to identify significant predictors of NDRS. A p value of less than 0.05 was considered to be statistically significant.

4. Results

4.1 Characteristics and Baseline Nutritional Profile of the participants.

Three hundred adolescents were involved in the research, the average age being 15.2 years old. Out of the respondents, 52.0 per cent were women and 48.0 per cent were men. According to baseline assessment, a significant percentage of adolescents were characterized by an irregular eating of breakfast, low levels of fruit and vegetable intake, high levels of processed snacks intake and low awareness of the need to prevent nutrient deficiency. These findings suggest that nutrition-related risk behaviors were common among the study population before implementation of the pediatric health promotion program.

4.2 Main Outcome measure: Nutrition Deficiency Reduction Score (NDRS)

The tremendous change in the Nutrition Deficiency Reduction Score (NDRS) after the school-based intervention of pediatric health promotion has been clearly shown in Figure 2. Baseline NDRS showed an average of 58.6 with a standard deviation of 10.4, showing the level of nutrition deficiency risk among adolescents was moderate before the intervention. The average NDRS rose significantly after the 8-weeks pediatric health promotion program to 76.9 +/- 9.2, which is a total improvement of 18.3 points. The figure also indicates that this increase was statistically significant ($p < 0.001$), which indicates that the observed change was not by chance. The increase in NDRS is indicative of significant changes in nutrition-related behaviors and outcomes, which involve increased frequency of breakfast, improved food quality, improved hydration habits, and decreased deficiency-related signs and symptoms, such as

fatigue, dizziness, and poor concentration. Therefore, Figure 2 represents clear visual evidence that the intervention proved to be efficient in terms of decreasing the risk of nutrition deficiency among adolescents and enhancing the general health behavior relating to nutrition.

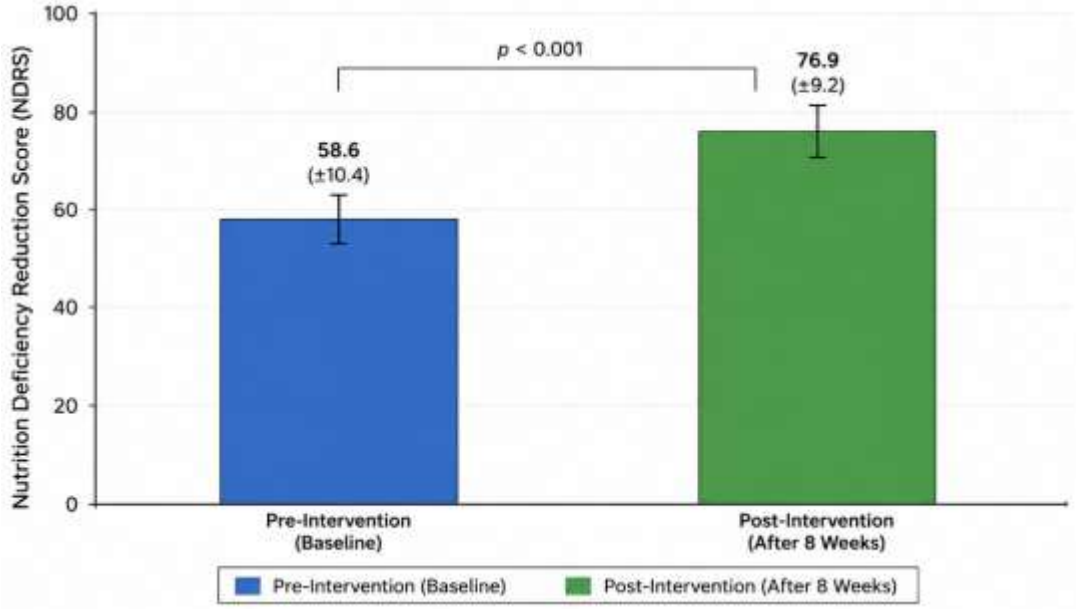

Figure 2. Pre- and Post-Intervention Comparison of Nutrition Deficiency Reduction Score (NDRS)

4.3 NDRS Improvement Interpretation.

The noted reduction of NDRS was also accompanied by positive changes in a number of nutrition-related behaviors. The adolescents who were involved in the intervention said that they ate breakfast more frequently, ate more fruits and vegetables, became more aware of rich food sources of iron and protein, decreased their junk-food intake, and became more hydrated. Also, the improvement in self-reported symptoms of tiredness, poor concentration, and dizziness also led to the increased NDRS values when comparing the results before and after the interventions. The findings show that pediatric health promotion provided at schools can positively impact the diet and nutrition-related health.

