Medical University – Varna
„Prof. dr. Paraskev Stoyanov”

Faculty of Dental medicine
Department of Pediatric dentistry

ABSTRACT

Of a dissertation for the conferral of the educational and scientific degree of "doctor" on the topic:

NUTRITION AND ITS INFLUENCE ON ORAL HEALTH DURING ADOLESCENCE

Dr. Kristiyana Lyubomirova Mineva

Field of higher education: 7. Health care and sports,

Professional direction: 7.2. Dental Medicine,

Scientific specialty: "Pediatric Dentistry"

Academic advisor:
Assoc. Prof. Dr. Milena Todorova Georgieva – Dimitrova, DMD, PhD

Varna, 2025 г.

The dissertation contains 291 pages and is illustrated with 44 tables, 20 figures and 20 appendices. The bibliography contains 503 literary sources, of which 5 in Cyrillic and 498 in Latin.

The dissertation has been discussed and directed for defense by the Department Council of the Department of Pediatric Dentistry, Faculty of Dental Medicine - Varna at the Medical University "Prof. Dr. Paraskev Stoyanov" - Varna on 25.04.2025.

The official defense of the dissertation will take place on 15.07.2025 from 13:00 o'clock at the Faculty of Dental Medicine - Varna at the Medical University "Prof. Dr. Paraskev Stoyanov" - Varna at an open meeting of the Scientific Jury.

Scientific Jury:

Chairman:

Prof. Dr. Dimitrichka Ducheva Bliznakova, DM, PhD – Internal Member

Members:

Assoc. Prof. Dr. Dobrinka Mitkova Damyanova, DMD, PhD – Internal Member

Prof. Dr. Ani Bozhidarova Belcheva-Krivorova, DMD, PhD – Medical University of Plovdiv – External Member

Assoc. Prof. Dr. Maria Petrova Shindova, DMD, PhD – Medical University of Plovdiv – External Member

Assoc. Prof. Dr. Asya Zaharieva Krasteva-Panova, DMD, PhD, DSc – Medical University of Sofia – External Member

The materials related to the defense may be accessed at the Scientific Department of the Medical University "Prof. Dr. Paraskev Stoyanov" - Varna, and they are also published on the official website of the Medical University - Varna.

Note: In the auto-abstract, the numbering of the tables and figures does not correspond with the numbering in the dissertation, along with the abbreviations employed.

CONTENTS

I. INTRODUCTION

In the 20th century, transformations in food planning and preparation facilitated the emergence of food processing plants, the fast food industry, ready-made and frozen foods, as well as the concept of mass marketing, all of which have significantly impacted contemporary nutrition, a global concern. The practice of consuming fast food either on the go or while driving, alongside the ordering of ready-made meals from restaurants or fast food establishments, has become increasingly prevalent. Major shifts are occurring in the dietary habits and consumption patterns of modern society, characterized by challenges related to two primary areas: undernutrition and overeating. The energy consumption patterns of communities are largely influenced by geographical latitude, dietary traditions and preferences, levels of physical activity, the economic and technological advancement of the nation, the socio-economic status of the majority of the regional population, educational attainment, food pricing, urbanization, and the ratio of urban to rural populations, as well as awareness and media influence. A plethora of nutrition information sources exists, including various communication materials, channels, and social networks. The manner in which nutrition information is conveyed through these sources is heterogeneous and frequently not presented in a format that is accessible to the general public. In certain instances, the primary motivating factor promoted may be health improvement, whereas in others, it may revolve around the marketing and sale of specific products. Aggressive advertising and strategic marketing of particular products targeted at specific consumers during designated periods and events can further augment choices related to food and beverages. An illustrative example of this is the numerous initiatives aimed at restricting the advertising of sugary products and salty snacks to children during peak television viewing times. The selection and evaluation of the sustainability of a specific dietary pattern must be thorough and involve a diverse range of specialists in the fields of health, medicine, sociology, and education, in conjunction with experts in systems engineering, agronomy, veterinary medicine, and environmental sciences. There exists a correlation between food advertising and the increased consumption of high-calorie products among both the adult population and children. A balanced diet is essential for providing the necessary nutrients for optimal general and oral health. Oral health encompasses not merely the teeth but also includes the gums, oral mucosa, tongue, lips, and salivary glands. The frequency of dietary intake

should be the first aspect examined in relation to changes in health status. The relationship between nutrition and oral health is crucial, as dietary patterns fundamentally influence the integrity of hard dental tissues and the health of the gums. Foods high in sugars and acids contribute to enamel demineralization and serve as a precursor to the development of carious lesions. Frequent acid attacks exacerbate the erosion of tooth enamel and elevate the risk of additional degradation. Nutritional deficiencies in essential minerals also compromise the structure of teeth and may lead to periodontal issues, lesions on the oral mucosa, and tongue ailments. The primary function of a balanced diet lies in sustaining overall health and preventing both systemic and oral diseases.

II. AIM AND OBJECTIVES

Aim: To investigate the correlation between nutrition and oral health during adolescence.

Objective 1: To perform a comprehensive analysis of the nutritional status of children aged 11 to 17 years.

1.1 To examine anthropometric indicators in adolescents within the age range of 11 to 17 years.

1.2 To evaluate the effectiveness of dietary habits in adolescents aged 11 to 17 years.

1.3 To assess dietary indicators among adolescents aged 11 to 17 years.

Objective 2: To undertake a comparative assessment of the primary indicators of oral health in children aged 11 to 17 years, specifically focusing on those with impaired nutritional status, both with and without the application of targeted preventive measures and recommendations within a preventive nutrition program.

Objective 3: To develop forecasts and guidelines for regulated and balanced nutrition in relation to oral health for adolescents (ages 11 to 17 years).

III. MATERIALS AND METHODS

Materials and Methods for Objective 1:

Study Design: This investigation is a cross-sectional study conducted during the period of 2023-2024. A sample of 300 adolescents, aged 11-17 years, who presented for a primary examination at the Medical University "Prof. Dr. Paraskev Stoyanov" - Varna, University Medical and Dental Center at the Faculty of Dental

Medicine, and clinical rooms within the Department of Pediatric Dentistry of the Faculty of Dental Medicine - Varna, was selected on a convenience basis.

Object of the Study: A total of 300 adolescents, aged 11-17 years, were examined and interviewed. These participants, residing in the city of Varna and its region, came for a primary examination at the dental office. To ensure the reliability of the study's outcomes, the patients were distributed by gender, with the difference in numbers not exceeding 10%.

The selection of participants was based on precisely defined criteria:

Criteria for Inclusion in the Study:

• Children in good general health, aged 11-17 years.

• Completion of a voluntary declaration of informed consent by a parent/guardian, along with an expressed desire for their child to participate in the study.

Criteria for Exclusion from the Study:

• Children aged under 11 years or over 17 years.

• Adolescents with systemic chronic diseases, specific health needs (SHP), or syndromes.

• Adolescents undergoing a special diet or medication.

• Adolescents with food allergies or intolerances.

• Adolescents with eating disorders (e.g., bulimia, anorexia).

• Adolescents receiving orthodontic treatment (removable or fixed orthodontic appliances).

• In the case of established pregnancy (for girls).

• In the event of parents' refusal to allow participation in the study for their child.

The unit of observation includes: 1) demographic indicators; 2) anthropometric indicators; 3) quality of diet and dietary indicators.

Signs of Observation: 1) age and gender; 2) height, weight, HAZ-index, body mass index (BMI), and body mass index for age (BMIZ); 3) Diet Quality Index-Adolescents (DQI-A), a food diary, and a questionnaire pertaining to dietary intake, quantity and quality of food consumed, physical activity, access to food, lifestyle, and harmful habits of the child, as well as risk factors and frequency of eating, personal preferences, and eating habits.

Time of the Study: 2023-2024.

Location of the Research:

• Medical University "Prof. Dr. Paraskev Stoyanov" - Varna, University Medical and Dental Center at the Faculty of Dental Medicine.

• Clinical halls at the Department of Pediatric Dentistry of the Faculty of Dental Medicine - Varna.

To attain the objectives of the research and to implement the previously established tasks, a self-developed toolkit was utilized. A comprehensive questionnaire (survey), a food diary, and two outpatient cards (pertaining to nutritional status and oral health) were prepared.

Sociological methods employed included documentary analysis, interviews, and in-depth surveys.

Methods for the first subparagraph of Objective 1:

Documentary methods:

For each child included in the study, a specially developed outpatient card is filled out, which encompasses a personal identification section, height, weight, and research indices for nutritional status. The measured weight is recorded in kilograms, with a precision of up to 100 grams. The height measurement is documented in centimeters (cm), with a maximum height measurement of 200 cm, accurate to 0.1 cm.

• **Height-for-age z-score (HAZ)** is an indicator employed to evaluate growth during adolescence. It compares the child's height with that of peers of the same age and sex as outlined in the WHO child growth standards to classify the nutritional status of the study participant.

HAZ = (reported height of the child - average height standard for age) / standard deviation of height for age.

Interpretation of Results:

1) $2 < HAZ < 3$ - overgrown

2) $1 < HAZ < 2$ - slightly overgrown

3) $-1 < HAZ < 1$ - normal growth

4) $-2 < HAZ < -1$ - marginally stunted

5) -3 < HAZ < -2 - moderately stunted

6) HAZ < -3 - severely stunted

• **Body Mass Index (BMI)** is a medical-biological indicator utilized to ascertain normal, healthy body weight according to varying heights and to diagnose obesity and malnutrition. It is measured in kilograms per square meter. For a more accurate interpretation of the results based on gender, the WHO standards for BMI by age are employed. The percentile denotes the percentage of observations that fall below a specific value.

Interpretation of Results:

1) <18.5 - underweight

2) 18.5-25 - normal body weight

3) 25-30 - overweight

4) 30-35 - obesity class I

5) 35-40 - obesity class II

6) >40 - obesity class III

Interpretation of the **BMI Percentile** Result:

1) <5% - underweight

2) 5%-85% - normal body weight

3) 85%-95% - at risk of obesity

4) >95% - overweight

• **The BMI z-score** indicator reflects the result for a standard deviation of BMI based on the child's age, gender, body mass index, and an appropriate reference standard. The BMI z-score can be determined (https://www.who.int/growthref/en/). This indicator reveals the percentage of observations falling below a certain value.

BMI Z-score = (reported BMI of the child - average standard for BMI for age) / standard deviation of BMI for age.

Interpretation of Results:

1) 2 ≤ BMIZ ≤ 3 – obese

2) 1 ≤ BMIZ ≤ 2 – overweight

3) -1 ≤ BMIZ ≤ 1 – normal

4) -2 ≤ BMIZ ≤ -1 – mild malnutrition

5) -3 ≤ BMIZ ≤ -2 - moderate malnutrition

6) BMIZ < -3 - severe malnutrition

Interpretation of Result **BMIZ Percentile**:

1) <5% – underweight

2) 5%-85% – normal body weight

3) 85%-95% – at risk of obesity

4) >95% – overweight.

Based on the assessed indicators determining nutritional status, children are categorized into six groups: severe malnutrition, moderate malnutrition, mild malnutrition, normal nutritional status, overweight, and obesity.

Methods for the second subparagraph of Objective 1:

In-depth interviews serve as a qualitative method of data collection, facilitating a comprehensive understanding of the research subject.

Documenting food and fluid intake constitutes a critical element of nutritional assessment, as it yields valuable information regarding dietary habits, including the quantity and quality of food consumed.

• DQI-A - Index

The Dietary Quality Index for Adolescents (DQI-A) emphasizes the principal aspects of a high-quality, healthy diet: dietary diversity, dietary quality, dietary adequacy, dietary surplus, and dietary balance. Each of these categories encompasses specific dietary components that require assessment. These distinct classifications assist in readily identifying the dietary aspects that necessitate the most improvement.

Diet Quality (DQ) evaluates whether optimal food choices are being made within designated food groups, classified as: (1) recommended group, (2) intermediate group, and (3) low-nutrient, high-energy group.

Dietary Diversity (DD) measures the extent of variation in dietary intake. This diversity metric is quantified using a point system that ranges from 0 to 9, where points are deducted for each food group recommended that is not adequately represented by at least one serving.

Dietary Equilibrium (DE) is ascertained through the difference between **Dietary Adequacy (DA)** and **Dietary Excess (DEx)**. Dietary Adequacy (DA) reflects the actual intake from food groups relative to the minimum recommended intake, while Dietary Excess (DEx) signifies the discrepancy between the actual intake and the maximum recommended intake for a specific food group.

To derive the DQI-A, the mean values of the DQ, DD, and DE components are calculated utilizing the following formula:

$$\textbf{DQI-A} = (\textbf{DQ} + \textbf{DD} + \textbf{DE}) / 3$$

Higher DQI-A scores correspond to superior diet quality, with scores ranging from 0 to 100. Patients are categorized into three groups: Group 1 (low diet quality) ranging from 0 to ≤45; Group 2 (medium diet quality) exceeding 45 to ≤60; and Group 3 (high diet quality) exceeding 60.

• Food Diary

Each child, with parental assistance, prepares a 3-day food diary that reflects their typical daily routine. The analysis concerning food preferences and patterns is based on six meals (breakfast, morning snack, lunch, afternoon snack, dinner, evening snack) within a 24-hour period across three randomly selected days of the week (two weekdays and one weekend day - Saturday or Sunday). The food diary is also essential for calculating the DQI-A score.

Methods for the third subparagraph of Objective 1:

Survey Method – A direct, individual, and anonymous survey is conducted for each child studied.

The survey comprises 38 questions, strategically divided into three principal categories: 1) physical activity, food accessibility, lifestyle, and detrimental habits of the child; 2) risk factors and frequency of eating; and 3) personal preferences and dietary habits. The survey is completed with the assistance of a parent or guardian, after which an informed consent form for participation in the study is signed by the parent or guardian in advance, with supplementary information pertaining to the patient (child), rather than the parent.

Materials and Methods for Objective 2

Study Design: A randomized controlled clinical trial involving the assessment of two parallel groups. The participating patients are monitored over a period of six months. A simple block randomization was executed with an equal number of children by gender (with a permissible difference of no more than 1). Randomization is conducted utilizing a computerized random number generator (Calculator.net; https://www.calculator.net/random-number-generator.html) to randomly assign the children in the study to either experimental or control procedures.

The study subjects comprise 210 adolescents aged 11 to 17 years who possess impaired nutrition and nutritional status from the city of Varna and the surrounding region. The participants are divided into two equal groups.

Criteria for Inclusion in the Study:

• Children with impaired nutritional status and a Body Mass Index Z-score (BMIZ) of 1 or less.

Criteria for Exclusion from the Study:

• Instances where parents decline participation in the study involving their child.

• Children will be excluded from the study if there is no follow-up conducted for a duration of six months.

First Group (Experimental Group) – Consists of 105 children, for whom specific preventive measures are implemented and recommended through a preventive program addressing the identified nutritional disorders.

Second Group (Control Group) – Comprises 105 children in whom no specific preventive measures are taken or advised through the preventive program pertaining to nutrition, although general measures may still be available.

The unit of observation includes: dental status, plaque accumulation, gingival disease, condition of the oral mucosa.

Signs of Observation: 1) DMFT index, DMFS index, SiC index, International Caries Detection and Assessment System (ICDAS), CarieScan Pro system, activity (A) and reversibility (R) of carious lesions, PUFA index; 2) OHI-S index, Plaque Control Index (PCR), Plaque-Free Score (PFS), Papillary Bleeding Index (PBI), Gingival Index (GI); 3) lesions on the oral mucosa – localization, type of lesion, and pain or discomfort.

Time of the Study: 2023 to 2024.

Location of the Research:

• Medical University "Prof. Dr. Paraskev Stoyanov" - Varna, University Medical and Dental Center at the Faculty of Dental Medicine.

• Clinical halls at the Department of Pediatric Dentistry, Faculty of Dental Medicine - Varna.

Clinical Methods

In order to conduct a clinical study on the oral health of adolescents with primary dentition, the research participants are categorized into two groups: the experimental group and the control group. Clinical and paraclinical methods are utilized to assess the status of oral hygiene, as optimal documentation is generated for the study to record the necessary data, facilitating systematic monitoring of the carious process, oral hygiene, and the condition of soft tissues, with the aim of effective treatment and prevention of oral diseases. All observed indicators are documented in an outpatient card specifically developed for the study. Each participant possesses a file that includes a history of successful treatment, alongside a general medical history, oral status, and a complete representation of the dentition when necessary—orthopantomography, as well as an assessment of the patient's caries risk.

Children are examined, treated, and provided with prophylactic care by a single dentist-researcher. Examinations are conducted in clinical settings, utilizing appropriately directed lighting, and are preceded by the cleaning of the oral cavity and the drying of the tooth surfaces. Sterile individual sets, which include a dental mirror, probe, and tweezers, are employed for each child, in addition to disposable personal protective equipment for the pediatric dentist.

Following the collection of detailed data regarding the oral condition of the researched adolescents and according to the assessment of caries risk—high, medium, or low—a specific preventive program is recommended. For children with established impaired nutritional status and inadequate nutrition in the experimental group, the necessary adjustments to the permitted foods in the diet are particularly emphasized, thereby ensuring a balanced diet and an improvement in the established oral condition.

Parents of all children provide informed consent for clinical examinations, paraclinical examinations (if deemed necessary), and the documentation of detailed oral status while receiving information regarding the study undertaken.

Each of the indices outlined below is reported during both the initial and control examinations (of six) and is included in the detailed oral registration status report of each patient within the dental office.

• **DMFT index**—this is the most universally recognized index for reporting the prevalence of dental caries.

D—indicates teeth with carious lesions, representing the experience of caries.

M—denotes teeth that are absent from the dentition due to complications arising from carious lesions. Teeth that are severely compromised by caries, deemed irreparable, and subject to extraction are counted as missing.

F—refers to teeth that have been restored following treatment of a carious lesion. Although a tooth may possess multiple fillings, it is counted as one.

T—tooth.

M and F indicate past experiences with caries.

All erupted permanent teeth are examined. The examination excludes the following:

— Third molars.
— Unerupted—impacted teeth.
— Congenitally missing and odd-numbered teeth.
— Teeth extracted for reasons other than complications of dental caries (such as orthodontic treatment or trauma).
— Teeth restored for reasons other than dental caries (trauma, dysplasia, or for prosthetic treatments such as bridge support).

