

SHORT THESIS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY (PhD)

**Factors affecting adolescents' health and health behaviour in light
of a school intervention study**

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1. Introduction

Adolescents' health behaviour changes with age; however, the vast majority of behaviours and habits acquired at this age persist into adulthood, so these behaviours determine not only present, but also later health status.

Regarding the adult mortality and morbidity data, it can be said that the main causes of mortality - both worldwide and in Hungary - are cancer and diseases of the circulatory system. Data from 2019 shows that the prevalence, mortality and DALY (Disability-Adjusted Life Years) rate per 100,000 people of the Hungarian adult population aged 20-54 exceed the world and Central European average.

The latest European Health Interview Survey (EHIS) reports a high prevalence of those lifestyle factors, which are the risk factors of chronic non-communicable diseases among the Hungarian population. These include low fruit and vegetable consumption, low physical activity, and high smoking and alcohol consumption rates. Based on these health behaviour characteristics, we can say that cancer and circulatory system diseases are justifiably present in a high proportion of the Hungarian population. For people to be able to maintain their health and avoid these diseases, a healthy lifestyle routine must be mastered at the earliest possible age.

2. Literature review

2.1 The definition of health and health promotion

Humanity's image of health has appeared in many forms throughout history, and these views have greatly influenced contemporary approaches to health. In the 19th century and the first half of the 20th century, diseases and their cure became more the focus of medicine, and prevention and maintaining health were less emphasized (biomedical health model). In 1946, along with a more complex approach to health, the World Health Organization described health as a state of complete physical, mental and social wellbeing and not merely the absence of disease or infirmity. Reflecting this approach, in addition to the biomedical model, a bio-psycho-social health model interpreting the disease as a much more complex process has emerged, which calls for a joint, systematic analysis of the physiological, mental and social factors of diseases and their prevention. An individual's health depends mainly on their lifestyle, which is greatly influenced by their environment, the opportunities provided by society, and culture. The socio-economic model of health describes this system of relationships. One of the main components of socio-economic indicators is educational attainment, which is closely linked to employment and thus to another important determinant, income. Those with higher education and income have better health behaviours and health status than those with lower social status. For these reasons, when we talk about improving the population's health, we cannot ignore these factors either. The WHO stated in the Ottawa Charter in 1986 that "health promotion is the process of enabling people to increase control over, and to improve, their health". To have control over their health and want to maintain and improve it, it is first and foremost essential that they see health as a value. The primary socialization channels of the individual - the family and the school - play a significant role in the value creation process.

2.2 The characteristics of adolescence

Adolescence is the stage of human life where adulthood begins, both biologically and spiritually. The WHO defines this period between the ages of 10-19. During puberty, a number of biochemical changes occur in the body: the size and proportions of the body change depending on gender, secondary sexual characteristics, and reproduction ability develop. The bio-socio-psychological transition marks the end of childhood, so in addition to the biological, social and psychological changes, qualitatively new and important forms of behaviour appear. Health-conscious behaviours of children and adolescents are usually not developed individually but through comprehensive socialization. During the first years of life, children's health behaviours are significantly influenced by parents. When children enter adolescence, they are increasingly determining their health behaviours. Accordingly, many health-related attitudes and behaviours are tried, mastered, or discarded at this stage in life.

2.3 Health Behaviour and Health of adolescents and their determinants

The health behaviour of Hungarian school-age children is not very favourable in an international context. Hungarian children eat more unhealthily than their counterparts in other countries, with a higher proportion of regular smokers, drinkers, and those who are sexually active. Hungarian adolescents consider their health more unfavourable, and the prevalence of overweight and obesity is higher.

Complex environmental, socio-cultural and socio-economic factors establish the health and health behaviours of the adult and school-age population. For instance, higher income and education are also associated with more favourable health behaviours and health. At the same time, the system of habits and values developed in the family, parents are role models for the children, and the opportunities that parents can provide for the children are also important for the growing generation.

With the spread of the biomedical health model in the 19th and 20th centuries, physical health came to the fore, so despite the paradigm shift in the second third of the 20th century, we often forget about mental well-being, which is based on similarly complex socio-economic and lifestyle factors. In addition, in the sensitive period of bio-psycho-social development during adolescence, we also have to pay close attention to mental health.

In addition to gender (e.g. girls exercise less, their mental health is less favourable) and age (e.g. older adolescents are more prone to risk behaviours), adolescents' health and health behaviour may also be affected by their socioeconomic status and social relationships. Teenagers living in better financial conditions are more satisfied with their lives, less overweight, and less likely among them the extreme alcohol consumption. Students who experience greater family or social support are more likely to cope with their everyday problems, have better mental health and are less affected by physical and mental symptoms. Mental well-being can even be affected by lifestyle (harmful habits, eating, and exercise). It can be assumed that there are complex interactions between social and economic factors, health behaviours, and mental health in adolescence. However, the combined effect of these has been studied in only a relatively small number of comprehensive studies.

2.4 Health-related Knowledge

One of the possible tools for health promotion activities during puberty is the development of health literacy, which is also based on lifelong learning opportunities. Health education can help to turn the acquired knowledge into favourable health behaviour. The literature presents several examples for the positive relationship between knowledge and behaviour, but also the phenomenon of cognitive dissonance is well-known. However, studies on the relationship between health behaviour and knowledge, especially among adolescents, are rare.

2.5 School Health Promotion

School also plays an important role in shaping lifestyle because children spend a significant part of their time in school, which is a crucial area for institutional socialization. Therefore, health promotion in school is of paramount importance in promoting adolescents' health behaviour and health.