4.4 Secondary Outcome Measures

The combination of Table 3 and Figure 3 show that there was a statistically significant positive change in all three of the secondary outcome measures after the intervention. Nutrition Awareness Score (NAS) was 61.4 ± 11.2 at baseline and 81.7 8.9 post-intervention with an increase of 20.3, which is significant in its own right since it demonstrates the fact that adolescents have acquired a greater amount of knowledge concerning balanced diet, nutrient deficiency prevention, and healthy food choice. Accordingly, the Healthy Eating Behavior Index (HEBI) increased by 18.5 points to 74.3 ± 8.6 with a rise of 18.5 points and indicating more health-conscious eating habits and compliance with recommended dietary habits. The Preventive Lifestyle Practice Score (PLPS) also significantly increased the 59.1 ± 10.1 to 77.6 ± 9.4, or 18.5 points, which is a significant improvement in terms of increased involvement in hydration, meal frequency, and healthy daily habits. As Table 3 illustrates, all 3 variables showed statistically significant improvement with $p < 0.001$ and Figure 3 visually indicates that post-intervention scores were always higher when compared to the pre-intervention scores in all secondary metrics, thus in evidence of effectiveness of the pediatric health promotion program in enhancing nutrition awareness, eating behavior, and lifestyle prevention habits among adolescents.

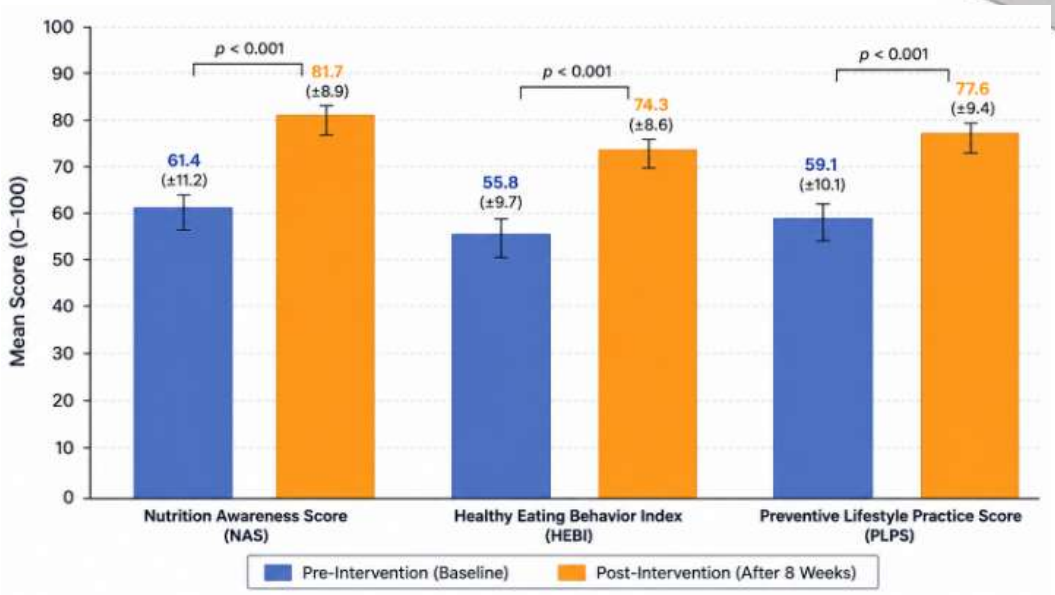

Figure 3. Pre- and Post-Intervention Comparison of Secondary Outcome Measures (NAS, HEBI, and PLPS)