In calculating the DMFT index, each of the researchers counts the erupted permanent teeth (T) once. Deciduous teeth are not included in the calculation of the DMFT index. The calculation of the individual index is carried out selectively for each research child from both groups, by determining each component separately: DT, MT, and FT, after which all components are summed: DT + MT + FT = DMFT. For each group, the individual DMFT index values of all 105 participants are totaled and divided by the number of individuals studied within the group.

• **DMFS index**—represents the cumulative number of surfaces with caries, missing teeth, and those that are filled, where D (decay) indicates a carious lesion, M (missing) denotes a missing tooth, F (filling) represents a filled tooth, and S (surface) indicates a tooth surface.

When the DMFT index is used to evaluate each individual surface of each tooth, it is referred to as DMFS. The previously mentioned rules and criteria also apply to the DMFS index. The sole difference between the two indices lies in the fact that DMFS does not take into account teeth.

Each component DS, MS, and FS is calculated separately, with the following formula applied for the individual index:

DMFS = DS + MS + FS

For each group, the individual values of the DMFS indices from all 105 participants are totaled and then divided by the number of individuals within the group.

- **Significant Caries Index (SiC Index)** - represents the average DMFT index of one third of the individuals in the study groups exhibiting the highest score.

In order to calculate the SiC index, the following steps are required:

— Sort the individuals in the study groups based on their DMFT indices.
— Select one third of the 105 June individuals from the experimental group and one third of the 105 June individuals in the control group who possess the highest DMFT index values.
— Calculate the average DMFT index value for this selected subgroup of 35 children.

• International Caries Detection and Assessment System (ICDAS)

The surface characteristics of the tooth structure are pivotal in determining the potential histological depth of carious lesions as measured by ICDAS. Prior to the assessment of carious lesions, the tooth surfaces must be cleaned, isolated, and sniffed for a minimum of 5 seconds under specific lighting conditions, utilizing a dental mirror which facilitates the accurate registration of incipient caries. A ball probe (WHO probe) is employed to examine the tooth surface, promoting the removal of any residual plaque or food debris, while assessing the surface contours, the presence of minor cavitation, and the quality of any existing obturation or sealant. The ICDAS employs a two-digit coding method for

categorizing restorations and sealants, with the first digit indicating the type of restoration/sealant and the second digit denoting the caries detection status ranging from 0 to 6, correlating with the severity of the carious lesion.

Codes and criteria for primary carious lesions are outlined as follows:

0 = Sound tooth surface: No evidence of caries observed after drying the tooth surface for 5 seconds.

1 = First visual change in enamel: Opacity or discoloration (white or brown) is evident following prolonged drying of the tooth surface.

2 = Clear visual change in enamel, observable without drying the tooth surface.

3 = Localized cavitation/destruction of enamel (without clinical visual signs of dentin involvement), discernible even without surface drying.

4 = Change in the opacity and color of the underlying dentin.

5 = Isolated cavitation with visible dentin.

6 = Extensive (over half the surface) distinct cavitation with visible dentin and a likelihood of pulp involvement.

If required for verification and accurate diagnosis during the registration of carious lesions on smooth proximal surfaces (mesial or distal) at the initial examination or for subsequent monitoring in a controlled environment, a comprehensive assessment of the dentition is conducted using orthopantomography. Radiographic information is crucial for clinical findings concerning the detection of lesions at various stages of progression, particularly significant for proximal caries. For verification, accurate diagnosis, and the minimization of random errors (BIAS), primary carious lesions on occlusal surfaces and free smooth registration surfaces (buccal/lingual) documented during clinical examinations are associated with ICDAS codes. This system is then correlated with results obtained from spectroscopy, which provides insights into whether the tooth is healthy, exhibits initial caries, or presents with an advanced carious lesion.

- **CarieScan Pro** is a system that includes a handpiece and a soft tissue cable, which establishes contact between the handpiece and the lips and cheeks through a hook and a sensor (disposable), resembling a small toothbrush. CarieScan Pro offers numerous advantages over other visualization and measurement systems, including the accuracy and informativeness of results

(92.5%). It is distinct from other diagnostic methods, thereby minimizing the incidence of false positive and false negative results. This system facilitates the early and accurate diagnosis of not only initial carious lesions but also those lesions that reach the dentin, which may remain undetected during visual examinations of the dentition, even by experienced practitioners. The evaluation of dental tissues is conducted by transmitting a very weak direct current (inaudible to the patient) through the tooth and measuring its impedance.

Preparing the patient for examination involves the following steps:

1. All tooth surfaces must be thoroughly cleaned of plaque, with particular attention given to the occlusal and free smooth surfaces to be examined (buccal/lingual). Cleaning should be performed using a toothbrush without toothpaste or an Air Flow device.

2. Isolation of the examined tooth is achieved using cotton rolls, OptraGate, oral diapers, and aspiration.

The measurement process with CarieScan Pro includes the following procedures:

1. Attaching the sensor to the device.

2. Activating the device, at which point the digital display indicates it is in ready-to-use mode (RdY).

3. Connecting the intraoral hook to the soft tissue cable and attaching the cable to the device, ensuring the final positioning of the hook is in contact with the lips/cheeks.

4. Drying the tooth surface for a duration of 5 seconds and removing any residual saliva.

5. After pressing the Enter button, the display switches to measurement mode.

6. The sensor is then placed firmly against the examined surface, and automatic reading commences. After a period of 4 seconds, the result is displayed accompanied by a sequence of sound signals. A color-coded pyramid appears on the display, indicating any violations of the TST.

Interpreting the results:

0. Sound tooth surface – LCD – G, LED – one green line, AUDIO – single beep - (ICDAS code 0)

1. Earliest change in subsurface enamel - LCD – 1-20, LED – one green and one yellow line, AUDIO – triple beep - (ICDAS code 1)

2. Change in subsurface enamel layer - LCD – 21-30, LED – one green and two yellow lines, AUDIO – triple beep - (ICDAS code 2)

3. Clearly detectable change in subsurface enamel structure - LCD – 31-50, LED – three yellow lines, AUDIO – triple beep - (ICDAS code 3)

4. Localized cavitated/non-cavitated enamel lesion - LCD – 51-90, LED – three yellow lines, AUDIO – triple beep - (ICDAS code 3)

5. Carious lesion affecting the entire enamel layer, penetrating the EDG and impacting the superficial dentin layer - LCD – 91-99, LED – four yellow bars, AUDIO – three beeps - (ICDAS code 4)

6. Detectable non-cavitated/cavitated carious lesion with significant dentin involvement - LCD – R, LED – one red bar, AUDIO – six rapid beeps - (ICDAS codes 5, 6)

- **Active carious lesions (A**) - Furthermore, clinicians should take into account the number of active carious lesions (A) by relying on clinical indicators to assess the activity of enamel lesions. These indicators include visual appearance, tactile sensation, and the propensity for plaque accumulation, particularly for lesions located adjacent to the gingiva, which may necessitate completed gingival treatment.
- **The PUFA Index** represents a novel measure for evaluating the prevalence and severity of oral conditions associated with untreated caries, providing insights into the clinical implications of untreated dental caries, such as pulpal involvement or odontogenic abscesses, which may be more serious than the carious lesions themselves. The PUFA index is visually assessed, without the use of instruments, and one score is assigned per tooth. Lesions in surrounding tissues that are not associated with complicated caries are excluded from the count.

Codes and criteria for reporting PUFA – index:

— P - Dental pulp involvement is reported when the pulp chamber is visibly open or when the coronal tooth structures are compromised due to a carious process,

resulting in the presence of only roots or root fragments of the tooth. No probing is conducted to diagnose pulp involvement.

— U – Traumatic ulceration of the surrounding soft tissues (e.g., tongue or buccal mucosa) is due to injury from residual sharp fragments of a tooth (such as a dislocated severely decayed tooth or root fragments).

— F - A fistula is noted when a suppurating fistula course is encountered in relation to a tooth that exhibits pulp involvement.

— A/a - An abscess is documented when soft tissue swelling with purulent contents is associated with a tooth that has pulp involvement.

The resulting score for an individual is calculated in an analogous cumulative manner (P + U + F + A) as that of the DMFT – index. Consequently, for a specific child, the score can vary from 0 to 32 PUFA for the permanent dentition. The prevalence of complications stemming from untreated caries is computed as a percentage within the study group as follows:

PUFA / D x 100 =

• Oral Hygiene Index Simplified - OHI-S

This index is utilized to evaluate the cleanliness of the oral cavity by assessing the tooth surfaces covered with debris and/or calculus. The OHI-S comprises two components - the Debris Index Simplified (DI-S) and the Calculus Index Simplified (CI-S). The two scores may be employed separately or combined to create the OHI-S index. Specifically, 6 teeth (16, 11, 26, 36, 31, 46) – referred to as Ramfjord teeth, one in each sextant and corresponding respectively to only one surface of each tooth – a total of 6 surfaces (the buccal surfaces of teeth 16, 11, 26, 31 and the lingual surfaces of teeth 36 and 46) are evaluated through the pre-application of the Plaque Test Indicator (Ivoclar Vivadent) Liquid 10ml, followed by rinsing of the oral cavity and visualizing dental plaque, food residues, matter alba, and exogenous stains using a photopolymer lamp.

DI-S scoring codes and criteria:

0 – No food debris, plaque, matter alba, or stains

1 - Food debris, plaque, matter alba, or stains covering up to one-third of the tooth surface

2 - Food debris, plaque, matter alba, or stains covering up to two-thirds of the tooth surface

3 - Food debris, plaque, matter alba, or stains covering more than two-thirds of the tooth surface

CI-S scoring codes and criteria:

0 – No calculus

1 – Supragingival tartar covering no more than one-third of the evaluated tooth surface

2 – Supragingival tartar covering more than one-third but not exceeding two-thirds of the tooth surface, or the presence of discrete patches of subgingival tartar around the cervical portion of the tooth.

3 – Supragingival calculus covering more than two-thirds of the tooth surface or an encompassing band of subgingival calculus surrounding the cervical region of the tooth.

Calculation:

The OHI-S for the individual is derived from the DI-S and CI-S scores, with the aggregate results obtained from summing the values reported for the six examined tooth surfaces and dividing by the number of surveyed surfaces. The DI-S and CI-S values range from 0 to 3 – Excellent value = 0, Good value = 0.1–0.6, Satisfactory value = 0.7–1.8, Poor value = 1.9–3.0 for the researched indices.

The DI-S and CI-S scores are combined, resulting in an OHI-S score that ranges from 0 to 6.

Interpreting OHI-S:

Excellent oral hygiene = 0, Good oral hygiene = 0.1–1.2, Fair oral hygiene = 1.3–3.0, Poor oral hygiene = 3.1–6.0

Reporting group OHI-S score:

The average value for individuals within the group is calculated by summing the results from all adolescents examined and dividing this resultant numerical value by the total number of individuals evaluated in the group.

- **Plaque Control Record Index (PCR)** – This index involves the examination of all available teeth, during which the presence of dental plaque is recorded on four dental surfaces: mesial, distal, buccal, and lingual/palatal. This

assessment is conducted subsequent to the application of the Plaque Test Indicator (Ivoclar Vivadent) Liquid (10 ml). Following the rinsing of the oral cavity and the visualization of the dental plaque using a photopolymer lamp, the cervical area of the dental surfaces adjacent to the gingival marginal edge is evaluated.

The index is calculated as a percentage representing the dentition with detectable plaque, achieved by dividing the number of dental surfaces exhibiting plaque by the total number of dental surfaces examined, with the resulting quotient multiplied by 100. A lower percentage signifies a more favorable oral hygiene status of the examined patient.

- **Plaque-free score (PFS)** – This score indicates the percentage of tooth surfaces within the dentition that are devoid of plaque. It is derived by subtracting the PCR index (%) from 100%.
- **Papillary Bleeding Index (PBI)** – This index is particularly valuable for assessing the gingival condition in the area surrounding the interdental papillae. The assessment is carried out by inserting an atraumatic periodontal probe into the base of the papilla from the mesial side, moving the probe coronally to the tip of the papilla, and repeating this procedure on the distal side. After a duration of 20-30 seconds, upon completing the examination of the quadrant, the intensity of bleeding is evaluated using four grades. All four quadrants are examined (quadrants 1 and 3 orally, and quadrants 2 and 4 buccally), resulting in a total of 28 registered zones.

PBI scoring codes and criteria:

Score 0 – No bleeding

Score 1 – A single discrete bleeding point

Score 2 – Bleeding points or a solitary line of blood are present

Score 3 – The interdental area is filled with blood following probing

Score 4 – Profuse bleeding

The amount of bleeding is calculated utilizing the formula for determining the PBI value. The PBI is computed by summing the scores and dividing this total by the number of researched papillae. The average PBI is categorized according to the following ranges:

0 – No inflammation

0.1–1.3 - Mild inflammation;

1.4 – 2.7 - Moderate inflammation;

2.8 – 4 - Severe inflammation;

- **Gingival Index (GI)** - This index is utilized to assess the degree of gingival damage based on the color of the gingiva, its consistency, and the presence of bleeding upon probing. The examination consists of isolating the teeth and gingiva, drying them, and observing them under adequate lighting with a dental mirror and probe. An atraumatic periodontal probe is employed to compress the gingiva to ascertain its consistency and to traverse along the soft tissue wall adjacent to the entrance of the gingival sulcus to evaluate for gingival bleeding. Four tooth surfaces (mesial, distal, buccal, oral) are evaluated for all available teeth or selected Ramfjord teeth (16, 11, 26, 36, 31, 46).

GI scoring codes and criteria:

0 - Normal gingiva

1 - Mild inflammation - Slight swelling, slight alteration in gingival color, no bleeding upon probing

2 - Moderate inflammation - Redness, swelling, and gloss of the gingiva, with bleeding upon probing.

3 - Severe inflammation - characterized by marked redness and swelling of the gingiva, ulceration, and a propensity for spontaneous bleeding.

Calculation:

Each of the four gingival surfaces for a tooth is assigned a score ranging from 0 to 3. The gingival index for a specified tooth is the total of the scores for the four surfaces divided by 4, whereas the GI for a group of teeth is the cumulative score for each tooth divided by the number of teeth within the group. For an individual patient, the GI is computed as the total of the scores for all examined surfaces divided by the number of study surfaces. For a study group of patients, it is the cumulative sum of all GIs within the group divided by the number of individuals studied.

Interpretation:

Healthy gingiva = 0

Mild gingival inflammation = 0.1 – 0.9

Moderate gingival inflammation = 1.0 – 1.9

Severe gingival inflammation = 2.0 – 3.0

Materials and Methods for Objective 3

The object of this study encompasses international and Bulgarian scientific publications pertaining to Varna, along with educational literature, guidelines from international professional organizations, and the results of our own studies conducted on an experimental group of adolescents aged 11 to 17 years, whose BMIZ scores are equal to or greater than one, sourced from the city and region.

The unit of observation comprises dietary indicators, dental status, plaque population, and gingival damage.

Signs of Observation:

• Oral health assessment indices (DMFT, DMFS, SiC, ICDAS, CarieScan Pro system, activity - A and reversibility - R of carious lesions, PUFA, OHI-S, PCR, PFS, PBI, GI) - incorporated into an outpatient card developed for the study.

• A three-day food diary.

• A questionnaire.

Time of the Study: 2023 to 2024.

Location of the Research:

• Medical University "Prof. Dr. Paraskev Stoyanov" - Varna, including the University Medical and Dental Center at the Faculty of Dental Medicine.

• Clinical halls within the Department of Pediatric Dentistry at the Faculty of Dental Medicine - Varna.

In order to implement the third task, a survey was carried out through a direct, anonymous questionnaire, supplemented by a three-day food diary aimed at collecting information about personal food preferences, physical activity, access to food, lifestyle choices, and detrimental habits of the children. This also included

identifying risk factors, frequency of eating, and overall dietary habits. The questionnaire consists of thirty-seven questions. A clinical trial was additionally conducted to assess the dynamics of oral health indicators in adolescents within the experimental group, both prior to and following the implementation of a preventive program designed to rectify nutritional status, as established by the three-day food diary and the questionnaire on dietary errors.

Each child in the experimental group receives tailored recommendations for dietary adjustments, and based on the data acquired from the survey as well as the conducted studies, twenty-nine dietary recommendations have been compiled in relation to the oral health of adolescents. Informative and motivational materials have been developed for patients and their parents detailing the impact of nutrition on overall health during adolescence.

Statistical Methods

The following statistical methods were employed:

1. Descriptive Methods

Frequency analysis was conducted to calculate absolute and relative frequencies (%) of qualitative variables (nominal and ordinal). The results are presented in tabular format.

Variance analysis of quantitative variables was performed, determining central tendencies via arithmetic mean and median, and variability through standard deviation, quartiles, interquartile range, and 95% confidence interval.

A graphical method was utilized for the visualization of results.

2. Hypothesis Testing Methods

Methods to assess the normality of the distribution of quantitative variables employed include the Kolmogorov-Smirnov test for groups larger than thirty participants and the Shapiro-Wilk test for groups smaller than thirty participants.

For the comparison of two independent samples, depending on the distribution type used, Student's t-test, Mann-Whitney test, and the Wilcoxon rank test for dependent samples were applied. For comparisons involving more than two groups, analysis of variance (ANOVA) and the Kruskal-Wallis test, along with Post Hoc tests for multiple comparisons were utilized.

Pearson's χ^2 criterion, Fisher's exact test, and Kruskal's tests were used for the analysis of categorical variables. To explore correlations, Pearson's correlation coefficient and Spearman's rank correlation coefficient were employed.

The significance level of the null hypothesis is maintained at a predetermined value of $\alpha = 0.05$.

For the statistical analyses, the statistical package SPSS for Windows, version 25, along with Jamovi, was utilized version 2.4, Microsoft Excel were used.

IV. RESULTS AND DISCUSSION

Results and Discussion on Objective 1

1.1 Objective: Investigation of Anthropometric Indicators in Adolescents Aged 11-17 Years.

Among the 300 adolescents studied, 157 were identified as boys (52. 3%) and 143 as girls (47. 7%), with ages ranging from 11 to 17 years, yielding a median age of 13 years.