In 2000, the International Union for Health Promotion and Education (IUHPE) collected and evaluated evidence on the effectiveness of health promotion, including school health promotion, over the previous 20 years. The IUHPE found that interventions were most effective when, together with behavioural change, they: focused on academic and social outcomes; were comprehensive and holistic; linked school to health organizations and other sectors; were sufficiently deep; had been running several school years; and fundamentally influenced students' social and academic growth.

Several literature review studies have compared the methods of school interventions and their effectiveness. The reviews concluded that more, better-designed, reliable intervention studies with long-term follow-up are needed, with the potential to determine effectiveness with greater certainty; hence, it is important to strive for program sustainability.

The world's largest health and disease prevention organizations—including the US Centre for Disease Prevention and Control, the World Health Organization, and the School for Health in Europe Network Foundation—heavily support the complex approach of school health promotion.

In Hungary, there are numerous laws; governmental and non-governmental organizations alike have taken public health actions and launched programs to foster adolescents' health and health behaviour in the past few years. However, whether these methodologically extremely heterogeneous initiatives have actually improved the health and health behaviour of Hungarian adolescents is not clear due to a lack of documented evaluation of their effectiveness.

Given the health status and health behaviour of the Hungarian population, especially school-age children, the significance of any efforts that help to influence them positively is unquestionable. Accordingly, understanding the factors associated with adolescent health behaviour and physical and mental health contributes to the development of effective health promotion programs.

2.6 Objectives

In the light of the above, it is clear that exploring factors related to adolescents' health behaviour and physical and mental health is vital in determining the direction of effective health promotion programs. However, it can also be stated that 1) only a few studies have examined the combined effect of socioeconomic factors and health behaviour on mental health in adolescence; 2) exploring the relationship between health behaviour and knowledge was among the aims of a small number of studies, mainly dealing with sexuality and sexually transmitted diseases; 3) and few comprehensive school health promotion programs have been implemented so far in Hungary, and their effectiveness has not been measured in all cases.

Accordingly, the focus of the present dissertation is on three objectives in order to fill these gaps in knowledge and investigate areas that have not been studied or have been little studied in previous research.

The **I. aim** was to assess the combined impact of gender, socioeconomic status, social support, and health behaviour on adolescents' mental health.

In our first study, we sought the answer to the following question:

1. What is the relationship between socioeconomic status, social support, health behaviour and adolescent mental health (life satisfaction, depression, and psychosomatic symptoms)?

Accordingly, we set up the following hypothesis:

Hypothesis₁: Adolescents' satisfaction with life is higher, with fewer depressive and psychosomatic symptoms reported in the case of more favourable socioeconomic status, social support, and health behaviour.

The **II. aim** was to investigate the relationship between health-related knowledge and health behaviour

In our second study, we sought the answers to the following questions:

1. Does dietary knowledge relate to adolescent eating habits?
2. Does knowledge about physical activity relate to adolescent physical activity?

Based on these, we formulated the following hypotheses:

Hypothesis_{2.1}: A higher level of nutrition-related knowledge is associated with more favourable eating habits of adolescents when adjusted for demographics and the family's socioeconomic status.

Hypothesis_{2.2}: A higher level of physical activity-related knowledge is associated with more favourable physical activity in adolescents when adjusted for demographic indicators and the family's socioeconomic status.

The **III. aim** was to develop a replicable and sustainable health promotion program among high school students and determine its effectiveness.

In our third study, we sought the answers to the following questions:

1. Can our high school intervention program have a positive effect on the health knowledge of students in the intervention group about nutrition, physical activity, smoking, alcohol consumption, and sexual health?
2. Can our high school intervention program have a positive effect on the attitudes towards a healthy lifestyle of students in the intervention group?
3. Does our high school intervention program have a positive effect on students' health behaviours in terms of nutrition, physical activity, screen time, smoking, alcohol consumption, and sexual behaviour?
4. Does our high school intervention program have a positive impact on students' health status in terms of self-rated health, mental health, and nutritional status?

In connection with the above questions, we examined the following hypotheses:

Hypothesis_{3,1}: With our high school intervention program, we have a positive effect on the health knowledge of the students in the intervention group about nutrition, physical activity, smoking, alcohol consumption, and sexual health.

Hypothesis_{3,2}: With our high school intervention program, we have a positive effect on the attitudes of students towards a healthy lifestyle in the intervention group.

Hypothesis_{3,3}: With our high school intervention program, we have a positive effect on students' health behaviours in terms of nutrition, physical activity, screen time, smoking, alcohol consumption, and sexual behaviour.

Hypothesis_{3,4}: With our high school intervention program, we have a moderate impact on students' health status in terms of self-rated health, mental health, and nutritional status.

3. Materials and Methods

3.1 I. Study: Contributing Factors in Adolescents' Mental Well-Being - The Role of Socioeconomic Status, Social Support, and Health Behaviour

3.1.1. Study Population

A cross-sectional health survey of a school-aged child population was carried out in the second largest Hungarian town (Debrecen) in accordance with the study protocol of the Hungarian HBSC survey. The study population consisted of 7th, 9th, and 11th grade students who were enrolled in different schools of the town. Multistage, stratified cluster sampling was performed where the strata included the school maintainer (municipality and church), school type (primary and secondary school), and grade. Finally, the sample consisted of 1955 students. All the students from the selected grades were included in the sample.

3.1.2. Data Collection

Data collection was carried out in 2015 with a self-reported, anonymous online questionnaire, which was identical to the questionnaire of the Hungarian Health Behaviour in School-aged Children (HBSC) survey. The research was performed with ethical approval; written parental consent was obtained from all participants, but, independent of the given parental consent, the participation of the students was voluntary. This study used 33 questions divided into four main sections: socioeconomic and demographic data, social support, health behaviour, and mental well-being.