Table 3. Pre- and Post-Intervention Comparison of NAS, HEBI, and PLPS

Variable	Pre-Intervention Mean ± SD	Post-Intervention Mean ± SD	p-value
Nutrition Awareness Score (NAS)	61.4 ± 11.2	81.7 ± 8.9	< 0.001
Healthy Eating Behavior Index (HEBI)	55.8 ± 9.7	74.3 ± 8.6	< 0.001
Preventive Lifestyle Practice Score (PLPS)	59.1 ± 10.1	77.6 ± 9.4	< 0.001

4.5 Correlation Analysis

Table 4 is the correlation coefficient between NDRS and NAS, HEBI and PLPS, indicating that all of the variables of the study were positively and significantly correlated with each other. The highest correlation was found between NDRS and HEBI ($r = 0.82$, $p < 0.001$) and this means that adolescents who had a healthy eating pattern were more likely to demonstrate the highest risk reduction in terms of nutrition deficiency. Similar positive correlation was observed between NDRS and NAS ($r = 0.78$, $p < 0.001$), which indicated a close association between increased knowledge in nutrition and better nutrition outcomes. Moreover, the NDRS and PLPS were positively related ($r = 0.75$, $p < 0.001$), which proved that enhanced preventive health behaviors like hydration, regular meals, and healthy habit were positive contributors to reduce the risk of nutrition deficiency. The interrelationships between the secondary variables were also found to be positive with NAS being correlated with HEBI ($r = 0.74$, $p < 0.001$) and PLPS ($r = 0.69$, $p < 0.001$), and the relationship between HEBI and PLPS was also significant ($r = 0.71$, $p < 0.001$). In general, Table 4 shows that nutritional awareness, healthy eating behavior, and preventive lifestyle practice were highly interrelated and had a collective impact on the nutritional health of adolescents.

Table 4. Correlation Matrix Among NDRS, NAS, HEBI, and PLPS

Variable	NDRS	NAS	HEBI	PLPS
NDRS	1.00	0.78***	0.82***	0.75***
NAS	0.78***	1.00	0.74***	0.69***
HEBI	0.82***	0.74***	1.00	0.71***
PLPS	0.75***	0.69***	0.71***	1.00

4.6 Regression Analysis

Figure 4 shows the relative strength of standardized regression coefficients of Nutrition Deficiency Reduction Score (NDRS) predictors and indicates that Healthy Eating Behavior Index (HEBI) was the most significant predictor of improving NDRS. The value shows that HEBI had a standardized coefficient of 0.39 = 0.001 ($p < 0.001$), which is the most positive contribution to the alleviation of the risk of adolescent nutrition deficiency. This was next succeeded by Nutrition Awareness Score (NAS) with $\beta = 0.31$ ($p < 0.001$) revealing that heightened nutrition knowledge was also a significant factor in enhancing NDRS. Preventive Lifestyle Practice Score (PLPS) was moderately lower but statistically significant with 8 = 0.27 ($p = 0.002$) which means that healthy daily routine and meal schedules and hydration practices also led to improved nutrition-related outcomes. All of the predictors, as shown in Figure 4, had positive regression coefficients which validated the assumption of independent relationship of improvements in eating behavior, nutrition awareness and preventive lifestyle practices with increased NDRS values. As the ranking of the coefficients in the figure indicates, the most predictive effect was on the behavior-related dietary improvement, then the knowledge-based awareness, and the overall preventive lifestyle engagement.