The average height of the studied cohort was 161. 12 cm (SD = 11. 904 cm), and the average value of the Height- for- Age Z- score (HAZ) was 0. 703 (SD = 0. 959). A significant proportion of children, accounting for 65% (CI 60%- 70%) in terms of HAZ score, were classified as having normal growth. Additionally, 11% of participants (CI 8%- 15%) were categorized as overgrown, while 21% (CI 16%- 26%) were slightly overgrown. Only 3% (CI 1%- 6%) of the adolescents studied exhibited as marginally stunted. The mean body weight for the studied children was 58. 25 kg (SD = 12. 244 kg), with a mean Body Mass Index (BMI) of 22. 303 kg/m ² (SD = 2. 862 kg/m ²). Regarding BMI, the majority, 72. 3% (CI 67%- 77%) of children fell within the range of 18. 5-25 kg/m ², identifying the latter group as overweight; specifically, this group constituted 15. 7% (CI 12%- 20%). Furthermore, 0. 0.3% (0%- 2%) of the studied children were classified as obese class I, and 11. 7% (CI 8%- 16%) were recognized as underweight. The mean BMI percentage for the adolescents was 77. 737 (SD = 21. 863), with the largest proportion, 63. 7% (CI 58%- 69%), categorized as "at risk of obesity"; additionally, 9% (CI 6%- 13%) were classified as obese, while 27. 3% (CI 22%- 33%) were of normal weight. The calculated mean value for the BMIZ score was 0. 818 (SD = 0. 809), with 68% (CI 62. 4%- 73. 2%) of adolescents categorized as overweight, 2. 3% (CI 0. 9%- 4. 8%) as obese, 23. 3% (CI 18. 7%- 28. 5%) as of normal weight, and 6. 3% (CI 3. 9%- 9. 7%) as falling within the "mildly underweight" category. In terms of the BMIZ percentage, the average value is 75. 629 (SD = 24. 17), with the majority of children identified as "at risk of obesity" -52. 8% (CI 47%- 59%), followed by those with normal body weight at 36. 36.8% (CI 31%- 43%), with 9% (CI 6%- 13%) categorized as overweight and only 1. 1.3% (0%- 3%) identified as underweight **(Tab. 1).**

Table 1. Nutritional Status of Children According to Measured Anthropometric Indicators and Indices.

Index*	Group	Number	p

HAZ score	overgrown	33	**< 0.001**
	slightly overgrown	62	
	normal growth	196	
	marginally stunted	9	
BMI	underweight	35	**< 0.001**
	normal body weight	217	
	overweight	47	
	obesity class I	1	
BMI ‰	normal body weight	82	**< 0.001**
	at risk of obesity	191	
	overweight	27	
BMI Z score	obesity	7	**< 0.001**
	overweight	204	
	normal body weight	70	
	mild malnutrition	19	
BMI Z-score ‰	underweight	4	**< 0.001**
	normal body weight	110	
	at risk of obesity	158	
	overweight	27	

***HAZ score= Height-for-Age Z Score; BMI=Body Mass Index; BMI %=Body Mass Index в %; BMIZ score=BMI-for-age; BMI Z score ‰=BMI-for-age в %**

The findings of our study indicate that boys have a mean height of 165 cm (152;172), in contrast to girls with a mean height of 161 cm (153;165) ($p < 0.01$). A statistically significant difference in height between the two sexes was identified ($p=0.013$). Boys exhibit a higher mean body weight of 59 kg (49; 68) compared to girls at a mean of 56 kg (49; 65) ($p=0.36$). Regarding HAZ score values, boys demonstrate a higher mean of 0.72 (0.29;1.59) ($p < 0.001$). The boys' BMI value is recorded as a mean of 22.4 (20.7; 23.7), while for girls, the mean is 22.8 (20.4; 24.9). No statistically significant difference in BMI measurements was observed ($p=0.06$). The BMI percentage calculations yield a mean of 87 (79; 91) for boys and a mean of 86 (78.5; 88) for girls ($p < 0.005$). The boys' BMI Z-score percentile is reported as a mean of 1.08 (0.76; 1.29), whereas for girls, it is a mean of 1.06 (0.76; 1.14) ($p = 0.09$). The BMI Z-score percentile was determined to be

identical for both sexes, with a mean of 86; however, the variation was found to be slightly greater for boys (78;90) compared to girls (77.5;87) (r=0.09). **(Tab. 2)**.

Table 2. Main anthropometric indicators and indices according to the gender of the research adolescents.

	Gender*	Number	Me (Q1 -Q3)	p
Height (cm)	1	157	165 (152; 172)	**0.01**
	2	143	161 (153.5; 165)	
Weight (kg)	1	157	59 (49; 68)	0.36
	2	143	56 (49; 65)	
HAZ-score	1	157	0.72 (0.29; 1.59)	**< 0.001**
	2	143	0.32 (-0.07; 0.74)	
BMI	1	157	22.4 (20.7; 23.7)	0.06
	2	143	22.8 (20.4; 24.9)	
BMI ‰	1	157	87 (79; 91)	**0.005**
	2	143	86 (78.5; 88)	
BMI Z-score	1	157	1.08 (0.76; 1.29)	0.09
	2	143	1.06 (0.76; 1.14)	
BMI Z score ‰	1	157	86 (78; 90)	0.09
	2	143	86 (77.5; 87)	

***1-boys; 2-girls;**
HAZ-score=Height-for-Age Z Score; BMI=Body Mass Index; BMI %=Body Mass Index Percentiles; BMIZ-score=Body Mass Index Z Score; BMIZ %=Body Mass Index Percentiles

1.2 Objective: To investigate the effectiveness of the diet in adolescents aged 11 to 17 years.

To determine and calculate the Diet Quality Index for Adolescents (DQI-A), a three-day food diary was utilized, encompassing six meals: breakfast, pre-lunch meal, lunch, afternoon snack, dinner, and evening meal over a 24-hour period on

three randomly selected days of the week, including two weekdays and one weekend (Sunday). The results obtained indicate that among the 230 children with impaired nutritional status, the majority, specifically 148 children classified as overweight, exhibited low diet quality. Furthermore, out of a total of seven children diagnosed with obesity, five displayed low diet quality. Among the 19 individuals assessed with established mild malnutrition, 18 demonstrated high diet quality. Notably, the highest concentration of adolescents with normal body weight was associated with high diet quality. **(Tab.3)** A strong positive and statistically significant correlation was observed between diet quality and the disorders present in the nutritional status of the studied children *(Kendall Tau-B = 0.65, $p < 0.001$)*. This indicates that children consuming low-quality diets are more likely to be overweight and are "at risk of obesity."

Table 3. Distribution of study adolescents according to BMIZ z-score in diet quality groups.

Groups based on diet quality**	BMIZ z-score group*				Total, n (%)	Test χ^2	p
	1	2	3	4			
1	5 (71.4)	148 (72.5)	6 (8.6)	0 (0.0)	159 (100)	178	< 0.001
2	2 (28.6)	45 (22.1)	14 (20.0)	1 (5.3)	62 (100)		
3	0 (0.0)	11 (5.4)	50 (71.4)	18 (94.7)	79 (100)		
Total, n (%)	7 (100.0)	204 (100.0)	70 (100.0)	19 (100.0)	300 (100)		

*** BMIZ z-score group - 1 group (obesity); 2 group (overweight); 3 Group (normal body weight); 4 group (marginally stunted);**

****Groups based on diet quality- 1-group (0 до ≤ 45); 2-group (> 45 до ≤ 60); 3-group (>60)**

In a study involving 300 children, the quality of the diet was assessed using the Diet Quality Index - Adolescents (DQI-A). The average DQI-A score for the 157 girls examined was 37% (34; 68), whereas for the 143 boys evaluated, it was 34% (25; 57) ($p < 0.001$) **(Tab. 4)**.

Table 4. Average DQI-A score by gender

	Gender*	Number	Me (Q1-Q3), %	Minimum, %	Maximum, %
DQI-A	1	157	37 (34; 68)	22.7	95.8

Score	**2**	143	34 (25; 57)	14.4	90.9

***1-boys; 2-girls**

Among the participants analyzed, 159 adolescents demonstrated low diet quality, 62 exhibited average diet quality, and 79 presented high dietary quality. The findings indicated that 80 boys and 79 girls possessed low dietary quality, while 33 girls and 29 boys exhibited average dietary quality. Moreover, only 44 boys and 35 girls were categorized as having high dietary quality. No statistically significant difference was identified between the two sexes across the three groups, as assessed by the Diet Quality Index for Adolescents (DQI-A) (χ^2 = 0.638; df= 2; p=0.727) **(Tab. 5)**.

Table 5. Diet quality (DQI-A) by sex.

Gender*	**Groups based on diet quality **, number**			**Total number**	**p**
	1	**2**	**3**		
1	80	33	44	157	0.73
2	79	29	35	143	
Number	159	62	79	300	

***1-boys; 2-girls**

****1-group (0 до ≤ 45); 2-group (> 45 до ≤ 60); 3-group (>60)**

The age of the patients under study exhibited a correlation with the efficacy of the dietary regimen. A moderate strength of the age-diet quality association was recorded *(Kendall Tau-b = 0.261, p < 0.001)*. Among the 73 adolescents who were 11 years of age, the majority, comprising 53 children, demonstrated low dietary quality; 9 exhibited average quality, and only 11 displayed high dietary quality (p < 0.001). Within the cohort of 12-year-old children, 5 had high dietary quality, 14 presented with average quality, and 21 were categorized as low quality (p < 0.001). Of the 13-year-olds, 34 had a Diet Quality Index for Adolescents (DQI-A) between 0 and ≤ 45, 7 ranged from > 45 to ≤ 60, and 6 were categorized as < 60 (p < 0.001). Among the 15-year-old adolescents, 13 demonstrated low diet quality, while an equal number exhibited high diet quality, with 12 categorized as having medium quality (p < 0.001). In the group of 33 sixteen-year-old adolescents, 11 had low dietary quality, 6 presented with medium quality, and 16 were identified as having high diet quality (p < 0.001). Finally, among the 17-year-olds, an equal number of individuals exhibited medium and high dietary

quality – 7 and 6 were classified with low quality, respectively ($p < 0.001$) **(Tab.6)**.

Table 6. Diet Quality Index (DQI-A) in adolescents by age.

Age	Groups based on diet quality *, number			p
	1	2	3	
11	53	9	11	**< 0.001**
12	21	14	5	
13	34	7	6	
14	21	7	21	
15	13	12	13	
16	11	6	16	
17	6	7	7	
Total	159	62	79	

***1-group (0 до ≤ 45); 2-group (> 45 до ≤ 60); 3-group (>60)**

The findings indicate that the average value of the Diet Quality Index for Adolescents (DQI-A) is 34% for participants aged 11 years (Confidence Interval: 34%-47%) and for those aged 13 years (Confidence Interval: 26%-47%). In adolescents aged 12 years, the average value increases to 37% (Confidence Interval: 34%-60%). For 14-year-olds, the average value of the index representing the quality of the diet is 46% (Confidence Interval: 35%-68%). Furthermore, there is a noted increase in the average value of DQI-A with advancing age, reaching 52% (Confidence Interval: 37%-68%) at age 15, 58% (Confidence Interval: 24%-80%) at age 16, and remaining at 58% (Confidence Interval: 25%-69%) at age 17 ($p=0.01$). A statistically significant difference was observed ($\chi^2=16.6$; df = 6; $p=0.011$) **(Tab. 7).**

Table 7. Average DQI-A-score by age.

	Age	Number	Me (Q1-Q3)	Minimum	Maximum	p
DQI-A score	11	73	34 (34; 47)	24.2	95.8	
	12	40	37 (34; 60)	22.7	95.8	

	13	47	34 (26; 47)	23.7	95.8	**0.01**
	14	49	46 (35; 68)	24.2	95.8	
	15	38	52 (37; 68)	24.2	90.9	
	16	33	58 (24; 80)	14.4	90.9	
	17	20	58 (25; 69)	14.4	70.2	

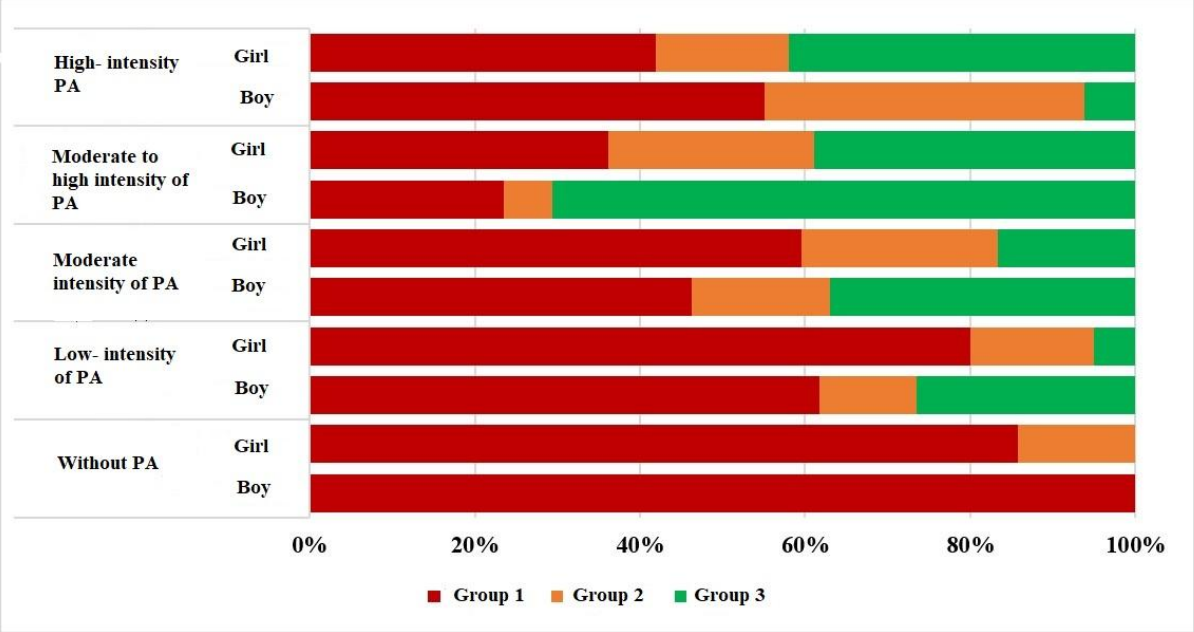
DQI-A score = Diet Quality Index for Adolescents

1.3. Objective: Investigation of Dietary Indicators in Adolescents Aged 11 to 17 Years

A direct, individual, and anonymous survey was administered to each of the children analyzed. The survey encompassed 38 questions. The results obtained are recorded in a database containing responses to the questions, categorized into three principal groups: 1) physical activity, food accessibility, lifestyle, and valuable habits of the child; 2) risk factors and frequency of eating; and 2) personal preferences and eating habits.

The findings related to the physical activity (PA) of the adolescents under study indicate that only 6. 12% of boys with high dietary quality engage in high-intensity PA, in contrast to 41. 41.94% of girls. Regarding average dietary quality, 38. 78% of boys and 16. 13% of girls participate in high- intensity physical activity, whereas with low dietary quality, the percentages are 55. 10% for boys and 41. 41.94% for girls ($p < 0.001$). A moderate to high intensity of PA is observed among the highest relative proportions of girls and boys with high dietary quality, at 38. 89% and 70. 59%, respectively. In boys, a statistically significant difference was noted among three groups according to dietary quality concerning moderate to high intensity PA ($p < 0.001$), while no statistically significant difference was identified among the DQI- A groups in girls. Moderate intensity of PA was recorded in 46. 30% of boys and 59. 52% of girls with DQI-A scores ranging from 0 to ≤ 45. A moderate intensity of PA was also found in 16. 67% of boys with average dietary quality and in girls with high dietary quality. Furthermore, moderate intensity of PA was observed in 37. 04% of boys with

DQI- A scores exceeding 60 and in 23. 81% of girls with DQI- A scores between> 45 and ≤ 60. A statistically significant difference was identified in the groups based on dietary quality for both sexes (p < 0. 001). Concerning low- intensity physical activity, the data indicate that the highest proportion of boys and girls with low dietary quality are from the carrier group, at 61. 76% and 80. 00%, respectively (p < 0. 001). Adolescents lacking food accessibility display low dietary quality for boys (100%) and low (85. 71%) and medium (14. 29%) dietary quality for girls. **(Fig. 1)** A moderate strength of association was established between the intensity of physical activity and dietary quality *(Cramer V = 0. 0.2, p = 0. 002).*



1- group (0 to ≤ 45); 2- group (> 45 to ≤ 60); 3- group (>60); PA – physical activity

Figure 1. Distribution of girls and boys based on activity intensity with varying quality of physical diet.

Adolescents tend to sleep more on weekends compared to weekdays. On weekdays, sleep duration ranges from 6 to 9 hours (Mean = 7 hours), with 50% of participants sleeping between 6 and 8 hours. In contrast, during weekends, adolescents sleep between 8 and 12 hours (Mean = 10 hours), with 50% of them sleeping between 9 and 10 hours. A correlation was identified between the overall stress levels of the adolescents involved in the study and the number of hours of sleep on weekdays, manifesting a moderately negative correlation (- 0. 5, p < 0. 001). This trend of moderate negative correlation persisted for school- related stress costs (- 0. 31, r < 0. 001), family- related stress levels (- 0. 34, r < 0. 001),

financial stress levels (- 0. 3, r < 0. 001), health- related stress levels (- 0. 35, r < 0. 001), as well as the weekly hours of sleep. Additionally, a weak negative relationship was noted between social stress and sleep (- 0. 11, r = 0. 05). A moderate negative correlation (- 0. 26, r < 0. 001) was observed between family stress and the weekly hours of sleep. Among the 157 boys included in the study, 17 reported engaging in daily smoking. Of these, 8 belonged to the high- quality diet group (47. 1%), 7 were in the medium- quality group (41. 41.2%), and 2 fell within the low- quality group (11. 8%). Out of the 143 girls, 20 smoked cigarettes daily, with 11 girls categorizing their diet as low quality (55. 0%), 5 as high quality (25. 0%), and 4 as medium quality (20%) ($\chi^2 = 7.5$; r = 0. 02). The remaining 140 boys and 123 girls did not report smoking cigarettes, with 78 boys (55. 7%) and 68 girls (55. 3%) indicating low dietary quality, 26 boys (18. 6%) and 25 girls (20. 3%) indicating medium dietary quality, and 36 boys (25. 7%) and 30 girls (24. 4%) indicating high dietary quality ($\chi^2 = 1.5$; p = 0. 93). **(Tab. 8)**

Table 8. The relationship between smoking among adolescents and diet quality.