The following socioeconomic and demographic data were collected: gender, age, place of residence (Debrecen or other surrounding settlements), type of school (primary school, vocational school, vocational high school, and high school), parental educational attainment (university or college, secondary school, vocational certificate, maximum primary school, do not know), subjective perception of family wealth (5-item scale with answers from “very well off” to “not at all well off”; these were collapsed into three categories: not well-off/average/well-off), and family affluence. The last was measured by the Family Affluence Scale (FAS), for which the total score (0–13 points) was calculated based on car, computer, and dishwasher ownership; having a bathroom and one's own bedroom; and the number of family holidays abroad during the last year. Then, three categories were created based on the total points: 0–5 low, 6–7 medium, 8–13 high affluence.

To measure perceived social support from family and friends (peer support), we used the Multidimensional Scale of Perceived Social Support (MSPSS). Besides social support, the quality of family communication was also measured with the short version of the clear communication scale from the Family Dynamics Measure II (FDMII).

Health behaviour was assessed in terms of eating habits and physical activity. Dietary habits, such as the regularity of having breakfast (on how many days during the week), were measured. The frequency of consumption of healthy (fruits, vegetables) and unhealthy food (sweets, sugar-containing soft drinks, energy drinks, salty snacks, and fast foods) was

assessed. Questions about the frequency of having breakfast and the evening meal together with parents were also included. There were also questions regarding active (regularity of moderate-to-vigorous and vigorous physical activity) and passive ways of spending free time. Sedentary behaviour was measured with the time spent on three types of screen-based activity a day. Students were asked how many hours a day of their free time they usually spend watching TV, videos, and DVDs; playing games on a computer; or using electronic devices not for playing (e.g., Internet use, chat, e-mailing).

The mental well-being of the students was characterized by life satisfaction, measured by the Cantril ladder; depression; and the frequency of psychosomatic symptoms. To measure depression, the short version of the Child Depression Inventory (CDI) was used. The health complaints index was used for the assessment of the frequency of psychosomatic symptoms (e.g. headache, feeling low/nervous, difficulties in getting to sleep).

3.1.3. Data Analysis

The data analysis was conducted in several steps. First of all, variables that were not completely filled in were imputed to overcome the constraint of biased or overestimated results that may arise from missing data. Next, the health behaviour and social support questions were evaluated with factor analysis in order to generate health behaviour and social support patterns. The number of factors with eigenvalues higher than one was determined using principal component analysis and varimax (orthogonal) rotation. The scree plot curve had declinations at seven factors, which also indicated a seven-factor model, similar to the eigenvalue specification. Health behaviour questions with factor loadings > 0.50 were used to interpret each pattern. The model significance was tested with Bartlett's test of sphericity ($p < 0.001$) and the goodness of fit was tested with the Kaiser–Meyer–Olkin Measure of Sampling Adequacy ($KMO = 0.716$), which convinced us that the seven-factor model depicted the latent structure of the original set of questions. The resulting standardized factor scores were introduced into the multivariate models as continuous explanatory variables.

Then, we used descriptive statistics to provide an overview of the respondents' characteristics, and finally multivariate multiple regression was used to analyse the main determinants of mental well-being. The method differs from ordinary multiple regression because several outcome variables (in this case, life satisfaction, depression, psychosomatic symptoms) are jointly regressed on a set of predictors (here, socioeconomic and demographic data, social support, and health behaviour). To estimate the overall statistical significance of the models, we calculated Wilks' lambda based on a multivariate analysis of variance (MANOVA) procedure, followed by multivariate multiple regressions. Based on the analyses, firstly we determined the R-squares for each outcome measure. Secondly, we studied the relationship between the adolescents' mental well-being and studied covariates in one model together. Associations were quantified by regression coefficients (β) and the corresponding 95% confidence interval (CI). Post-estimation with hypothesis testing was used to analyse the gender differences across the studied outcomes. To avoid the inflated likelihood of a Type I error due to multiple testing, the significance level of each test was adjusted using Bonferroni correction, which divides the significance level by the number of tests. P-values less than

0.008 were considered to be significant ($0.05/6 = 0.008$). Statistical computation was performed with Intercooled Stata 12.0 for Windows.

3.2 II. Study: Investigation of Relationship between Health-Related Knowledge and Health Behaviour

3.2.1. Study Population

In this cross-sectional study, we invited ninth-grade students who started their studies in the 2016–2017 and 2017–2018 academic years in a secondary school in Hajdú-Bihar County, Hungary ($n = 258$). As an inclusion criterion, written parental informed consent was sought, but irrespectively of the given parental consent, the participation of the students occurred on a voluntary basis. The research was performed with the ethical approval of the Medical Research Council Scientific and Research Committee, Hungary (49460-5/2016/EKU).

3.2.2. Data Collection

Data collection was carried out in the autumn of 2016 and 2017. To assess health behaviour and health-related knowledge, self-administered, anonymous questionnaires were used. The knowledge-related questions were compiled by the authors, while the questions concerning health behaviour (eating habits and physical activity) and demographic and socioeconomic data were taken from the Hungarian version of the Health Behaviour in School-Aged Children (HBSC) survey.

The following demographic and socioeconomic data were collected: gender, birth year, educational attainment (maximum primary school, vocational certificate, secondary school, university or college), employment status (employed, unemployed) of the mother and father, and family affluence. Family affluence was measured with the ‘Family Affluence Scale’ (FAS III), which was also used in the first study.

Eating habits were evaluated through five variables, i.e., breakfast and consumption of different types of food (fruits, vegetables, sweets, and sugar-containing soft drinks).