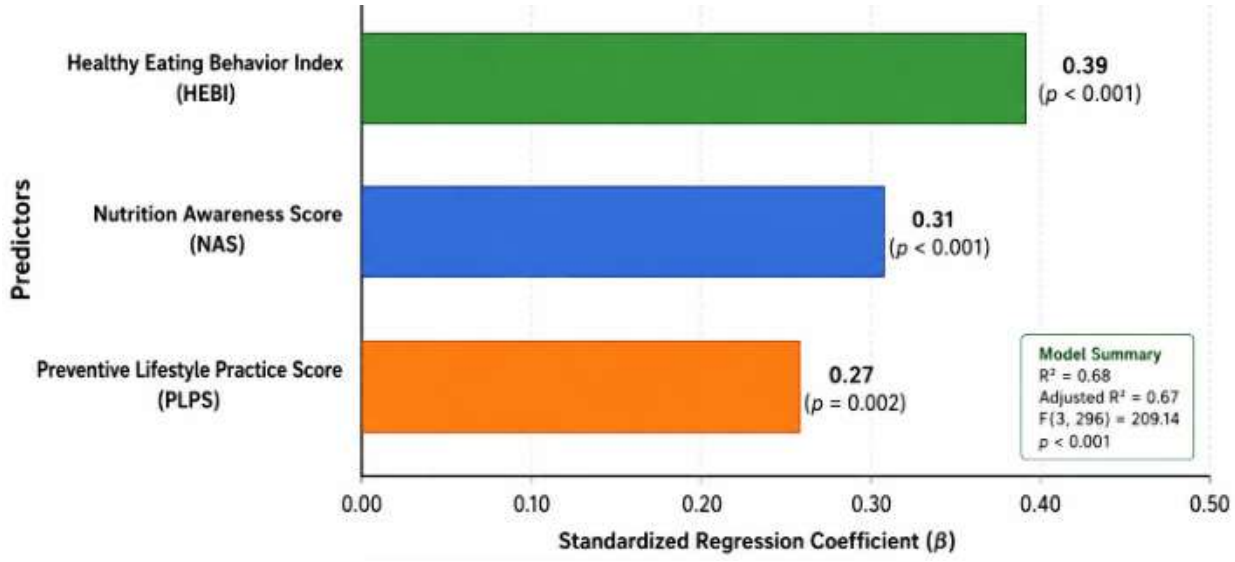

Figure 4. Regression Coefficient Plot Showing Predictors of Nutrition Deficiency Reduction Score (NDRS)

4.7 Summary of Findings

Altogether, the findings indicate that the school-based pediatric health promotion program was efficient in enhancing the health-related outcomes in terms of nutrition among adolescents. The considerable growth of NDRS along with

the gains made in NAS, HEBI, and PLPS demonstrate the importance of a school-focused approach to health promotion in minimizing nutrition deficiencies among adolescents and promoting sustainable healthy lifestyles. The correlation and regression result also indicate that nutrition awareness, healthy eating habits and preventive lifestyle participation are significant interrelated predictive factors of enhanced nutrition-related health of adolescents.

5. Discussion

This study has shown that school-based pediatric health promotion can dramatically decrease the risk of nutrition deficiency and enhance the preventive educational outcome of lifestyle. The large gain in NDRS suggests that there have been increases in the meal regularity, quality of diet, hydration, and decrease in symptoms of deficiency in adolescents. Further positive associations between NDRS and NAS, HEBI, and PLPS indicate that the higher the nutrition awareness, the greater the healthy nutrition and preventive lifestyle practices. Regression analysis revealed that the strongest predictor of NDRS was healthy eating behavior in line with nutrition awareness and preventive lifestyle practice, highlighting the crucial role of applying knowledge of nutrition into daily routines. These results endorse school-based health promotion programs that are nutrition-based and promote the adoption of the same programs within schools. The research was however constrained by self-reported information, the chosen school environments and the lack of clinical nutritional measurements. Future research on the subject ought to incorporate bigger groups, extended follow-ups, and biochemical assessment of nutritional status.

6. Conclusion

The study established that school-based pediatric health promotion interventions have the potential to greatly enhance the outcomes on nutrition-related factors as indicated by the Nutrition Deficiency Reduction Score (NDRS) post-preventive lifestyle education. The results indicate that the structured interventions based on healthy eating, nutrition awareness, hydration, and the preventive lifestyle can be effective in minimizing the risk of nutrition deficiency in adolescents. Enhanced meal frequency, nutritional quality, and nutritional deficiency well-being demonstrates that schools can be effective and powerful settings to provide pediatric nutrition promotion. It was also found that the preventive lifestyle practices, nutrition awareness, and healthy eating behavior were positively linked to the improvement of the NDRS, which supports the importance of knowledge and behavior change in the nutritional health of adolescents in combination. Altogether, these results suggest the incorporation of pediatric nutrition education and preventive lifestyle interventions into the routine school health systems as a sustainable policy in enhancing the well-being of adolescents, minimizing health risk factors caused by nutrition, and ensuring long-term positive health outcomes of the population.

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