Answer	Gender	Groups based on diet quality **					
		1	2	3	Общо	χ^2	p
Daily smoking, n (%)							
Yes	Boy	2 (11.8)	7 (41.2)	8 (47.1)	17 (100.0)	7.5	**0.02**
	Girl	11 (55.0)	4 (20.0)	5 (25.0)	20 (100.0)		
	Total	13 (35.1)	11 (29.7)	13 (35.1)	37 (100.0)		
No	Boy	78 (55.7)	26 (18.6)	36 (25.7)	140 (100.0)	1.5	0.93
	Girl	68 (55.3)	25 (20.3)	30 (24.4)	123 (100.0)		
	Total	146 (55.5)	51 (19.4)	66 (25.1)	263 (100.0)		

****1-group (0 to ≤ 45); 2-group (> 45 to ≤ 60); 3-group (>60)**

n – number of adolescents

Among the adolescents investigated, 22.7% reported the consumption of coffee, including regular coffee, caffe latte, and cappuccino, with the proportion of adolescents engaging in daily coffee consumption amounting to 31.7%. **(Fig. 2)** A weak positive correlation was identified between the level of stress and the consumption of various types of coffee, where ρ (0.2) (r=0.002).

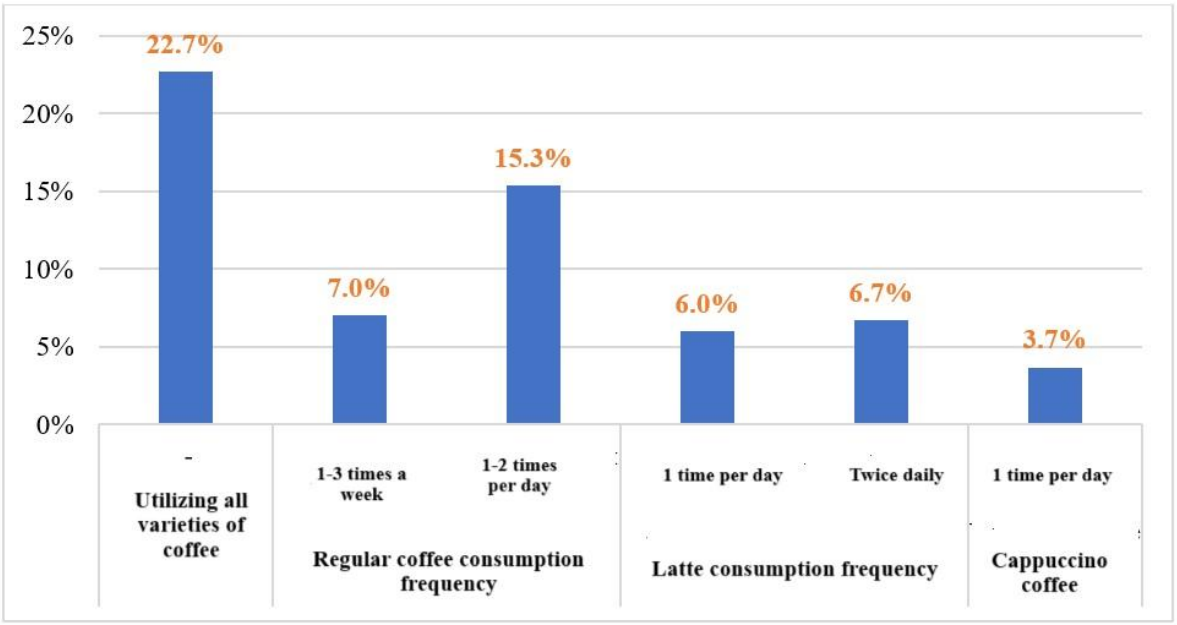


Figure 2. Distribution of coffee consumption types among the surveyed adolescents.

A significant proportion of teenagers (56.3%) allocate between 5 to 6 hours in front of television or computer screens (r=0.03), with the majority being male. Furthermore, 7.3% of these individuals exceed 6 hours of screen time (p <0.001), while 30% spend between 3 to 4 hours (p <0.001). Only 6.3% report spending less than 2 hours in front of screens (p <0.001) **(Fig. 3).**

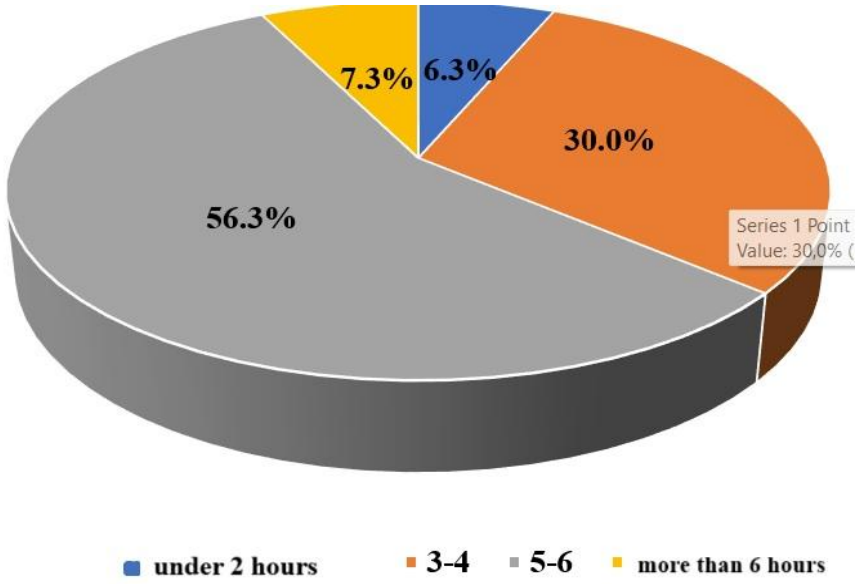
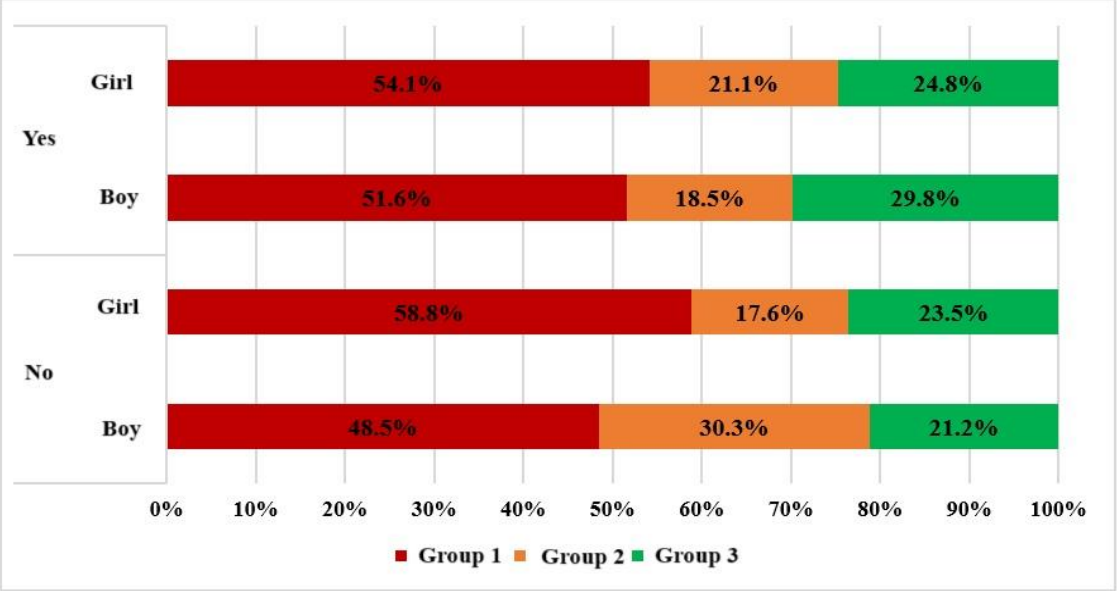


Figure 3. Distribution percentage of children in research concerning changes in screen time.

A weak negative correlation (ρ = -0.12) was identified between the number of hours spent in front of a screen and the amount of sleep on weekdays (r = 0.03). Conversely, a moderate positive correlation (ρ = 0.4) was noted between the hours dedicated to screen time and the level of stress experienced by adolescents post-study (r <0.001). Among the boys examined, 51.6% of those with low dietary quality reported eating while using a screen, compared to 18.5% with medium dietary quality and 29.8% with high dietary quality. The remaining 33 boys did not indicate that they ate in front of a screen. Among the girls studied, 109 engaged in eating while using a screen; of these, 54.1% had low dietary quality, 21.1% had medium dietary quality, and 24.8% had high dietary quality. The remaining 34 girls reported that they did not eat while spending time in front of a screen. **(Fig. 4)** Furthermore, within the adolescent population, a weak relationship was detected between total screen time and dietary quality *(Cramer V = 0.22, r < 0.001)*, with a stronger correlation observed among boys *(Cramer V = 0.27, r = 0.005)*.

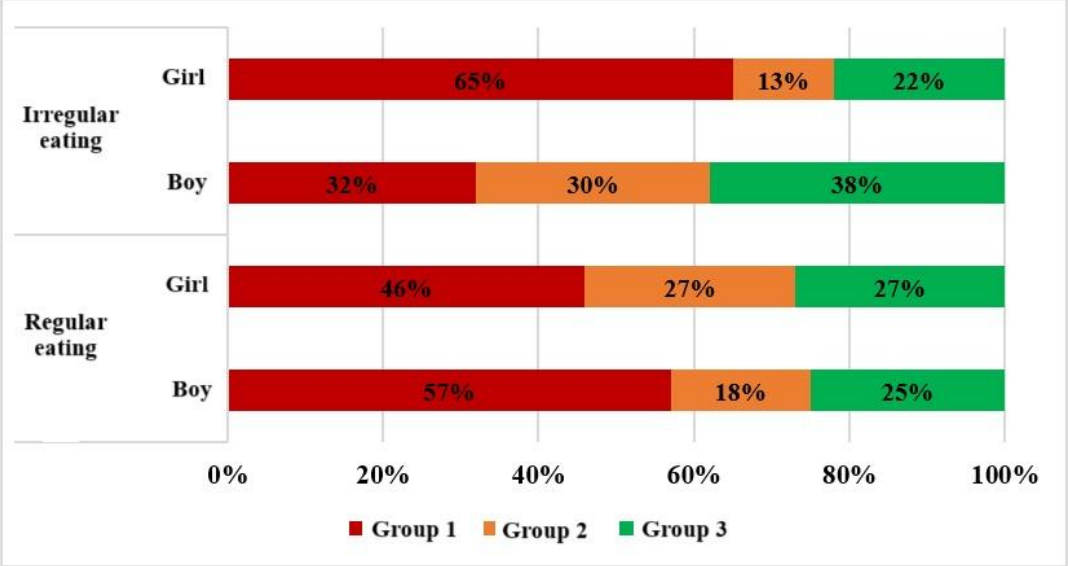


1-group (0 to ≤ 45); 2-group (> 45 to ≤ 60); 3-group (> 60)

Figure 4. Distribution of the number of girls and boys consuming meals in front of a screen, categorized by varying diet quality.

The results indicate that among all the boys studied, 38% with high diet quality do not consume meals regularly each day, whereas 25% maintain regular eating habits. Conversely, 57% of boys with low diet quality have regular meals, and 32% do not adhere to regular eating patterns. Among girls, the highest percentage—65%—exhibits low diet quality and irregular meal consumption;

additionally, there exists a noticeable percentage of girls with high diet quality who consume meals regularly—27%. A statistically significant differentiation was identified between the two sexes across the three dietary quality groups ($p < 0.05$). A moderate correlation was observed between adolescents with irregular meal patterns and diet quality *(Cramer V=0.32; p=0.005)*. **(Fig. 5)**



1-group (0 to ≤ 45); 2-group (> 45 to ≤ 60); 3-group (>60)

Figure 5. Distribution of the frequency of eating (regular and irregular) among boys and girls participants, categorized by varying diet quality.

Among the adolescents surveyed, 18 girls indicated instances of overeating in the morning, with 88.9% reporting a low-quality diet, while the remaining 11.1% reported a high-quality diet. At lunchtime, 96 participants acknowledged overeating, with one-third being boys. Among boys, 42.4% reported an average quality of diet, while 39.4% reported low quality and incidence of overeating at lunch. Among girls who engaged in overeating at lunch, 66.7% exhibited low dietary quality. A statistically significant difference was identified between gender and groups according to the Diet Quality Index-Adolescents (DQI-A) (χ^2=8.925; p=0.012). A weak correlation was observed between the tendency to overeat at lunch and dietary quality among adolescents *(Cramer V=0.3; p=0.01)*. In terms of evening overeating, 162 adolescents reported such behavior, consisting of 77 boys and 85 girls. Of the boys, 55.8% had a low-quality diet, followed by 29.9% with an average quality and 39.4% with a high-quality diet. Among girls who overate in the evening, 66.7% demonstrated a low-quality diet. A statistically significant difference was found between gender and DQI-A groups (χ^2=10.544; p=0.005). Additionally, a weak correlation was found between adolescents who

do not overeat in the evening and dietary quality *(Cramer V=0.3; p<0.001)*. **(Tab. 9)**

The survey reveals that boys most frequently overeat meat, bread, salad, pizza, beans, and sweet desserts, whereas girls are particularly inclined toward overeating pizza, pasta, meat, and desserts.

Table 9. Analysis of Overeating Patterns by gender and dietary intake

Answer	Gender	Groups based on diet quality **				χ^2/ Fisher's exact test *	p (χ^2/ Fisher's exact test*)
		1	2	3	Total		
Overeating in the morning, n (%)							
Yes	Boy	0 (-)	0 (-)	0 (-)	0 (100.0)	-*	1*
	Girl	16 (88.9)	0 (0.0)	2 (11.1)	18 (100.0)		
	Total	16 (88.9)	0 (0.0)	2 (11.1)	18 (100.0)		
No	Boy	80 (51.0)	33 (21.0)	44 (28.0)	157 (100.0)	0.22	0.89
	Girl	63 (50.4)	29 (23.2)	33 (26.4)	125 (100.0)		
	Total	143 (50.7)	62 (22.0)	77 (27.3)	282 (100.0)		
Overeating at lunch, n (%)							
Yes	Boy	13 (39.4)	14 (42.4)	6 (18.2)	33 (100.0)	8.925	**0.012**
	Girl	42 (66.7)	10 (15.9)	11 (17.5)	63 (100.0)		
	Total	55 (57.3)	24 (25.0)	17 (17.7)	96 (100.0)		
No	Boy	67 (54.0)	19 (15.3)	38 (30.6)	124 (100.0)	2.438	0.295
	Girl	37 (46.3)	19 (23.8)	24 (30.0)	80 (100.0)		
	Total	104 (51.0)	38 (18.6)	62 (30.4)	204 (100.0)		
Overeating in the evening, n (%)							
Yes	Boy	43 (55.8)	23 (29.9)	11 (14.3)	77 (100.0)	10.544	**0.005**
	Girl	45 (52.9)	12 (14.1)	28 (32.9)	85 (100.0)		
	Total	88 (54.3)	35 (21.6)	39 (24.1)	162 (100.0)		
No	Boy	37 (46.3)	10 (12.5)	33 (41.3)	80 (100.0)	15.734	**< 0.001**
	Girl	34 (58.6)	17 (29.3)	7 (12.1)	58 (100.0)		
	Total	71 (51.4)	27 (19.6)	40 (29.0)	138 (100.0)		

****1-group (0 to ≤ 45); 2-group (> 45 to ≤ 60); 3-group (>60)**
n – number of adolescents

Adolescents who consume meals while walking account for 120 of all respondents, with two-thirds of these being female. Among boys who eat out, 37% maintain a high-quality diet. Conversely, the group characterized by low dietary quality is most prominent among females. A statistically significant difference has been identified between gender and Diet Quality Index for Adolescents (DQI-A) groups (χ^2=14.368; p<0.001). Furthermore, a moderate strength of the relationship is observed between adolescents eating out while walking and diet quality, as demonstrated by *(Cramer's V=0.35; p<0.001)*. Regarding boys who eat in front of a computer, 84 adolescents reported this behavior, of whom 74 were male. The majority (51.4%) of boys in this scenario exhibit low dietary quality (p >0.05). Additionally, a medium strength of the relationship between boys eating in front of a computer and diet quality is noted *(Cramer V = 0.3, p <0.001)*. Among girls, the group characterized by low diet quality is again the most numerous (r >0.05). In this context, the relationship between the dietary habits of girls eating in front of the computer and diet quality is weak *(Cramer V = 0.009, p=1)*. A total of 193 adolescents in the study reported eating in front of a television. Among boys, 55.4% demonstrate low dietary quality (p >0.05). A weak strength of the relationship between eating in front of the television and diet quality is observed in boys *(Cramer V = 0.23, p=0.02)*. For females who consume meals in front of the television, 58.4% exhibit low diet quality. Within this group, the relationship between television viewing and diet quality remains weak *(Cramer V = 0.2, p=0.04)*. A total of 76 of the studied adolescents acknowledged eating on the couch. Within the male cohort, 39.5% belong to the low diet quality group, while 72.7% of females also exhibit low diet quality. A statistically significant difference was noted between gender and DQI-A groups (χ^2=13.572; p=0.001). A moderate strength of the relationship between adolescents eating on the couch and diet quality was observed *(Cramer V=0.4; p=0.001)*. Fifteen of the children studied reported eating in bed, including eight girls. The majority of females were categorized within the low diet quality group. A statistically significant difference was observed between gender and DQI-A groups (p=0.044). Furthermore, a significant strength of the relationship between adolescents eating in bed and diet quality was noted *(Cramer V=0.7; p=0.044)*. Twenty-nine respondents reported eating in a car, of which 27 were female. Among these females, 74.1% displayed low diet quality. No statistically significant difference was found between gender and DQI-A groups. A moderate strength of the relationship between adolescents eating in a car and diet quality was noted *(Cramer V=0.4; p=0.13)*. Of the 300 adolescents studied, 87 reported eating in

a restaurant. Among both sexes, the group with low diet quality once again prevailed. A statistically significant difference was observed between gender and groups on the DQI-A (χ^2=7.33; p=0.02). **(Tab. 10)**