Physical activity was described from two points of view: moderate-to-vigorous physical activity (MVPA); and vigorous physical activity (VPA).

Health-related knowledge was measured separately for nutrition and physical activity. A relatively high score meant relatively good health knowledge.

3.2.3. Data Analysis

The statistical analysis was restricted to participants who provided complete information on all variables included in the analyses.

Descriptive statistics were used to provide an overview of the respondents regarding demographic data, socioeconomic status, and health-related knowledge. To investigate the relationship between health-related knowledge and health behaviour, we created path models, where the primary outcome variables were moderate-to-vigorous and vigorous physical activity as well as breakfast, fruits, vegetables, sweets, and soft drinks consumption. Health-

related knowledge for nutrition and physical activity was investigated as a secondary outcome. The different models were used to describe the relationship between adolescents' knowledge and health behaviour independently from the respondents' demographic and socioeconomic status.

To test our seven hypothesized models (a separate model for each of the health behaviour variables), recursive path analysis models were developed with IBM SPSS AMOS 25.0 to capture the relationship between all variables of interest. The model specifications, including correlations and path justification of the dependent and independent variables, were based on preliminary hypotheses, namely, that during the investigation of the relationship between health behaviour and health-related knowledge we cannot ignore the context in which the adolescents are living, which was the reason to involve demographic and socioeconomic variables into the analysis.

After developing the theoretical model, regression paths were created to determine whether health-related knowledge would influence eating habits and physical activity independently from demographic and socioeconomic data, while correlation paths were constructed among independent factors to account for possible intercorrelations and multicollinearity.

Finally, for the examination of modification indices and the revision of model pathways and correlations, seven overidentified recursive path models that retained all of the original hypothesized structures were configured.

3.3 III. Study: School intervention's impact on adolescents' health-related knowledge and behaviour

3.3.1. Study Population

We carried out our study at a secondary school in a rural town in East Hungary between 2016 and 2019. We performed the recruitment, inclusion, and randomization of 9th-grade adolescents in two waves in autumn of 2016 and 2017 (12 classes in total, 260 pupils). The school is a mixture of high, vocational high, and secondary school institution types. From all the attainable classes, we randomly allocated six classes by institution type to the control group, where participants received no intervention, and six classes to the intervention group. We invited all students of the classes to participate in the survey. We sent consent forms to the parents of all adolescents; only students who received parental consent and gave active consent themselves were eligible to be involved with the ethical permission of Hungary's Medical Research Council Scientific and Research Committee (49460–5/2016/EKU).

3.3.2. Data Collection to Measure and Evaluate the Effectiveness of the Intervention

In both the intervention and control groups, all students were assessed via an anonymous, self-administered questionnaire at baseline and immediately at the endpoint (post-intervention) of the intervention (2 and 3 school year follow-up) in a cross-sectional manner.

We wanted to include students in our study until the end of their studies, but due to the COVID-19 epidemic, some of the intervention sessions and the planned post-measurement

were cancelled, as schools continued their education online, which did not allow the sessions and surveys to as in previous years.

With the pre-measurement, we wished to determine the participants' baseline characteristics, as well as the possible differences between the intervention and control groups. With the post-intervention survey, we assessed changes in student health-related knowledge, attitudes toward a healthy lifestyle, health behaviour, and health status that were attributable to the intervention. We also administered the post-intervention survey to the control group to describe the changes among the subjects that were independent of the intervention. All of the questionnaires used at each time point were identical and completed in a classroom setting, supervised by a research team member.

Students were followed up anonymously during the study, for which we also asked some questions (in the form of a password reminder question used for phones and e-mail accounts) in each document to be filled in (health behaviour questionnaire, knowledge test sheet, NETFIT data collection sheet); and we asked them to enter a custom code of their choice as well. Over the years, we were able to identify which questionnaires were completed by the same student based on the answers to these questions and the code without revealing their identities.

Measurement of Health-Related Knowledge

The research team developed most of the health-related knowledge tests to gauge students' knowledge. The health-related knowledge test covered topics from the intervention sessions and from the health behaviour questionnaire: nutrition, physical activity, risky behaviour (alcohol consumption, smoking, and addiction), and sexuality. We calculated the students' average score for each topic. Overall, a higher score implied better knowledge. During the analysis, we examined the change in test scores overall and by topic.

Measurement of Health Behaviour

To compile the health behaviour questionnaire, we used questions from three previous nationwide studies in Hungary after preliminary consultation with the research leaders. Thus, we developed our questionnaire based on the self-administered, anonymous questionnaire employed in the Hungarian Health Behaviour in School-Aged Children 2014 (HBSC 2014) survey, the School Health Communication Survey, and the Hungarian European School Survey Project on Alcohol and Other Drugs 2015 (ESPAD 2015).

The first part of the questionnaire focused on demographic and socioeconomic data and questions were taken from the Hungarian version of the Health Behaviour in School-Aged Children (HBSC) survey. We used the following demographic and socioeconomic data: gender, the parents' education level (maximum primary school, vocational certificate, secondary/high school, university, or college), and the participant's family affluence. We measured family affluence with the Family Affluence Scale (FAS III), which can be used to assess material assets in a family.

In the second part of the questionnaire we measured the nutrition habits (frequency of breakfast consumption; healthy and unhealthy eating), frequency of teeth brushing, and physical activity (MVPA, VPA, screen time), smoking habits (cigarette, electronic cigarette,

hookah), alcohol consumption, drunkenness, and binge drinking, substance use, sexual behaviour, self-rated health and the attitudes toward a healthy lifestyle.

Measurement of Nutritional Status

Based on the Hungarian National Student Fitness Test (NETFIT®), we collected data on students' body fat percentage, height, and weight to calculate their BMI.

3.3.3. The Intervention

First, we carried out a pre-measurement to assess the students' health-related knowledge, attitudes toward a healthy lifestyle, and health status. We planned the health promotion sessions based on the main results of the pre-measurement, so the main problems determined the topics.

Taking advantage of the opportunities provided by the Hungarian school health promotion framework, we organized regular healthy lifestyle sessions for the intervention group. These were embedded into the curriculum (built into lessons of different subjects) with the help of the involved teachers, and usually required 2–3 lessons per academic year for each topic. Our goal was to expand students' knowledge, to help them acquire the right skills and attitudes, and to shape their behaviour accordingly through classes led by a public health professional and a public health student. Some of the sessions were implemented in collaboration with the local health promotion office.

We built the sessions around the following topics (in line with the knowledge test and the health behaviour questionnaire): health as a value, nutrition, physical activity, sexuality, addiction, alcohol consumption, smoking, substance abuse, cancer in light of lifestyle factors, and mental health.

To help the students gain diverse knowledge, skills, attitudes, and behaviours, we employed various interactive methods and tools such as mind maps; individual, pair and group work; presentations; posters; professional websites; and telephone applications.

3.3.4. Theoretical Framework of the Study

To design effective interventions, a team of psychologists (Michie and colleagues) in 2011 synthesized all the theories describing behavioural change and developed the COM-B model, which describes the conditions influencing behaviour. In the COM-B model, capability (the physical and psychological ability to enact a behaviour), opportunity (the physical and social environment that enables a behaviour), and motivation (the reflective and automatic mechanism that activates/inhibits a behaviour) all affect an individual's behaviour, thereby also influencing the previously listed factors; capability and opportunity separately affect one's motivation. We used this model as the theoretical framework for our study. We assumed that by developing students' abilities, enhancing motivation, and changing environmental factors, we could facilitate a positive effect on the health behaviour of adolescents and thus on their health status.

The basis of our intervention was the development of cognitive abilities and the enhancement of motivation. Our intervention did not cover students' physical ability; it was taken as given.

We measured students' motivation, including their intentions and habits, by their attitudes and health behaviour. Regarding the students' social environment, the cohesion among classmates was improved through games and group tasks. The management of the school and the teaching staff were supportive and inquiring, but were not involved directly in the intervention. The involvement of the parents was planned, but could not happen due to low parental activity. On the other hand, we were able to contact the staff of the local health promotion office as part of the health sector and to carry out some of our work with them. The shaping of the physical environment was limited by infrastructural constraints and the fact that the members of the control group were also students of the given educational institution, which is why we were able to change only the classrooms for the duration of the sessions with the help of posters and pictures on the blackboard. We also monitored changes in students' physical and mental health. Sessions related to mental health would have received more emphasis in the 2019–2020 school year; however, most of these classes were cancelled due to the COVID-19 pandemic.

3.3.5. Data Processing and Statistical Analyses

We gathered a total of 465 data sheets during the intervention period. At baseline, we included 145 adolescents in the intervention group, and 115 respondents in the control group. We excluded 80 students from the analysis because of migration between the intervention and control groups, or because they did not participate in the pre-measurement or post-measurement. The restriction of this sample resulted in a database of 384 data sheets (192 people).

We used descriptive univariate analyses to describe the baseline characteristics of the adolescents. After taking random missing patterns into consideration, we imputed all variables that contained missing values with multiple imputation.

We quantified the intervention's effect on the imputed database using generalized estimating equations (GEE), which comprise a generalized linear modelling technique for modelling longitudinal correlated or clustered data. We corrected all analyses for the respondents' gender and family affluence, their parents' education level, and the time period they spent in the intervention (two or three years). To determine the intervention-specific effect, we took into account the differences between baseline and post-intervention status and between the intervention and control groups, where the question was whether the change in the outcome from pre-intervention to post-intervention differed between the two groups (intervention and control). We measured this directly via the interaction of the intervention and the study time term in the GEE models.

4. Results

4.1 I. Study: Contributing Factors in Adolescents' Mental Well-Being - The Role of Socioeconomic Status, Social Support, and Health Behaviour

4.1.1 Descriptive Statistics

Of the remaining 1955 students, 1641 filled out the questionnaire, so the overall response rate was 83.9%. The average age was 15.28 years (standard deviation, SD: 1.70), and the proportion of boys was 60.8%. Approximately 62% of the respondents lived in Debrecen, and 42% of the adolescents studied in high school. Almost one third of the fathers and nearly 40% of the mothers had university or college certificates. Twelve percent of the respondents had a high FAS score, but on the other hand, nearly 40% of the adolescents described their family wealth status as well-off. The average score of life satisfaction was 7.42 (SD: 1.94), and the score was 21.17 (SD: 7.77) for psychosomatic symptoms. The mean score of the depression scale was 2.12 (SD: 2.44), and 21.8% of the students belonged to the depressive mood category.

4.1.2. Result of the Factor Analysis

The seven factors were responsible for 66.12% of the total variance. Factor 1 was determined by different types of unhealthy foods (sweets, sugar-containing soft drinks, salty snacks, fast-foods, and energy drinks), and factor 2 was related to the questions on entertainment screen time (computer games and television or video watching). The questions about physical activity formed factor 3 (frequency of vigorous physical activity, weekly hours of vigorous and moderate-to-vigorous physical activity), while the different questions about social support connected to factor 4 (perceived social support from family, quality of family communication, perceived social support from friends (peer support)). Factor 5 consisted of using electronic devices not for playing. The following questions make up the 6th factor: eating together with parents and breakfast consumption. Factor 7 comprised of questions on healthy food consumption (vegetables and fruits).