Table 10. Preferred place for eating by gender and diet quality

Answer	Gender	Groups based on diet quality**				χ^2/ Fisher's exact test*	p (χ^2/ Fisher's exact test*)
		1	2	3	Total		
Outside on foot, n (%)							
Yes	Boy	16 (34.8)	13 (28.3)	17 (37.0)	46 (100.0)	14.368	**< 0.001**
	Girl	50 (67.6)	15 (20.3)	9 (12.2)	74 (100.0)		
	Total	66 (55.0)	28 (23.3)	26 (21.7)	120 (100.0)		
No	Boy	64 (57.7)	20 (18.0)	27 (24.3)	111 (100.0)	4.706	0.095
	Girl	29 (42.0)	14 (20.3)	26 (37.7)	69 (100.0)		
	Total	93 (51.7)	34 (18.9)	53 (29.4)	180 (100.0)		
On the computer, n (%)							
Yes	Boy	38 (51.4)	23 (31.1)	13 (17.6)	74 (100.0)	1.971	0.373
	Girl	7 (70.0)	1 (10.0)	2 (20.0)	10 (100.0)		
	Total	45 (53.6)	24 (28.6)	15 (17.9)	84 (100.0)		
No	Boy	42 (50.6)	10 (12.0)	31 (37.3)	83 (100.0)	0.638	0.727
	Girl	72 (54.1)	28 (21.1)	33 (24.8)	133 (100.0)		
	Total	114 (52.8)	38 (17.6)	64 (29.6)	216 (100.0)		
In front of the TV, n (%)							
Yes	Boy	51 (55.4)	22 (23.9)	19 (20.7)	92 (100.0)	0.185	0.912
	Girl	59 (58.4)	23 (22.8)	19 (18.8)	101 (100.0)		
	Total	110 (57.0)	45 (23.3)	38 (19.7)	193 (100.0)		
No	Boy	29 (44.6)	11 (16.9)	25 (38.5)	65 (100.0)	0.163	0.922
	Girl	20 (47.6)	6 (14.3)	16 (38.1)	42 (100.0)		
	Total	49 (45.8)	17 (15.9)	41 (38.3)	107 (100.0)		
On the couch, n (%)							
Yes	Boy	17 (39.5)	16 (37.2)	10 (23.3)	43 (100.0)	13.572	**0.001**
	Girl	24 (72.7)	1 (3.0)	8 (24.2)	33 (100.0)		
	Total	41 (53.9)	17 (22.4)	18 (23.7)	76 (100.0)		
No	Boy	63 (55.3)	17 (14.9)	34 (29.8)	114 (100.0)	3.964	0.138
	Girl	55 (50.0)	28 (25.5)	27 (24.5)	110 (100.0)		

	Total	118 (52.7)	45 (20.1)	61 (27.2)	224 (100.0)		
On the bed, n (%)							
Yes	Boy	0 (0.0)	0 (0.0)	7 (100.0)	7 (100.0)	-*	**0.044***
	Girl	4 (50.0)	1 (12.5)	3 (37.5)	8 (100.0)		
	Total	4 (26.7)	1 (6.7)	10 (66.7)	15 (100.0)		
No	Boy	80 (53.3)	33 (22.0)	37 (24.7)	150 (100.0)	0.14	0.93
	Girl	75 (55.6)	28 (20.7)	32 (23.7)	135 (100.0)		
	Total	155 (54.4)	61 (21.4)	69 (24.2)	285 (100.0)		
In the car, n (%)							
Yes	Boy	0 (0.0)	0 (0.0)	2 (100.0)	2 (100.0)	- *	0.13*
	Girl	20 (74.1)	1 (3.7)	6 (22.2)	27 (100.0)		
	Total	20 (69.0)	1 (3.4)	8 (27.6)	29 (100.0)		
No	Boy	80 (51.6)	33 (21.3)	42 (27.1)	155 (100.0)	0.35	0.83
	Girl	59 (50.9)	28 (24.1)	29 (25.0)	116 (100.0)		
	Total	139 (51.3)	61 (22.5)	71 (26.2)	271 (100.0)		
In a restaurant, n (%)							
Yes	Boy	24 (57.1)	12 (28.6)	6 (14.3)	42 (100.0)	7.33	**0.02**
	Girl	24 (53.3)	5 (11.1)	16 (35.6)	45 (100.0)		
	Total	48 (55.2)	17 (19.5)	22 (25.3)	87 (100.0)		
No	Boy	56 (48.7)	21 (18.3)	38 (33.0)	115 (100.0)	5.21	0.07
	Girl	55 (56.1)	24 (24.5)	19 (19.4)	98 (100.0)		
	Total	111 (52.1)	45 (21.1)	57 (26.8)	213 (100.0)		

****1-group (0 to ≤ 45); 2-group (> 45 to ≤ 60); 3-group (>60)**
n – number of adolescents

Among the adolescents surveyed, 280 individuals consume home-cooked meals for breakfast. A relative proportion of June demonstrated low diet quality in both genders (p >0.05). Furthermore, a moderate strength of association was identified between adolescents who do not consume home-cooked meals for breakfast and their diet quality *(Cramer V = 0.33; p = 0.4)*. A total of 70 adolescents consumed home-cooked snacks prior to lunch, two-thirds of whom were female. The average percentage of boys exhibiting high diet quality was 53.3%. Conversely, 61.8% of the girls displayed low diet quality. No statistically significant difference was observed between genders and the DQI-A groups. In terms of lunch consumption, 293 adolescents from the study reported having home-cooked meals. Again, the predominance of low diet quality was apparent in both genders (p >0.05). With

respect to home-cooked food consumption for afternoon snacks, 42 adolescents reported this, 35 of whom were female. All boys demonstrated high diet quality, while among girls, those with low (48.6%) and high (45.7%) diet quality were predominantly represented. A moderate strength of the relationship between adolescents, the consumption of home-cooked food for afternoon snacks, and diet quality was observed *(Cramer V = 0.41; p = 0.04)*, establishing a statistically significant difference between genders and the DQI-A groups (p = 0.04). Additionally, 31 of the surveyed adolescents reported having home-cooked snacks in the evening, 35 of whom were girls. All boys exhibited high diet quality, while 61.5% of the girls fell into the third group according to the DQI-A. A statistically significant difference between genders and DQI-A groups is also established in this context (p = 0.01). All studied adolescents expressed a preference for home-cooked meals at dinner. **(Tab. 11)**

Table 11. The consumption of home-cooked meals throughout the week, categorized by gender and dietary quality.

Answer	Gender	Groups based on diet quality**				χ^2/ Fisher's exact test*	p (χ^2/ Fisher's exact test*)
		1	2	3	Total		
Homemade breakfast food, n (%)							
Yes	Boy	78 (52.7)	32 (21.6)	38 (25.7)	148 (100.0)	0.68	0.71
	Girl	76 (57.6)	25 (18.9)	31 (23.5)	132 (100.0)		
	Total	154 (55.0)	57 (20.4)	69 (24.6)	280 (100.0)		
No	Boy	2 (22.2)	1 (11.1)	6 (66.7)	9 (100.0)	2.22	0.32
	Girl	3 (27.3)	4 (36.4)	4 (36.4)	11 (100.0)		
	Total	5 (25.0)	5 (25.0)	10 (50.0)	20 (100.0)		
Homemade food for a pre-meal snack, n (%)							
Yes	Boy	5 (33.3)	2 (13.3)	8 (53.3)	15 (100.0)	- *	0.09*
	Girl	34 (61.8)	3 (5.5)	18 (32.7)	55 (100.0)		
	Total	39 (55.7)	5 (7.1)	26 (37.1)	70 (100.0)		
No	Boy	75 (52.8)	31 (21.8)	36 (25.4)	142 (100.0)	2.19	0.33
	Girl	45 (51.1)	26 (29.5)	17 (19.3)	88 (100.0)		
	Total	120 (52.2)	57 (24.8)	53 (23.0)	230 (100.0)		
Homemade food for lunch, n (%)							
Yes	Boy	75 (50.0)	31 (20.7)	44 (29.3)	150 (100.0)	1.02	0.59
	Girl	79 (55.2)	29 (20.3)	35 (24.5)	143 (100.0)		
	Total	154 (52.6)	60 (20.5)	79 (27.0)	293 (100.0)		
No	Boy	5 (71.4)	2 (28.6)	0 (0.0)	7 (100.0)	- *	1*
	Girl	0 (-)	0 (-)	0 (-)	0 (100.0)		
	Total	5 (71.4)	2 (28.6)	0 (0.0)	7 (100.0)		
Homemade food for afternoon snack, n (%)							

Yes	Boy	0 (0.0)	0 (0.0)	7 (100.0)	7 (100.0)	- *	0.04*
	Girl	17 (48.6)	2 (5.7)	16 (45.7)	35 (100.0)		
	Total	17 (40.5)	2 (4.8)	23 (54.8)	42 (100.0)		
No	Boy	80 (53.3)	33 (22.0)	37 (24.7)	150 (100.0)	1.88	0.39
	Girl	62 (57.4)	27 (25.0)	19 (17.6)	108 (100.0)		
	Total	142 (55.0)	60 (23.3)	56 (21.7)	258 (100.0)		
Homemade food for evening snack, n (%)							
Yes	Boy	0 (0.0)	0 (0.0)	5 (100.0)	5 (100.0)	- *	**0.01***
	Girl	16 (61.5)	0 (0.0)	10 (38.5)	26 (100.0)		
	Total	16 (51.6)	0 (0.0)	15 (48.4)	31 (100.0)		
No	Boy	80 (52.6)	33 (21.7)	39 (25.7)	152 (100.0)	0.8	0.67
	Girl	63 (53.8)	29 (24.8)	25 (21.4)	117 (100.0)		
	Total	143 (53.2)	62 (23.0)	64 (23.8)	269 (100.0)		

****1-group (0 to ≤ 45); 2-group (> 45 to ≤ 60); 3-group (>60)**
n – number of adolescents

Among the children surveyed, 4% reported that they do not consume water. A total of 123 children reported drinking water, with 21.3% of them consuming up to 1 liter per day, and 19.7% consuming between 1 to 2 liters per day. Furthermore, 95 children expressed a preference for filtered water, with 23.3% of this group drinking up to 1 liter per day, and 8.3% consuming between 1 to 2 liters per day. Additionally, 197 children indicated that they drink bottled water, of which 48.7% consume up to 1 liter per day, and 17% consume between 1 to 2 liters per day. Moreover, 77 of the surveyed children utilize sports water, with 9.7% of them consuming 1 bottle per day, 1% consuming 2 bottles per day, 6.7% drinking 1 bottle per week, 2.3% consuming 2 bottles per week, and 6% consuming 2 bottles per month. **(Fig. 6)**

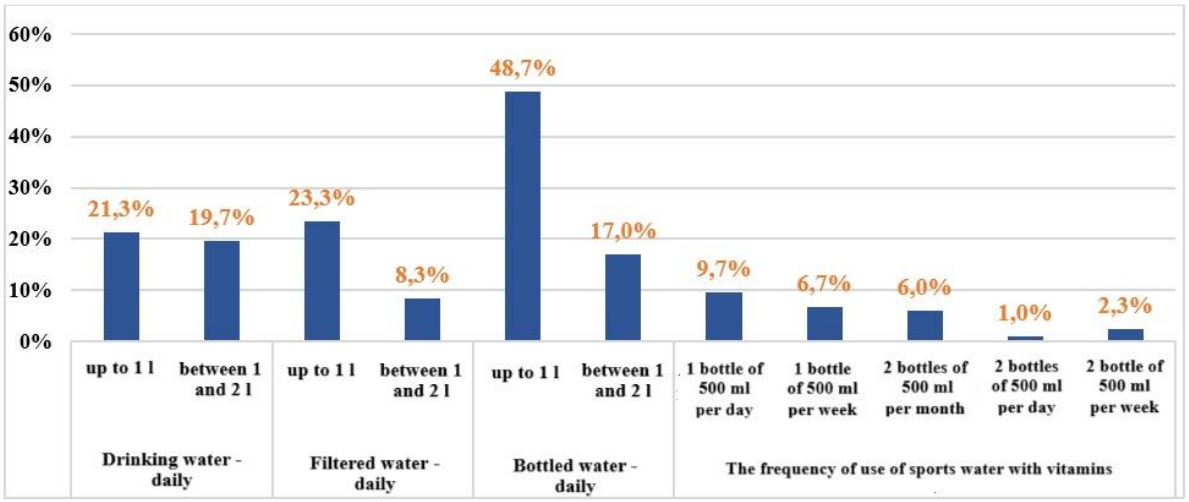


Figure 6. Distribution of the consumption of various types of water among the surveyed adolescents.

A total of 118 adolescents indicated that they consumed iced tea, with 90 of these individuals reporting daily consumption. Moreover, it was observed that more than half (56.7%) exhibited a low diet quality. A statistically significant difference was identified between gender and DQI-A groups (χ^2=13.629; p=0.001). **(Tab. 12)** Among all adolescents surveyed, 136 reported utilizing sweetened tea. The most common frequency of consumption was 1-2 times per week, particularly among children exhibiting low diet quality. Furthermore, 46 adolescents reported consumption ranging from 1 to 3 times a month, two-thirds of whom were girls. Increased frequency of sweetened tea consumption was correlated with higher diet quality among the children. A statistically significant difference was also discerned between gender and DQI-A groups (p=0.002). **(Tab. 12)**

Table 12. The consumption of various types of tea, categorized by gender and the quality of diet.

Answer	Gender	Groups based on diet quality**				χ^2/ Fisher's exact test*	p (χ^2/ Fisher's exact test*)
		1	2	3	Total		
Frequency of Utilization of Iced Tea, n (%)							
1-3 times daily	Boy	13 (34.2)	14 (36.8)	11 (28.9)	38 (100.0)	13.629	**0.001**
	Girl	38 (73.1)	7 (13.5)	7 (13.5)	52 (100.0)		
	Total	51 (56.7)	21 (23.3)	18 (20.0)	90 (100.0)		
3-4 times a week	Boy	2 (66.7)	1 (33.3)	0 (0.0)	3 (100.0)	- *	0.4*
	Girl	0 (0.0)	2 (66.7)	1 (33.3)	3 (100.0)		
	Total	2 (33.3)	3 (50.0)	1 (16.7)	6 (100.0)		
1-3 times a month	Boy	15 (68.2)	3 (13.6)	4 (18.2)	22 (100.0)	- *	1*
	Girl	0 (-)	0 (-)	0 (-)	0 (100.0)		
	Total	15 (68.2)	3 (13.6)	4 (18.2)	22 (100.0)		
Frequency of Consumption of Sweetened Tea, n (%)							
1-2 times daily	Boy	0 (0.0)	0 (0.0)	4 (100.0)	4 (100.0)	- *	0.14*
	Girl	2 (66.7)	0 (0.0)	1 (33.3)	3 (100.0)		
	Total	2 (28.6)	0 (0.0)	5 (71.4)	7 (100.0)		
1-2 times a week	Boy	20 (83.3)	2 (8.3)	2 (8.3)	24 (100.0)	- *	0.3*
	Girl	40 (67.8)	14 (23.7)	5 (8.5)	59 (100.0)		
	Total	60 (72.3)	16 (19.3)	7 (8.4)	83 (100.0)		
1-3 times a month	Boy	1 (8.3)	1 (8.3)	10 (83.3)	12 (100.0)	- *	**0.002***
	Girl	17 (50.0)	9 (26.5)	8 (23.5)	34 (100.0)		
	Total	18 (39.1)	10 (21.7)	18 (39.1)	46 (100.0)		

****1-group (0 to ≤ 45); 2-group (> 45 to ≤ 60); 3-group (>60)**
n – number of adolescents

Our results indicate that among the youth studied, 35% do not consume any type of juice, 7% engage in consumption on a monthly basis, 28% on a weekly basis, and 29% on a daily basis. The intake of natural juice once to three times a month

is reported by 11% of the 300 surveyed individuals. Furthermore, 43% consume natural juice once to three times a week, while 43% drink it once to three times a day. Additionally, 81% of the children consume fruit drinks once to three times a week, and 19% do so once to three times a day. The incidence of fresh juice consumption is reported by 44% of respondents as occurring once to three times a month, and by 1% as occurring once to three times a week. **(Fig. 7)**

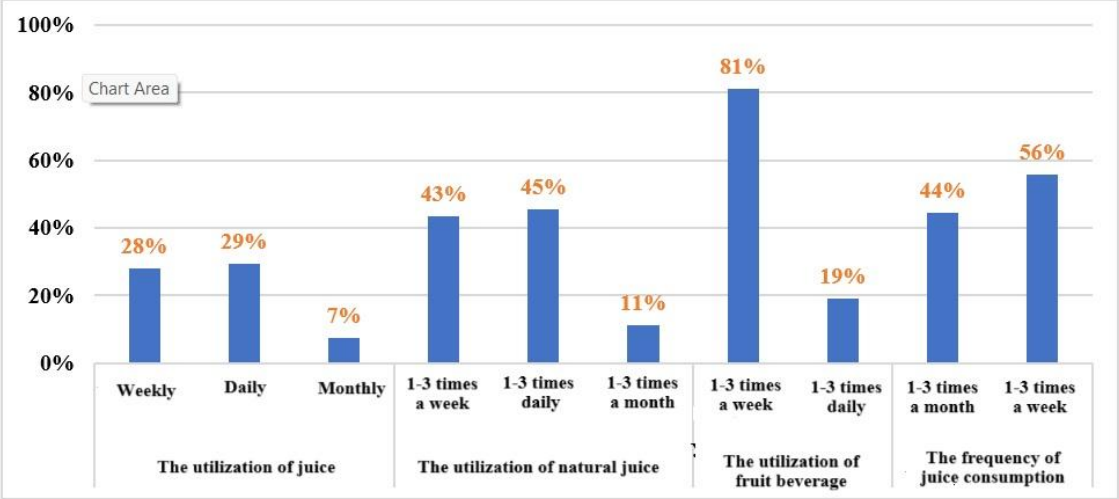


Figure 7. Distribution of the use of different types of fruit drinks among the surveyed adolescents

Candy consumption was reported by 263 respondents. The highest percentage of candy consumers was observed among boys and girls with poor dietary quality ($p > 0.05$). Of the remaining 37 adolescents who did not consume candy, two-thirds were female. Among the boys, 53.7% exhibited average dietary quality, while 66.7% of the girls demonstrated low dietary quality. A statistically significant difference was identified between genders and Diet Quality Index for Adolescents (DQI-A) groups ($\chi^2=6.684$; $p=0.035$). A moderate strength of relationship was noted between the adolescents who did not consume candy and their dietary quality *(Cramer V = 0.4, p=0.04)*. As presented in Table 13, the largest number of boys and girls received chocolates 2 to 3 times a week ($p=0.02$). A significant number of both boys and girls with low diet quality consumed chocolates 2 to 3 times a day ($p>0.05$). Moreover, boys with low dietary quality consumed chewing and jelly candies once daily ($p > 0.05$). Among girls with a DQI-A of 0 to ≤ 45, these candies were consumed 2 to 3 times a day ($p=0.001$). Of the 157 boys studied, only 22 reported using artificial sweeteners such as stevia, erythritol, aspartame, and saccharin. An equal number of boys (8) were classified in both the medium and high dietary quality groups ($p > 0.05$). In contrast, only 7 girls utilized sugar substitutes, with the remaining 136 girls abstaining from their use, as no

statistically significant difference was observed between these groups (p >0.05). A moderate strength of association was found between adolescents who employed artificial sweeteners and their dietary quality *(Cramer V = 0.4, p=0.07)*. Table 13 illustrates that no participants reported using artificial sweeteners such as xylitol, sorbitol, mannitol, acesulfame-K, neotame, sucralose, and monellin.