4.1.3. Determinants of Mental Well-Being

We found that boys have a higher life satisfaction and they are less affected by depressive and psychosomatic symptoms than girls.

Those who did not know the educational attainment of their father or whose fathers had a vocational certificate had more psychosomatic symptoms than those whose fathers had a university or college certificate. The students who did not know the educational attainment of their mother were less satisfied with their lives, and those students whose mothers had lower educational attainment than secondary school had fewer psychosomatic symptoms.

The lower subjective perception of family wealth had a negative effect on life satisfaction, and increased the development of depression, while family affluence had no effect on these mental well-being indicators.

Students from primary schools perceived fewer psychosomatic symptoms than high school students.

Those who had higher social support had better life satisfaction and had fewer depressive and psychosomatic symptoms.

Healthy food consumption was associated with higher life satisfaction, and those who consumed unhealthy foods were more likely to have psychosomatic and depressive symptoms. Regular breakfast consumption and family meals were positively related to life satisfaction, depression, and psychosomatic symptoms.

Regular physical activity had a positive effect on life satisfaction and depression, while higher entertainment screen time was related to lower life satisfaction and a higher risk of depression. Computer usage that was not for playing games increased the risk of depression and psychosomatic symptoms.

4.2 II. Study: Relationship between Health-Related Knowledge and Health Behaviour

4.2.1 Descriptive Statistics

Half of the respondents were female, and the ages ranged from 14 to 16 years among the participants. Nearly one-fifth of the fathers and approximately one-quarter of the mothers had a maximum primary school education. Approximately two-fifth of the fathers and more than one-quarter of the mothers had vocational certificates. Nearly one-fifth of the fathers and more than one-quarter of the mothers finished secondary school, while approximately 5% of the fathers and 8% of the mothers had college degrees. With regard to family affluence, the average FAS score was approximately 5.68 (SD=2.14). Nearly 90% of the fathers and approximately 80% of the mothers were employed.

4.2.2. Models for Nutrition-Related Knowledge and Eating Habits

Based upon the tested models, nutrition knowledge was associated with family affluence, age of the child, educational attainment of the father, and gender, but no relationship was found between knowledge and behaviour. Breakfast consumption was less frequent among girls. None of the investigated determinants showed any associations with fruit intake. Among the older students, the frequency of vegetable consumption was lower. There was a negative association between consumption of sweets and educational attainment of the mother, and a higher level of education predicted less frequent eating of sweets. For soft drinks, the same association was found with educational attainment of the mother as in the case of the sweets, and the consumption of soft drinks increased with age.

4.2.3. Models for Physical Activity-Related Knowledge and Physical Activity

Based upon the tested models on physical activity, only MVPA was associated with knowledge, and the determinants of knowledge and exercise can be seen below. A positive link was found between MVPA and family affluence; girls were less active than boys, and this was the only outcome for which higher physical activity-related knowledge showed a

relationship with exercise. Children's knowledge showed a correlation with educational attainment of the father and was higher among girls.

Similar determinants were detected for VPA, except that the employment status of the mother also influenced the frequency of exercise, while knowledge did not. The level of knowledge was associated with gender; among girls, the achieved scores were higher.

4.3 III. Study: School intervention's impact on adolescents' health-related knowledge and behaviour

We scrutinized data from 192 students after we cleaned the data: 43.8% at the 3-year follow-up and 56.2% at the 2-year follow-up. More than half of the students belonged to the intervention group; 49.5% were boys, 44.3% were high school students, 24.5% were vocational high school students, and 34.2% were vocational school students. Most fathers had a lower level of education than mothers: A higher proportion of fathers had a vocational certificate or lower, while more mothers had a baccalaureate or diploma. Nearly half of the students had a low FAS, one-third had medium FAS, and only one-fifth had high family affluence.

We found a positive relationship between the intervention's specific effect and the risky behaviour, sexuality, and total knowledge test scores.

A further outcome of our intervention was that among the students in the intervention group, the consumption of unhealthy foods was significantly lower, and the frequency of exercise significantly increased. There was a significant decline in the number of students in the intervention group who spent less than 3 hours playing on computers or consoles. There was a significantly greater chance of alcohol abstinence by the end of the study. In addition, the chances of not smoking also increased, but this was not significant.

Our intervention did not affect students' healthy lifestyle attitudes, sexual behaviour, self-rated health, or nutritional status.

5. Discussion

5.1 I. Study: Contributing Factors in Adolescents' Mental Well-Being - The Role of Socioeconomic Status, Social Support, and Health Behaviour

The mental well-being of adolescents was characterized based on three domains: life satisfaction, the presence of psychosomatic symptoms, and depression. Regarding our results, each well-being domain for boys — similar to the international and national survey — was favourable compared to those for girls, but there was no association with age and place of living. The sensitivity analysis also shows that these sex differences simultaneously exist, independent of other factors, across all the studied well-being variables. The differences among adolescents in psychosomatic symptoms, depression, and life satisfaction significantly varied across boys and girls; the effect of gender on well-being domains exists to various degrees. Based on the results of previous studies these differences may be explained partly by the hormonal, physical and psychological changes caused by puberty in girls. Another cause

can be if there is a big contrast between familial, peer and mass media values. Furthermore, the social environment will change in that period, the parents probably will be stricter with girls, and also the school performance has greater importance for them, which can lead to increased stress. From a sociological point of view, society usually overvalues maleness, which can enhance the development of role conflicts among young women. From the socioeconomic determinants, there was no clear relationship either with parental educational attainment or with the material assets (FAS) of the family; however, lower subjective family wealth was associated with lower life satisfaction and depressive mood.