Among the boys studied, 99 reported using meal replacements such as shakes, protein bars, smoothies, and protein powders. Of these, 41 exhibited low dietary quality, 32 had high dietary quality, and 26 displayed medium dietary quality (p >0.05). Among the remaining 58 boys who did not utilize these types of foods, the predominant category was those with low dietary quality. Regarding girls, 83 reported using meal replacements, with 36 belonging to the first DQI-A group, 28 from the third group, and 19 from the second group (p >0.05). The majority of girls with low dietary quality did not consume such foods. No statistically significant difference was revealed between genders and DQI-A groups. **(Tab. 13)**

Table 13. Intake of candy, artificial sweeteners, and food substitutes concerning nutrition and dietary quality.

Answer	Gender	Groups based on diet quality**				χ^2/ Fisher's exact test*	p (χ^2/ Fisher's exact test*)
		1	2	3	Total		
Candy, n (%)							
Yes	Boy	74 (51.4)	26 (18.1)	44 (30.6)	144 (100.0)	0.787	0.675
	Girl	63 (52.9)	25 (21.0)	31 (26.1)	119 (100.0)		
	Total	137 (52.1)	51 (19.4)	75 (28.5)	263 (100.0)		
No	Boy	6 (46.2)	7 (53.8)	0 (0.0)	13 (100.0)	6.684	**0.035**
	Girl	16 (66.7)	4 (16.7)	4 (16.7)	24 (100.0)		
	Total	22 (59.5)	11 (29.7)	4 (10.8)	37 (100.0)		
Artificial sweeteners, n (%)							
Yes	Boy	6 (27.3)	8 (36.4)	8 (36.4)	22 (100.0)	-*	0.083*
	Girl	5 (71.4)	0 (0.0)	2 (28.6)	7 (100.0)		
	Total	11 (37.9)	8 (27.6)	10 (34.5)	29 (100.0)		
No	Boy	74 (54.8)	25 (18.5)	36 (26.7)	135 (100.0)	0.638	0.727
	Girl	74 (54.4)	29 (21.3)	33 (24.3)	136 (100.0)		
	Total	148 (54.6)	54 (19.9)	69 (25.5)	271 (100.0)		
Meal replacement foods, varieties, n (%)							
Yes	Boy	41 (41.4)	26 (26.3)	32 (32.3)	99 (100.0)	0.276	0.871
	Girl	36 (43.4)	19 (22.9)	28 (33.7)	83 (100.0)		
	Total	77 (42.3)	45 (24.7)	60 (33.0)	182 (100.0)		
No	Boy	39 (67.2)	7 (12.1)	12 (20.7)	58 (100.0)	2.007	0.367
	Girl	43 (71.7)	10 (16.7)	7 (11.7)	60 (100.0)		
	Total	82 (69.5)	17 (14.4)	19 (16.1)	118 (100.0)		

**1-group (0 to ≤ 45); 2-group (> 45 to ≤ 60); 3-group (>60)
n – number of adolescents

Among the adolescents studied, 70.3% continue to consume soft drinks, with 30% engaging in this behavior between one and three times per day. Only 12% of the 300 children examined consume sugar-free soft drinks. Additionally, 26.3% of all adolescents studied incorporate energy drinks into their diets, with daily consumption noted in 20.7% of participants. **(Fig. 8)** A weak relationship is observed between daily consumption of energy drinks and diet quality among adolescents *(Cramer V=0.3; p=0.04)*.

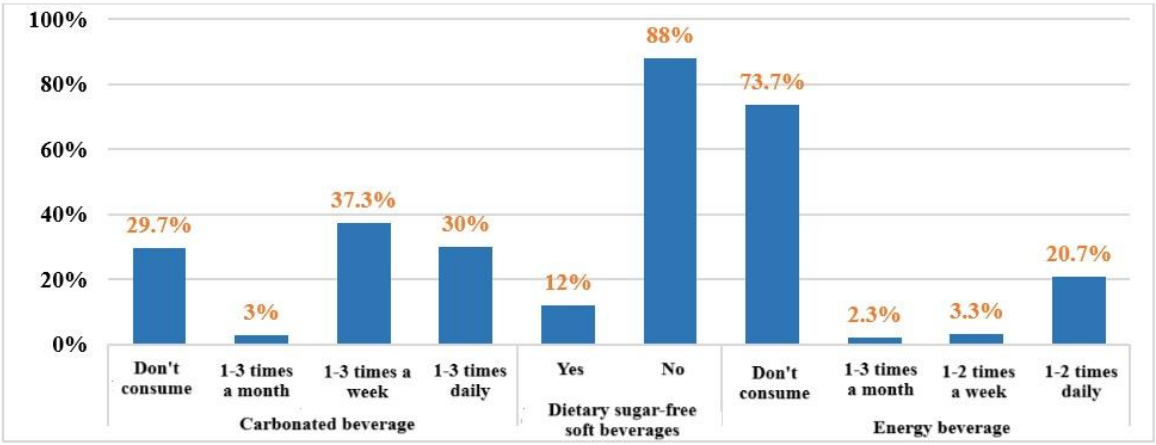


Figure 8. The distribution of carbonated beverage and energy beverage consumption among the surveyed adolescents.

Among all children surveyed, 9% reported consuming beer. Twelve percent of the adolescents indicated consumption of wine. Six percent of the surveyed adolescents reported consuming distilled spirits, while 3% indicated cocktail consumption. Additionally, site consumption was reported by 21% of the surveyed teenagers ($p < 0.05$). **(Fig. 9)**

Daily consumption of cider was reported by six adolescents, and fifty-eight individuals consumed it on a weekly basis. Eighteen children consumed distilled spirits on a monthly basis, whereas nine children reported engaging in the weekly consumption of cocktails.

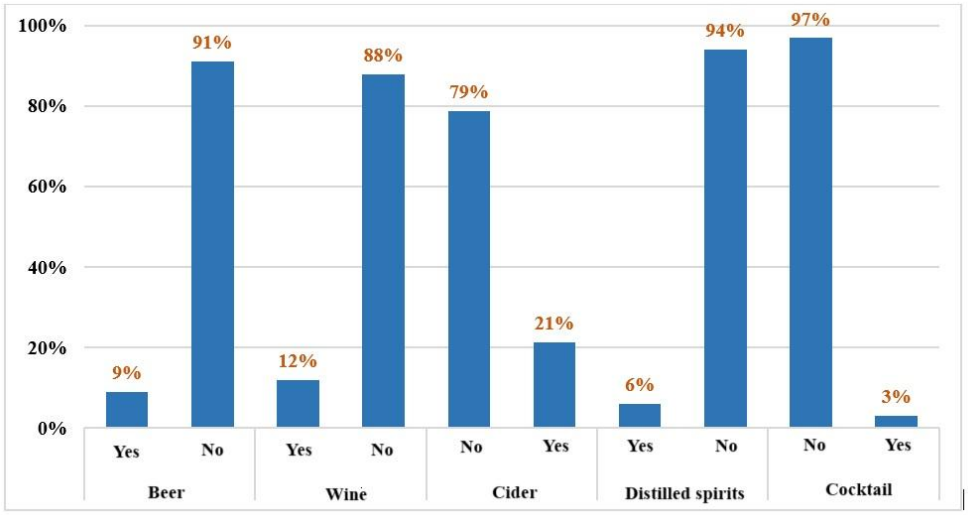
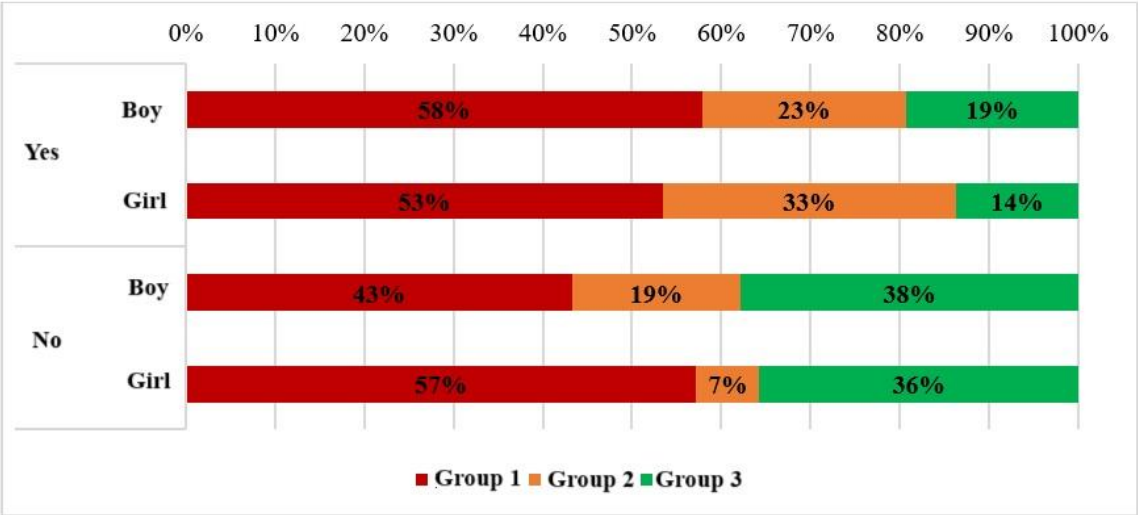


Figure 9. Number of adolescents consuming various types of alcoholic beverages.

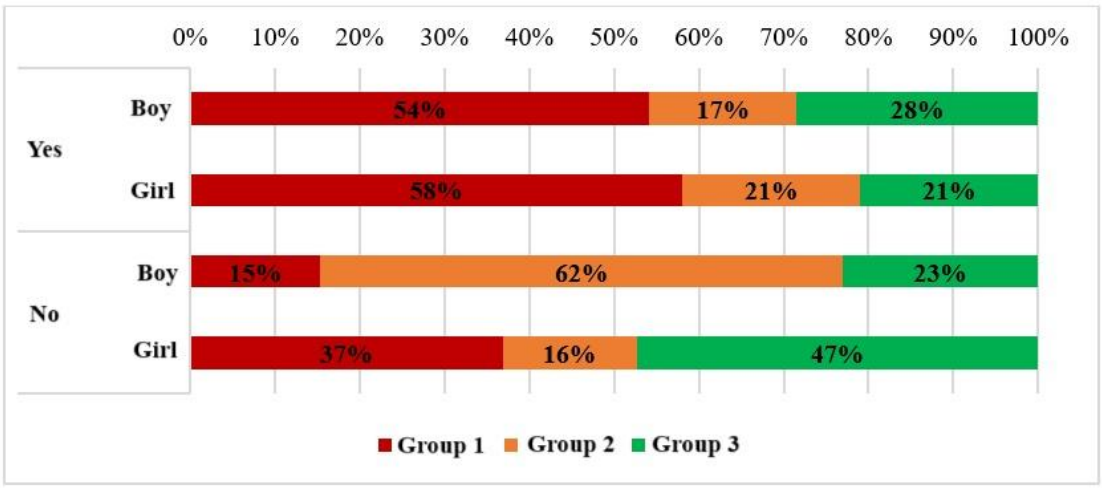
According to the survey, boys predominantly consume carbohydrate-based foods such as crackers, pretzels, popcorn, chips, snacks, saltines, cubes, and Doritos two to three times per week. Their daily consumption is highest among boys exhibiting average diet quality, followed by those with low diet quality. In contrast, girls demonstrate a higher frequency of daily consumption of these fast foods, particularly among those with a Diet Quality Index for Adolescents (DQI-A) ranging from 0 to ≤ 45, followed by girls with average diet quality. A statistically significant association is noted between the daily consumption of carbohydrate foods and overall diet quality in both sexes. Among the boys surveyed, 83 reported a preference for "fast foods." Of these respondents, 58% exhibited low diet quality, 23% demonstrated average diet quality, and 19% exhibited high diet quality. The remaining 74 boys did not consume this category of food, with 36% reporting high diet quality. Among the girls surveyed, 73 indicated that they consume fast food, with 53% possessing a low-quality diet, 33% maintaining a medium-quality diet, and 14% reporting a high-quality diet. The remaining 70 girls did not report any consumption of fast food, with 38% having a high-quality diet. **(Fig. 10)** A moderate strength of association was observed between fast food consumption and increased dietary intake in adolescent girls *(Cramer V = 0.4, $p < 0.001$)*, whereas the strength of association was deemed weak in boys *(Cramer V = 0.2, p=0.05)*.



**1-group (0 to ≤ 45); 2-group (> 45 to ≤ 60); 3-group (>60)

Figure 10. Distribution of girls and boys consuming "fast foods" based on varying diet quality.

A total of 268 adolescents from the study consumed foods that contained added sugar or honey. Among the male participants, 54% exhibited low dietary quality. In contrast, 62% of the boys who did not consume such foods demonstrated medium dietary quality, while 23% achieved high dietary quality. Regarding female participants, 58% incorporated foods with added sugar or honey into their diets. Of the 19 girls who did not consume these foods, 47% displayed high dietary quality. A moderate strength of association was observed between adolescents who did not consume foods containing added sugar or honey and the Diet Quality Index for Adolescents (DQI-A) groups *(Cramer V= 0.5; p=0.03)*. A significant proportion of girls with inadequate nutritional status frequently partake in sweet desserts, including cake, pie, éclairs, donuts, muffins, croissants, and gingerbread, on a daily basis ($p<0.05$) **(Fig. 11)** Among male participants, sweet pastries were most commonly consumed either 2-3 times per month or 2-3 times per week by children with low and medium dietary quality ($p < 0.05$). Daily consumption of banitsa was primarily observed among girls, while a significantly greater number of boys consumed it 2 to 3 times per week. In both genders, the highest percentage of participants was found in the groups with low dietary quality ($p < 0.05$).



**1-group (0 to ≤ 45); 2-group (> 45 to ≤ 60); 3-group (>60)

Figure 11. Distribution of girls and boys utilizing foods that contain added sugar or honey, categorized by varying dietary quality.

Out of the 300 children surveyed, 55% indicated that they consult food labels, whereas the remaining 45% do not. **(Fig. 12)** A weak correlation was observed between the calorie content presented on the food label and the overall quality of adolescents' diets *(Cramer V = 0.27, p < 0.004)*. Furthermore, a weak association was noted between the composition and content of the diet among adolescents *(Cramer V = 0.21, p = 0.04).*

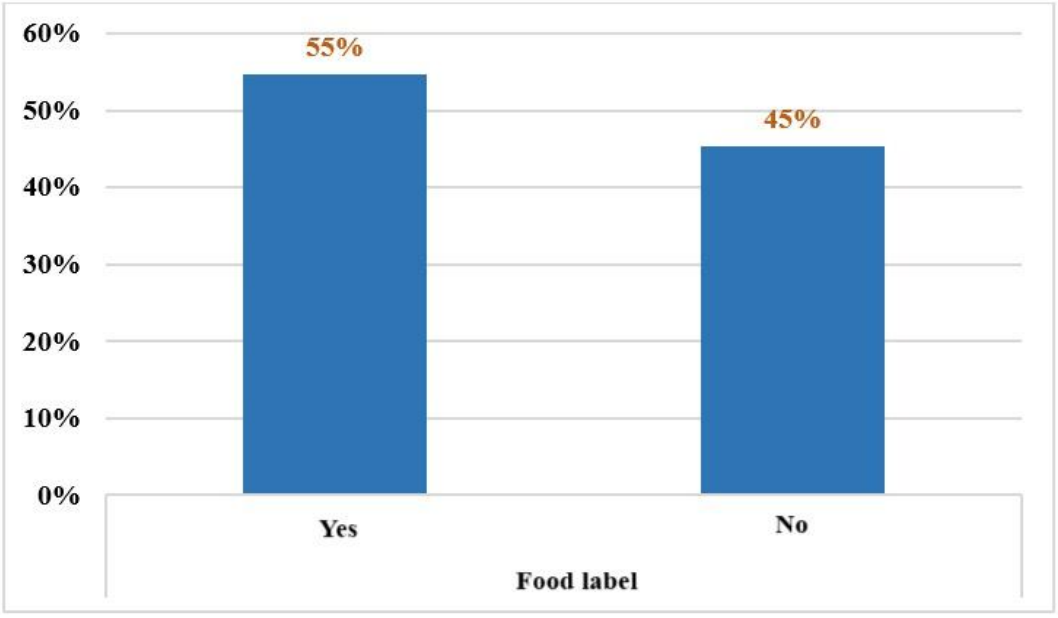


Figure 12. Distribution of children based on food labels, quantity

Discussion on Objective 1:

Anthropometric studies conducted during adolescence rely on the selection of specific indices for assessing normal growth within this age group and necessitate the accurate interpretation of the results obtained. To ascertain the nutritional status of a given patient, it is imperative to employ tables that utilize the World Health Organization (WHO) height and weight standards for adolescents, as distinct WHO standards are established for both sexes during this developmental stage due to the unique period of growth and maturation involved.