These results are in line with a previous meta-analysis suggesting that mental well-being is linked to subjective socioeconomic status (SES) and that the effect is independent of objective SES. This can perhaps be explained by the hypothesis that subjective SES reflects the relative status while objective FAS is the absolute social position of a person, and the perception of socioeconomic rank can influence mental health outcomes through psychological processes.

Life satisfaction was positively related to healthy eating, social support, and physical activity. Unhealthy eating, sedentary lifestyle, and lower social support were associated with higher depression scores. Higher social support and eating together with parents decrease psychosomatic symptoms, while unhealthy eating and spending more time before the computer increase them.

Our results do not differ from those of previous studies where the effect of similar factors (but not all of them together) was investigated. Thus, the same relationships have been found concerning the connection between mental health and healthy eating. The reason for this association could be the appropriate intake of micronutrients and vitamins which are necessary for proper mental function, and probably because negative mood can lead to the frequent consumption of unhealthier foods as a coping mechanism (to increase the serotonin level). The positive effect of physical activity on mental health has also been proven; this could be because of the physiological effects of exercise, because of an indirect effect due to increased self-esteem, or be connected with social support. Furthermore, the time spent engaging in screen-based activities has been connected to mental health problems by Brindova et al., Hoare et al., and Iannotti et al. This may be due to the decreased opportunity to be active, but the effect of the content of videos and games could also influence well-being, or it could be that those who already have mental health problems will choose these activities as compensation. The opportunity to communicate with parents along with support from family and peers are also established as protective factors for mental well-being because these can help to improve social skills, raise self-esteem, and enhance one's sense of security and belonging, which can strengthen one's ability to cope with stress.

Based on the results obtained, we can say that our first hypothesis (H_1) - "Adolescents' satisfaction with life is higher, with fewer depressive and psychosomatic symptoms reported in the case of more favourable socioeconomic status, social support, and health behaviour." - was partly proved because a better assessment of financial status, higher social support, and more favourable eating and exercise habits were associated with better mental health, however, we found no clear relationship with parents' educational attainment.

Strengths and Limitations

The uncertainty of the answers can be high for some variables (e.g., educational attainment of the parents), as the younger children did not all know this information. Because our questionnaire was the same as that used in the Hungarian HBSC survey, which was developed following international protocol, the uncertainty for these items is expected to be no higher than in other countries. Imputation was used to minimize the bias that may arise from missing data. Due to the cross-sectional design, clear conclusions cannot be drawn about the causal effect, but this study does provide a foundation for elucidating the relationship between the factors. Among the strengths of our study, we can mention the relatively large sample size and the fact that the determinants of mental well-being were investigated from a complex point of view using advanced statistical methods.

5.2 II. Study: Relationship between Health-Related Knowledge and Health Behaviour

According to our results, increased knowledge was not associated with the different components of a healthy diet but was influenced by age, gender, father's education level, and family affluence. Among the older students, the level of nutrition-related knowledge was lower, which may be because these students delayed starting secondary school or had to repeat the ninth-grade, which is usually due to low academic achievement and can lead to a lower nutrition-related knowledge score.

In the case of physical activity, only moderate-to-vigorous physical activity was associated with higher physical-activity-related knowledge. This can be influenced by the fact that for the students, physical education class is obligatory on each school day, and MVPA also includes activities performed in school.

The girls reached higher knowledge scores for both topics, as was expected based on previous studies. The reason for the inverse association between family affluence and knowledge should be further investigated. The association between knowledge and father's educational attainment can indicate that this family environment provides increased opportunities for learning experiences.

Regarding eating behaviour, girls ate breakfast less regularly than boys, which is in line with the results of the Hungarian HBSC survey. The educational attainment of the mother was inversely correlated with the consumption of sweets and soft drinks, which is supported by another study as well. Girls were less active than boys, similarly to the results of the Hungarian HBSC survey. Based on our data, family affluence and parental employment status are associated with a higher level of physical activity, which can be explained by the fact that these families have more opportunities to participate in physical activity by buying the necessary equipment, clothes, season tickets, etc.

Surprisingly, in the literature, a relatively small number of studies can be found regarding the association between knowledge and behaviour among adolescents; therefore, the possibility to compare our results with previous results is limited. A positive association has been found between nutrition knowledge and healthy eating in a study among children aged 4–16 years, while in a review, the association between food knowledge and dietary intake was not

obvious. In a recent intervention study, increased knowledge was not translated into sustained behaviour change regarding eating habits and physical activity, whereas in another study, a positive association between knowledge and sport activity could not be proven. These results are in line with ours.

Based on the results obtained, we can say that the "A higher level of nutrition-related knowledge is associated with more favourable eating habits of adolescents when adjusted for demographics and the family's socioeconomic status." hypothesis ($H_{2.1}$) was not proved, while the "A higher level of physical activity-related knowledge is associated with more favourable physical activity in adolescents when adjusted for demographic indicators and the family's socioeconomic status." hypothesis ($H_{2.2}$) was fulfilled only for one studied variable, the moderate-vigorous physical activity.

Strengths and Limitations

This study has limitations that could be further improved in future research. The cross-sectional design is not precise enough to draw clear conclusions in terms of causal effect, but it does provide a foundation for elucidating the relationship. The sample was highly restricted in age, and the participants were from a single high school, so the findings may not be generalizable to other subjects; to obtain a final model, additional research must use community samples. The proportion of the missing answers was approximately equal to one-third of the total number, but due to the low number of cases, the missing answers were not imputed. In addition, information bias may exist in a self-report survey, but this problem cannot be fully avoided, and we can assume that the amount of information bias is similar to that in other surveys.