The present study corroborates that the most appropriate indices for determining nutritional status in adolescence are the Height-for-Age Z-score (HAZ) in conjunction with the Body Mass Index Z-score (BMI Z-score), thereby enabling a distinction between height and body mass during this developmental phase. When calculating the BMI Z-score, it is essential to consider age, gender, BMI of the subjects under study, and an appropriate reference standard. From the results acquired, it is evident that a predominant issue among adolescents pertains to body weight. In relation to height, a significant percentage of adolescents exhibit normal growth patterns. More than two-thirds of the adolescents examined present with an impaired nutritional status characterized as overweight, thereby categorizing them within the "at risk of obesity" group.

The quality of the diet substantially affects the developmental outcomes of children and their nutritional status. A statistically significant difference was identified in the average value of the Diet Quality Index for Adolescents (DQI-A) among the 300 adolescents assessed, with girls exhibiting lower average values than their male counterparts. The majority of the children surveyed were found to have a diet of low quality. Age plays a pivotal role in the efficacy of the dietary choices made by the adolescents under study, with dietary quality tending to improve progressively as age increases.

The level of physical activity directly correlates with the quality of the diet and hydration practices. Higher intensity levels of physical activity are associated with superior dietary quality. Notably, only 37 out of the 300 respondents reported engaging in the harmful habit of smoking, while 68 reported coffee consumption, with a higher prevalence among females compared to males. The overall stress levels of the subjects analyzed are influenced by inadequate sleep duration on weekdays, increased coffee consumption, and prolonged screen time among the adolescents assessed. A significant percentage of children are observed spending more than two hours on screens while eating, which further contributes to the inferior quality of their diet.

The subpar quality of the diet in adolescents is contingent upon several factors, including frequency (regular versus irregular), consistency (pureed, mashed, or fried), and type (store-bought food) of the primary meals, instances of overeating, the quantity, type, and quality of snacks consumed, motivations for eating, as well as the dining environment. Adolescents exhibiting high dietary quality are typically characterized by the consumption of home-cooked meals, preferences for raw foods, nuts and seeds, a greater proportion of dairy products, white meat, the use of artificial sweeteners (sugar substitutes), meal replacement items (such as protein bars, protein powders, smoothies, shakes), use of dietary supplements, and an interest in the ingredients and caloric content of food labels.

Conversely, the consumption of sugary candies, sweet desserts, foods containing added sugars or honey, fast foods, salty carbohydrate-rich foods, as well as sweetened beverages such as iced tea and fruit juice, correlates with a lower quality diet among adolescents. Additionally, the dietary indicators among the studied female adolescents are markedly poorer when compared to their male counterparts.

Results and Discussion on Objective 2

To appropriately allocate the children examined in the first task, where a violation of nutritional status was identified, we conducted a controlled randomization. Consequently, we established two groups: experimental and control. Each group comprises 105 children exhibiting impaired nutritional status. Sixteen children with mild malnutrition and one child classified as overweight withdrew from the study due to their failure to attend the dental office for a check-up.

Following the randomization process, 210 children categorized as overweight or obese based on their BMIZ-score from the initial task were assigned to the two groups: experimental and control. The experimental group consisted of 102 children classified as overweight and three classified as obese. The control group comprised 101 children categorized as overweight and four categorized as obese **(Tab. 14)**.

Table 14. Distribution of the examined children by Body Mass Index Z-score in the experimental and control groups during the primary examination.

BMIZ-score group	Number of children in the research groups	
	Experimental group	*Control group*
Overweight	102	101

Obesity	3	4

BMIZ-score= BMI-for-age

The experimental group included 53 boys and 52 girls, while the control group included 52 boys and 53 girls. **(Tab. 15)**

Table 15. Distribution of adolescents by gender in the study groups at primary examination.

Gender	*Experimental group*	*Control group*
Boy	53	52
Girl	52	53

There were one hundred five children in both the experimental and control groups. In the experimental group, the median age was thirteen (11;15), and the median Diet Quality Index - Adolescents (DQI-A) score was 34% (25%-45%). In the control group, the median age was thirteen (11;14), and the median DQI-A score was 35% (27%-47%). **(Tab. 16)**

Table 16. Distribution by age and quality of diet in the study groups of adolescents at the primary examination.

	Group*	N	Median	Q1	Q3	Minimum	Maximum
Age	1	105	13	11	15	11	17
	2	105	13	11	14	11	17
DQI-A score, %	1	105	34	25	45	14	91
	2	105	35	27	47	14	91

***Group 1=Experimental group; Group 2=Control group**
DQI-A score=Diet Quality Index for Adolescents

In the experimental group during the initial examination, the median value of the DMFT index was recorded at 5 (3-7), whereas in the control group, it was 6 (3;9) (p=0.02). Within the experimental group, the median for D e 2 was 2 (2;4), for M it was 0, and for F e 2, it was 0 (0;3). In the second group, the median for D was 4 (2;6), for M it was 0, and for F it was 1 (0;3). A statistically significant difference was observed between the two studied groups concerning D ($p < 0.001$), while no statistically significant differences were found regarding M (p=0.48) and F

(p=0.16). The median of the DMFS in the experimental group was determined to be 6 (3;9), in contrast to 8 (4;11) in the control group (p=0.12). On examination, the most frequently observed type of caries was the occlusal caries, succeeded by approximal caries and those occurring on smooth surfaces (vestibular, lingual). The median of the SiC index was 8 (7;9) for the first group and 9 (9;13) for the second group (p=0.001). Within the experimental group, the median for A was 2 (2;4) and for R was 0, while in the control group, the median for A was 4 (2;6) (p <0.001) and for R it remained 0 (p=0.19). In terms of the depth of the carious process, the ICDAS (1-5) displayed a mean value of 0 for both the control and experimental groups; however, a statistically significant difference was noted between the groups according to ICDAS 1, 3, 4, and 5 (p <0.05). For ICDAS 6, the median was 1 (0;2) in the first group and 0 (0;2) in the second group. No statistically significant difference was observed between the groups for ICDAS 2 and 6 (p >0.05). Concerning the depth of the carious process assessed by spectroscopy, CSP (1-5) displayed a mean value of 0 in both groups. For CSP 6, the median was 1 (0;2) in the experimental group and 0 (0;2) in the control group (p=0.1). As a result, a statistically significant difference was once again observed between both groups for CSP 1, 3, 4, 5 (p <0.05), while no such difference was established for CSP 2 and 6 (p >0.05). The median of the PUFA index was 1 (0;2) in the first group and 0 (0;2) in the second group (p=0.01). The median prevalence of complications arising from the carious process stood at 33% (0%;50%) in the experimental group compared to 0% (0%;21%) in the control group, with 33% of the children in the experimental group experiencing complications related to caries (p <0.001). In the experimental group, the median of DI-S was 1.5 (1;1.8) (p=0.35), CI-S was 0.5 (0;0.8) (p=0.5), and OHI-S was 2 (1.16;23) (p=0.5). In the control group, the median for DI-S was 1.5 (1;2) (p=0.35), for CI-S it was 0.5 (0.3;0.9) (p=0.5), and for OHI-S it was 1.8 (1.2;2.3) (p=0.5). Regarding PCR in group 1, the median was recorded at 95% (80%;100%), while in group 2, it was 98% (90%;100%). The median of PFS was 5% (0%;20%) for the experimental group and 0% (0%;10%) for the control group. In relation to the median of PBI, it is 0.63 (0.25;1.13) for group 1 and 0.6 (0.42;1) for group 2 (p=0.8). The median of GI is 0.7 (0.4;1.29) for the experimental group and 0.58 (0.4;1.4) for the control group (p=0.9). In conducting a primary examination of the research groups comprising children, their caries risk was assessed. In the experimental group, 93 children were identified as being at high risk for caries, 2 at medium risk, and 10 at low risk. In the control group, 96 children were classified as at high risk for caries, 3 at medium risk, and 6 at low risk of caries (p=0.64). **(Tab. 17)**

Table 17. Distribution of study groups among children based on the evaluation of caries risk during the initial examination.

Group	Caries risk assessment*, number			p
	1	2	3	
Experimental group	93	2	10	0.64
Control group	96	3	6	

***Caries risk assessment: 1-high risk; 2-medium risk; 3-low risk**

A follow-up examination is conducted six months subsequent to the initial visit to the dental office and the establishment of a preventive program (emphasizing nutrition in the experimental group). The allocation of adolescents in the experimental and control groups based on BMIZ-score differs from the predetermined classification. In the experimental group, there are 51 children classified as having normal body weight and 54 identified as overweight. Conversely, in the control group, 26 children present with normal body weight, 78 are classified as overweight, and one child is categorized as obese. **(Tab. 18)**

Table 18. Distribution of the children evaluated by BMIZ score in both the experimental and control groups during the follow-up examination.

BMIZ-score group	Number of children in the research groups		p*
	Experimental group	*Control group*	
Normal body weight	51	26	**< 0.001**
Overweight	54	78	
Obesity	0	1	

BMIZ-score= BMI-for-age
*** Fisher's exact test**

Following a subsequent examination of the children involved in the study, the median Diet Quality Index for Adolescents (DQI-A) score in the experimental group was 48% (34%; 82%), whereas in the control group it was 35% (14%; 91%) **(Tab. 19).** A notable positive change in the DQI-A was noted in the experimental group during the follow-up examination, reflecting an increase of 22% ($p < 0.001$). Conversely, no significant change in the index was detected within the

control group (p > 0.05). This analysis indicates an improvement in dietary quality.

Table 19. Distribution of Diet Quality among the study groups of adolescents during the follow-up examination.

	Group*	N	Median	Q1	Q3	Minimum	Maximum	p
DQI-A score, %	1	105	48	47	58	34	82	**<0.001**
	2	105	35	26	46	14	91	

***Group 1=Experimental group; Group 2=Control group**
DQI-A score=Diet Quality Index for Adolescents

In the experimental group during the control examination, the median of the DMFT index was recorded at 6 (3;7), while in the control group, it was observed at -8 (6;11) (p <0.001). For group 1, the median of D was 1 (0;2), and in group 2, the median of D was 5 (3;7) (p <0.001). The median of M for both groups was 0 (p=0.98), and the median of F for the first group was 4 (2;6), whereas for the second group, it was 3 (0;5) (p=0.003). The median of DMFS in the experimental group was 7 (4;10), while that in the control group was 11 (9;15) (p <0.001). The median of the SiC index was 9 (7;9) for the first group and 12 (11;15) for the second group (p <0.001). Within the experimental group, the mean value of active carious lesions was 1 (0;2), and for reversible lesions, it was 0 (0;1). Conversely, in the control group, the median of active lesions was 5 (3;7) (p < 0.001), and for reversible lesions, it was 2 (0;2) (p < 0.001). Regarding ICDAS 1, its median was 0 in both the control and experimental groups. The median of ICDAS 2 was 0 for group 1 and 0 (0;2) (p < 0.001) for group 2. The median of ICDAS 3 was again 0 for both study groups, and the median of ICDAS 4 was 0 for the experimental group and 0 (0;1) for the control group (p < 0.001). For ICDAS 5, the median was 0 for group 1 and 1 (0;2) for group 2 (p < 0.001). In ICDAS 6, the median was 0 in the first group and 1 (0;3) in the second group (p <0.001). Regarding CSP 1, its median was 0 in both groups. The median of CSP 2 was 0 for the experimental group and 0 (0;2) for the control group (p <0.001). The median of CSP 3 was 0 in both study groups, while the median of CSP 4 was 0 for group 1 and 0 (0;1) for group 2 (p=0.004). Concerning the median of CSP 5, it was 0 for the experimental group and 1 (0;2) for the control group (p <0.001). In CSP 6, the median was 0 in

the experimental group and 2 (0;3) in the control group (p <0.001). The median of the PUFA index was 0 in the first group and 2 (0;3) in the second group (p <0.001). The median prevalence of carious complications was 0% in the experimental group and 25% (0%;40%) in the control group.

At the control examination, the median of DI-S in the experimental group was 1 (1;1.3), while in the control group, DI-S was recorded at 2 (1.5;2.4) (p < 0.001). In group 1, the median of CI-S was 0 (0;0.5), whereas in group 2, CI-S was 1 (0.5;1.5) (p < 0.001). The median of OHI-S was 1.2 (1;1.5) for the experimental group, and OHI-S reached 3 (2.16;3.7) for the control group (p <0.001). Regarding the median of PCR in group 1, it was determined to be 75% (65%;85%), while in group 2, it was found to be 100% (p <0.001). The median PFS was 25% (20%;35%) for the experimental group and 0% for the control group (p <0.001). In terms of the median PBI, it was recorded as 0.4 (0.2;0.7) for group 1 and 2 (0.8;3) for group 2 (p <0.001). The median GI was 0.5 (0.2;0.8) for the experimental group and 1.6 (1;2.2) for the control group (p <0.001).

A very strong to functional correlation was observed between the criteria for caries severity according to the ICDAS system and spectroscopy with the CarieScan Pro device. These relationships were statistically significant, revealing a very strong correlation between ICDAS 1 and CSP 1 (ρ(rho) = 0.96, p < 0.001), ICDAS 4 and CSP 4 (ρ(rho) = 0.85, p < 0.001), ICDAS 5 and CSP 5 (ρ(rho) = 0.94, p < 0.001), as well as between ICDAS 6 and CSP 6 (ρ(rho) = 0.9, p < 0.001). A functional correlation was also evidenced between ICDAS 2 and CSP 2, in addition to the correlation between ICDAS 3 and CSP 3 (ρ(rho) = 1, p < 0.001). **(Tab. 20)**

Table 20. Correlation between ICDAS (1-6) and CarieScan Pro (1-6)

	ρ	p
ICDAS 1 – CSP 1	0.96	**<0.001**
ICDAS 2 – CSP 2	1	**<0.001**
ICDAS 3 – CSP 3	1	**<0.001**
ICDAS 4 – CSP 4	0.85	**<0.001**
ICDAS 5 – CSP 5	0.94	**<0.001**

ICDAS 6 – CSP 6	0.9	**<0.001**

ICDAS=International Caries Detection and Assessment System
CSP=CarieScan Pro

Subsequently, a follow-up examination of the research groups comprising children is conducted, which evaluates their risk of caries. Within the experimental group, 55 children are identified as being at high risk of caries, 3 at medium risk, and 47 at low risk ($p < 0.001$). In contrast, within the control group, 100 of the children are categorized as being at high risk of caries, while only 5 are classified as being at low risk ($p < 0.001$). **(Tab. 21)** In the experimental group, 59.1% of the children who were identified as high risk of caries during the initial examination continued to be categorized as high risk at the follow-up examination. The remaining 40.9% of adolescents at high risk experienced a transition, with 37.7% moving to low risk and 3.2% to medium risk of caries during the controlled examination. Adolescents classified as medium risk of caries at the primary examination transitioned to low risk during the controlled examination. All children categorized as low caries risk during the initial examination remained in the same risk group at the follow-up examination ($\chi^2=40.6$, $df=2$, $p < 0.001$). In the control group, 96.9% of adolescents who were classified as high caries risk during the first visit did not experience any alteration in their risk assessment. The remaining 3.1% transitioned to low caries risk. Among the children classified as medium caries risk, 66.7% transitioned to high risk, while 33.3% transitioned to low risk during the follow-up examination. Of the adolescents categorized as low caries risk during the initial examination, 83.3% transitioned to high caries risk, while 16.7% remained at low caries risk ($p < 0.001$). **(Tab. 21)**

Table 21. Distribution of the groups of children under study based on the assessment of caries risk during a follow-up examination.

Group	Caries risk assessment*, number			p
	1	**2**	**3**	
Experimental group	55	3	47	**< 0.001**
Control group	100	0	5	

***Caries risk assessment: 1-high risk; 2-medium risk; 3-low risk**

Negative dynamics regarding the DMFT index were observed in the control group of children (Me = -2 (-3 – -2), p <0.001), as well as in the SiC index (Me = -3 (-3 – -2), p <0.001); conversely, no changes were noted in the experimental group for these indices. Concerning the DMFS index, negative dynamics were present in the control group (Me = -4 (-6 – -2), p <0.001), whereas the experimental group exhibited no change. Additionally, negative dynamics of the activity of the carious process were also recorded in the control group (Me = -2 (-3 – 1), p <0.001), with positive dynamics in the experimental group (Me = 2 (0 – 2), p <0.001). As for the dynamics of reversibility of the carious process, no changes were observed in either study group. The dynamics of ICDAS (1-5) remained unchanged in both the experimental and control groups. However, for ICDAS 6, negative dynamics were noted in the control group of children (Me = -1 (-2 – 0), p <0.001), while the experimental group showed positive dynamics (Me = 1 (0 – 2), p <0.001). With respect to the dynamics of CSP (1-5), no changes were evident in both study groups. Negative dynamics of CSP 6 were observed in the control group (Me = -1 (-2 – 0), p <0.001), in contrast to the positive dynamics demonstrated in the experimental group (Me = 1 (0 – 2), p <0.001). In relation to the PUFA index, negative dynamics were noted in the control group (Me = -1 (-2 – 0), p <0.001), while the experimental group reflected positive dynamics (Me = 1 (0 – 2), p <0.001). Negative dynamics of OHI-S were observed in the control group (Me = -1.1 (-1.54 – -0.5), p <0.001), whereas positive dynamics of the same index were recorded in the experimental group (Me = 0.7 (0.1 – 1.1), p <0.001). No changes in the dynamics of PCR % were observed in the control group, while the experimental group exhibited positive dynamics in this index (Me = 20 (0 – 28), p <0.001). In accordance with these findings, negative dynamics of PFS % were identified in the experimental group (Me = -20 (-28 – 0), p <0.001), with no change registered in the control group. Pertaining to PBI, negative dynamics were documented in the control group (Me = -0.95 (-1.75 – -0.14), p <0.001), while the experimental group displayed positive dynamics of the index (Me = 0.26 (0.1 – 0.5), p <0.001). Negative dynamics of GI were reported in the control group (Me = -0.8 (-1.35 – -0.16), p <0.001), contrasted by positive dynamics of the index in the experimental group (Me = 0.3 (0.15 – 0.5), p <0.001).

Discussion on Objective 2:

It has been observed that all children diagnosed with impaired nutritional status, specifically those classified as overweight or obese, are adversely affected by the

carious process, evidenced by the presence of carious lesions, restorations, or complications related to caries. Elevated values of the Decayed, Missing, and Filled Teeth (DMFT), Decayed, Missing, and Filled Surfaces (DMFS), Significant Caries (SiC) index, International Caries Detection and Assessment System (ICDAS), Caries Scan Pro (CSP), and the Prevalence and severity of oral conditions resulting from untreated dental caries (PUFA) were recorded in a cohort of 210 children, who were divided into two groups: experimental and control.

In all children exhibiting nutritional impairment, categorized as overweight or obese, an increase in plaque accumulation and variations in gingival health were noted, based on the assessments employing the Simplified Debris Index (DI-S), Simplified Calculus Index (CI-S), Oral Hygiene Index (OHI-S), Plaque Control Record (PCR), Plaque Free Score (PFS), Papillary Bleeding Index (PBI), and Gingival Index (GI).

Enhancements in dietary quality correspondingly contribute to improvements in the health status of the adolescents involved in this research as well as their oral health. A mere 22% increase in the Diet Quality Index for Adolescents (DQI-A) precipitates significant alterations in the indices used to assess oral health among adolescents, wherein dietary factors exert a profound influence on the progression of carious lesions, the emergence of dentinal caries, and the complications associated with caries, as well as the accumulation of plaque and the condition of gingival tissue, thereby refining the oral health risk profile of the patient.

A robust correlation, ranging from very strong to functional, was established between the minimum criteria for assessing the severity of the carious process according to the ICDAS system and results obtained through spectroscopy utilizing the CarieScan Pro device.

Results and discussion on Objective 3

The intake of essential nutrients, vitamins and minerals, as well as the way in which food is added and prepared, is of great importance for oral health, maintenance of oral homeostasis and oral immunity. As a result of a detailed analysis of the studied literature and the results obtained by us on previous tasks, tested basic proposals for balanced nutrition in relation to oral health in adolescents have been prepared.

1. Nutrition in adolescence should be tailored to the necessary energy needs of the body.

2. It is necessary to consume whole foods to increase chewing and salivation, with the possibility of avoiding refined, culinary processed foods or also known as "industrial foods", packaged foods.

3. To emphasize the quality of food consumed during intermediate storage, the way of eating, the number and practice of intermediate meals.

4. To improve the quality of the diet, it is advisable to replace high-energy snacks with low-energy alternatives.

5. If possible, emphasize the quality of the food consumed (animal meat and products from pastured animals, naturally grown fruits and vegetables).

6. Seek and obtain additional information on the prebiotic and probiotic properties and importance of foods.

7. Fresh, seasonal, local, organic vegetables/fruits, legumes (rich in fiber and protein, such as: beans, chickpeas, lentils, peas) and seeds, whenever possible (at every meal). To make the nutrients more easily digestible and as easily absorbed as possible, legumes should be soaked before cooking.

8. Daily consumption of fruits and vegetables, with a predominance of vegetables. Vegetables should be consumed at least two servings per day. Fruits up to two servings per day. Vegetables and fruits should be half of the portion for one meal.

9. Grains and fiber – barley, brown/black rice, buckwheat, oatmeal, millet, quinoa or other grains to be consumed daily – 1-2 servings, preferably with whole grains.

10. Meat – 2-3 times a week and fish 2-3 times a week – white meats are preferred. It is recommended to limit red meat to 1-2 servings a week.

11. Dairy and dairy products – consumption twice a day, paying attention to the fat content of the products used.

12. Eggs – 2 to 4 times a week.

13. Fats, oils, nuts – each meal should contain three main components – proteins, carbohydrates and fats. It is mandatory that they are natural, unprocessed or refined fats, with a higher content of polyunsaturated fatty acids. It is preferable to use rapeseed, soybean, corn, safflower oil or other unsaturated oils instead of solid fats during food preparation.

14. Daily intake of raw nuts (almonds, walnuts, pecans, pine nuts, cashews, hazelnuts), seeds (pumpkin, sunflower, sesame, chia, flaxseed) up to twice a day and spices (avoid/limit refined ready-made salt).

15. Inclusion in the menu of chilled, unpasteurized and sugar-free fermented foods (apple cider vinegar, kefir, sauerkraut, types of cheese).

16. Limit the addition of "modern", refined foods (maximum 1 meal per day, no more than 3 times a week), fast food, sugar (including honey, agave syrup, brown sugar, coconut sugar, molasses, maple syrup).

17. Avoid fruit juices (100% fruit juice up to 230 ml per day), consume whole fruits, use the amount of added fruit in smoothies. It is advisable to limit fruits with a higher fructose content and a high glycemic index (grapes, cherries, pineapple, watermelon, prunes) and dried fruits.

18. Avoid drinks that are sources of added sugar, including flavored milks (e.g. chocolate, strawberries) or containing low-calorie sweeteners, carbonated drinks, caffeinated, sports and energy drinks.

19. Alcohol consumption is not recommended in adolescence. Alcohol consumption is only an exception (holidays), rare, under parental supervision, without the use of hard alcohol.

20. Do not use nicotine products.

21. Limit the consumption of high-calorie sauces such as Alfredo, cream sauces, cheese sauces and hollandaise.

22. It is advisable to eat regularly and to limit unhealthy eating patterns, such as dining out, consuming food from food kiosks, eating in the car, or while relaxing on the couch at home, among other scenarios.

23. Dining out should be restricted to no more than one meal per day (including restaurants, eateries, street food, or food delivery services), with a focus on home-cooked meals.

24. Regular family dinners are encouraged to foster social interaction and to establish a dining model that adolescents can emulate.

25. It is prudent to avoid the consumption of carbohydrate-rich foods and beverages while engaging in activities in front of a television, smartphone, laptop, or tablet, as this may lead to the inadvertent consumption of substantial amounts of "empty" calories.

26. One should limit a sedentary lifestyle, with a maximum recommendation of 1-2 hours of screen time per day.

27. Regular physical activity of moderate intensity (personal engagement in sports) several times a week is advised, complemented by adequate rest (sleep) lasting 24 hours and proper weight management.

28. Water intake should be tailored to individual needs based on gender, age, physical activity, and other variables, such as personal preferences; a daily intake of 1.5 to 2 liters of water is recommended.

29. Blood levels of vitamins D, B9, and B12 should be assessed. If deemed necessary and following a consultation with a physician, supplementation with vitamin D, vitamin B9, vitamin B12, and vitamin C may be indicated.

Informative and motivational materials have been produced for patients and their parents regarding the impact of nutrition on overall health during adolescence, similar to the My Plate program recognized in literature and society.

V. IMPLICATIONS

1. The present study revealed that over two-thirds of the surveyed adolescents are classified as overweight and belong to the category at “risk of obesity.” When considering the correlation between height and body mass in this age group, it becomes evident that the predominant issue among adolescents is their body weight.

2. It has been established that the majority of the surveyed adolescents exhibit low dietary quality, as evidenced by their Diet Quality Index for Adolescents (DQI-A) scores.

3. The study indicates that both age and gender significantly influence nutritional quality; furthermore, enhancements in nutrition within a country contribute positively to the nutritional status of the individuals studied. Notably, girls demonstrate poorer nutritional indicators compared to their male counterparts in the study.

4. The prevalence of low nutritional quality is attributed to increased overall stress levels, prolonged screen time, inadequate physical activity, minimal water intake, overeating, a preference for high-calorie snacks, daily consumption of sugary foods, products containing added sugars or honey, “fast foods,” iced tea, sweetened tea, natural and fruit juices, soft drinks, energy drinks, and detrimental habits such as smoking, alcohol consumption, and excessive coffee intake.

5. Among adolescents exhibiting high nutritional quality, there is a notable preference for home-cooked meals, a higher intake of raw foods, seeds, and nuts, as well as increased consumption of dairy products and white meat. Additionally, there is a tendency to utilize artificial sweeteners (sugar substitutes), dietary supplements, and to be cognizant of the composition, nutritional content, and caloric value of food labels.

6. Following a six-month follow-up period, the statistical analysis of the collected data indicated a decline in oral health indices within the control group, while the experimental group exhibited positive changes in oral health indices or maintained stability in some areas after an improvement in DQI-A by 22%.

7. Enhancing the quality of nutrition predominantly yields a positive impact on the reduction of carious lesions, curtailing the progression of dentinal caries and related complications, diminishing plaque accumulation, improving gingival health, and enhancing the oral risk profile of adolescents.

VI. CONCLUSION

Among the 300 adolescents analyzed, 157 were male (52.3%) and 143 were female (47.7%), aged between 11 and 17 years, with a median age of 13 years. A total of 196 adolescents exhibited normal height growth (HAZ score = 0.703 ± 0.959). The calculated mean value for the Body Mass Index Z-score (BMIZ) was 0.818 (SD = 0.809), with 68% of the adolescents classified as overweight. In general, the male adolescents were taller than their female counterparts at this age, while the body weight of two-thirds of the adolescents of both sexes surpassed normal levels for their age group. Of the 300 adolescents evaluated, 230 exhibited nutritional disorders, of which 204 were overweight, 7 were obese, and 19 were mildly undernourished. A total of 159 adolescents presented with low diet quality (DQI-A score = 0 to ≤ 45), wherein 148 were overweight, 5 were obese, and 6 maintained normal weight. Sixty-two children were identified with average diet quality (DQI-A score > 45 to ≤ 60), comprising 45 overweight children, 2 obese children, 14 children with normal weight, and 1 mildly undernourished child. Only 11 overweight adolescents demonstrated high diet quality (DQI-A score > 60), along with 50 who were of normal weight and 18 who were mildly undernourished. The nutritional status of adolescents is influenced by the quality of their diet, which is contingent upon the sex and age of the studied individuals. As patients age, there is a corresponding improvement in dietary quality. The 143 females assessed had a low diet quality (DQI-A = 34%), which was lower than that of the 157 males evaluated (DQI-A = 37%).

Among the 159 adolescents with low diet quality, it was found that the majority displayed moderate to low levels of physical activity, and daily consumption of drinking water and sports drinks (up to 1 liter per day) was correlated with the observed results concerning physical activity levels. Among a total of 20 girls with harmful smoking habits, 55% exhibited low diet quality. The consumption of coffee and frequency of meals were notably higher among adolescents with low diet quality. Screen time and eating while in front of screens emerged as significant issues for adolescents with low diet quality, as they logged considerable hours in front of televisions, computers, or mobile devices. Factors contributing to low diet quality include reliance on fast food, enjoyment of eating, emotional eating, lack of preferences for healthy foods, and poor snack choices. Low diet quality was associated with dining out (consuming fast food on the go or from kiosks), eating while in front of a screen, and eating on couches, beds, or in cars. A strong preference for fried foods, mashed/pureed foods, and baked goods characterized this group. The dietary quality within this subgroup

significantly influenced their consumption of various candies and sweet desserts, the decreased use of sweeteners, and the intake of substitute foods and those with added sugar or honey. The most prevalent choices included daily consumption of iced tea, sweetened tea, natural fruit juice, and energy drinks. The greatest number of adolescents with low diet quality consumed fast food, while girls frequently added salty carbohydrate-rich foods to their diets. Fewer than one-third of adolescents showed interest in the composition, content, and caloric value indicated on food labels. All observed dietary characteristics of adolescents with low diet quality correlated with a heightened risk of dental caries, as evidenced by higher indices assessing the prevalence of carious lesions (DMFT = 8; SiC index = 15), their activity (A = 25), and severity (dentinal caries; ICDAS 5 = 8), along with existing complications from caries (asymptomatic closed pulpitis; PUFA = 1), poor oral hygiene, and increased plaque accumulation (OHI-S = 4; PFS = 0%), as well as moderate gingival inflammation (PBI = 1.5; GI = 1.3).

In a study involving 63 adolescents with average diet quality, it was observed that a substantial proportion engaged in moderate, moderate to high, or high- intensity physical activity, with reported water consumption extending up to 1 liter, thus constituting the largest subgroup within the sample. Notably, 41. 2% of boys within this demographic were reported to smoke cigarettes. Furthermore, a significant relative proportion of 66.7. 7% of boys demonstrated coffee consumption. The lowest percentage of adolescents in this study exhibited screen dependency amidst the average diet quality population. Additionally, overeating during lunch was reported by 42.4. 4% of boys categorized under average diet quality. Adolescents with average diet quality indicated poorer indicators concerning eating styles and dining locations when juxtaposed with their counterparts possessing high diet quality, while presenting better metrics compared to adolescents in the low diet quality group. The registered consumption of sweets and foods with added sugar or honey was found to be the least among the three groups, with a notable frequency of sweet desserts observed in comparison to children in the third group based on the Diet Quality Index-Adolescents (DQI- A). Adolescents identified with average diet quality also utilized sweeteners and various food items, such as meal replacements. Weekly juice intake was observed in 50% of adolescents maintaining average diet quality, with a high percentage reporting daily consumption of soft drinks, whereas energy drinks were nearly unused within this group. The consumption of fast food was lower than that of adolescents classified within the low diet quality spectrum. Salty carbohydrate foods were consumed weekly by the majority of boys in this

group. Furthermore, up to half of the adolescents expressed an interest in the composition, content, and caloric value presented on the labels of processed foods. These nutritional characteristics prevalent among young individuals with average diet quality contribute to their elevated risk for dental caries, underscored by high indices for assessing the prevalence of carious lesions (DMFT = 6; SiC index = 9), activity (A = 12), and severity (dentin caries; ICDAS 5 = 5), as well as existing carious complications (asymptomatic closed pulpitis; PUFA = 1), poor oral hygiene indicated by increased plaque accumulation (OHI- S = 2; PFS = 20%), and mild gingival inflammation (PBI = 1; GI = 0. 7).

In a study involving 79 adolescents exhibiting high nutritional quality, the predominant percentage of participants engaged in moderate to high intensity physical activity, with this cohort frequently consuming between 1 to 2 liters of water. It was determined that this group exhibited the highest intake of sports drinks. Among a total of 17 males with a detrimental smoking habit, 47.1. 1% demonstrated high nutritional quality. The findings reveal that 38% of the boys and 22% of the girls with high nutritional quality did not adhere to a regular daily eating pattern. The favored dining setting for adolescents with high nutritional quality was at a table, whether at home or in a restaurant. Participants from this demographic are characterized by the consumption of home- cooked meals and a preference for raw or cooked foods. In contrast to adolescents in groups 1 and 2, those with high nutritional quality consume fewer candies and sweet desserts; however, males tend to consume more foods with added sugar or honey. These adolescents also utilize sweeteners, or sugar substitutes, in their diets. Weekly juice consumption was reported among 17 (43. 6%) of the boys with high nutritional quality, while daily intake was notably lower for iced tea, sweetened tea, natural fruit juices, fresh non- alcoholic beverages, as well as weekly consumption of energy drinks. The prevalence of consumption regarding “fast food” and salty carbohydrate- laden foods among these adolescents is minimal. More than half of the adolescents express interest in the composition, content, and caloric value of food labels presented to them. The distinctive characteristics of the nutrition among adolescents of high nutritional quality result in the classification of these children within medium and low caries risk categories, and less frequently in the high caries risk group. Lower values were observed in the indices assessing the prevalence of carious lesions (DMFT = 4; SiC index = 7), activity (A = 5), and severity (dentin caries; ICDAS 5 = 2), as well as for loss of carious complications (asymptomatic closed pulpitis; PUFA = 0), indicating good

oral hygiene and minimal plaque accumulation (OHI- S = 1. 2; PFS = 50%), alongside mild gingival inflammation (PBI = 0. 6; GI = 0. 5).

VII. CONTRIBUTIONS

Original Contributions:

1. For the first time in our country, the DQI-A score has been utilized to assess the effectiveness of dietary habits, establishing a relationship with anthropometric indicators in adolescents aged 11-17 years.

2. It has been demonstrated that the variation in the DQI-A score is influenced by the gender and age of the adolescents studied, their dietary patterns, frequency of meals, types, quantities, and quality of food consumed during primary and secondary meals, risk factors, personal preferences, and eating habits.

3. It has been established that adolescents who monitor the composition, content, and caloric value on food labels possess a higher DQI-A score.

4. For the first time, the dynamics of key indicators of oral health subsequent to dietary improvement (DQI-A score) has been illustrated through the implementation of specific nutritional recommendations within a preventive program for the adolescents studied.

5. An algorithm comprising 29 nutritional recommendations has been developed and validated to enhance dietary quality in relation to oral health among adolescents.

Confirmed Contributions:

1. It is confirmed that the predominant issue facing adolescents is body weight, contributing to a significant portion of the population being classified as overweight and falling within the "risk of obesity" category.

2. A direct correlation has been established among all forms of physical activity, the effectiveness of dietary habits, and water consumption in adolescents.

3. It has been substantiated that the overall stress levels in adolescents are contingent upon limited sleep duration during weekdays, increased caffeine intake, prolonged screen time, and eating in front of a screen, which collectively correlate with suboptimal dietary choices.

4. Evidence confirms that the consumption of sweetened foods and beverages, along with fast food, is associated with lower DQI-A scores in adolescent girls and boys exhibiting nutritional deficiencies, as well as with a decline in their oral health indicators.

5. A robust functional relationship has been established between the grading of criteria for carious lesions severity according to the ICDAS system and the use of spectroscopy with the CarieScan Pro device.

VIII. PUBLICATIONS ASSOCIATED WITH THE DISSERTATION

1. Mineva K., Georgieva-Dimitrova M. Influence of water- and fat-soluble vitamins on oral health in adolescence. Scripta Scientifica Medicinae Dentalis. 2024. DOI:http://dx.doi.org/10.14748/ssmd.v10i1.9172

2. Mineva K., Georgieva-Dimitrova M., Bakhova A. Oral hygiene habits in adolescents with disturbances in the nutritional status. Journal of Medical and Dental Practice. 2024. Vol.11.Issue 2. DOI: 10.18044/MedInform.2024112.1901

3. Mineva K, Georgieva-Dimitrova M. Accumulation of plaque and gingival inflammation in an adolescent with compromised nutritional status.MedInform. Issue 2.2025. DOI: 10.18044/MedInform.2025122.2059

Participation in the dissertation work:

• Achieved second place in the poster session of the scientific conference "Foods, Herbs, Nutraceuticals and Nutrition for Better Health," organized under item 3.3 of project №BG-RRP-2.004-0009-Co2 MUVE-TEAM. The presented topic was: „Pathologic features in the oral cavity in adolescence with disturbance in the nutrition status”.

• Participated in the poster session of the "3rd IAPD Global Summit," held from 8 to 10 November 2024 in Porto, Portugal, where the topic discussed was: “Diet Quality and its Influence on Anthropometric Parameters and Oral Hygiene Status in Adolescents”.