Despite these limitations, the study has notable strengths. First, the conclusions were drawn based on complex data analyses of a sample of Hungarian adolescents. The sample size was relatively small but was adequate for structural equation model construction, which confirmed that all models tested in the study were acceptably fitted to the data. The applied retrospective data collection followed standardized protocols, and different behaviours were investigated at the same time as suggested in a recent article. Second, the study specifically focused on the complex relationships between adolescent's health behaviour and knowledge. The present findings highlight a number of potentially productive directions for future research, such as finding the most important targets of programs that can improve health behaviour and the kind of relationships and interactions that exist between these determinants of health behaviour.

5.3 III. Study: School intervention's impact on adolescents' health-related knowledge and behaviour

Our high school intervention program, which focuses on the development of knowledge and skills and covers several segments of a healthy lifestyle, was embedded into the curriculum in the framework of the school system and school health promotion. As a result of the intervention study, it became possible to improve the students' knowledge about health, as well as some areas of their health behaviour.

Students' overall knowledge in the intervention group showed a significant increase compared to the control group, except for the tests regarding diet and physical activity. One reason might be that both groups included students from the food industry (bakers, confectioners, and chefs), trade, hospitality, and sports, areas for which training contains more information about nutrition and physical activity. Our intervention was not able to change the students' attitudes toward a healthy lifestyle in a positive direction.

Our intervention had a positive impact on unhealthy diet; however, we did not achieve a positive shift in terms of breakfast regularity and healthy eating (fruit and vegetable consumption) compared to the control group. One reason may be that adolescents have much more control over the consumption of unhealthier foods than the consumption of breakfast or fruits and vegetables. The latter is perhaps more influenced by family eating habits and affluence. The students' frequency of MVPA increased compared to that of the control group. In the intervention group, the duration of playing games on a computer or game console rose significantly. The Hungarian HBSC 2018 survey examined the relationship between physical activity and screen time, and found that those who do not exercise and move enough spend more time playing computer games; the relationship between screen time and exercise turned out to be U-shaped. In this way, our findings are in line with the Hungarian national experience.

Regarding cigarette use, there was a more favourable trend in the intervention group than in the control group, but this trend was not statistically significant. This outcome is encouraging, as it is conceivable that there would have been a significant difference between the two groups if the intervention were to have been continued. Our intervention also had a positive effect on the frequency of alcohol consumption, and last month's abstinence was significantly more likely in the intervention group.

Our intervention failed to influence sexual behaviour (sexual activity and contraception use), self-rated health, and nutritional status. The latter may be due to positive shift in health status where nutrition might be expected in the longer term following a change in health behaviour. Improving these indicators could be facilitated by health promotion programs that focus more on students' physical activity and eating habits (e.g., by transforming the school environment to encourage exercise and healthy eating, or by promoting healthier eating opportunities through peer helpers).

Based on the results, we can say that the "With our high school intervention program, we have a positive effect on the health knowledge of the students in the intervention group about nutrition, physical activity, smoking, alcohol consumption, and sexual health." hypothesis ($H_{3.1}$) was proven in terms of nutrition and physical activity. At the same time, "With our high school intervention program, we have a positive effect on the attitudes of students towards a healthy lifestyle in the intervention group." and "With our high school intervention program, we have a moderate impact on students' health status in terms of self-rated health, mental health, and nutritional status." hypotheses ($H_{3.2}$ and $H_{3.4}$) were not fulfilled. "With our high school intervention program, we have a positive effect on students' health behaviours in terms of nutrition, physical activity, screen time, smoking, alcohol consumption, and sexual

behaviour.” hypothesis_{3.3} was partly fulfilled because unhealthy eating, moderate-intensity exercise, and last month’s alcohol consumption were influenced positively.

Strengths and Limitations

Planning

One of the limitations of our intervention is that the intervention and control group studied in the same school, so we cannot rule out that the knowledge and skills acquired during the intervention may have also appeared among the members of the control group. Due to this study design, we could not change the wider school environment (e.g., using posters, courtyards, stair decorations), which could have had a further positive effect on students’ health behaviour. However, from a research point of view, the difference between the intervention and control groups was probably smaller in light of other background factors that could potentially influence the effect of the intervention (e.g., exercise opportunities in the broader environment, food supply) than in the case of another control group, but of course we cannot be sure that the intervention and the control groups were totally homogenous. One of the study’s strengths is that we took into account the aspects of IUHPE, namely, that our program has been operating at regular intervals for several years and addressing several segments of a healthy lifestyle.

Implementation

The goal of the program was hampered by the COVID-19 pandemic, which resulted in restrictions for the spring of 2020, when some sessions and the closing data collection had to be cancelled. This may have had a negative effect on the results obtained, and we can assume that based on the data for the entire time period, changes in other areas could be made as well.

From the angle of IUHPE, we were able to involve the health sector in our program and to coordinate some parts of our work with the activities of the local health promotion office.

A further strength of the program was that, as part of the intervention, a public health professional participated in the daily life of the school and regularly consulted with the school management and teachers regarding the planned intervention sessions and measurements. Thanks to this individual’s presence, the teachers became more open to the program, and some teachers volunteered for a certain activity. Professional participation in school life also helped to facilitate the students’ acceptance of the program and to build a solid relationship with them, which was essential for effective collaboration.

Another strength of the program is that, with cost-effectiveness in mind, we tried to develop it taking into account the school’s capabilities, so we mostly used existing and easily accessible tools (e.g., blackboard, computer, projector, websites, and telephone applications) during the intervention. The intervention sessions were carried out taking into consideration the specifics of each class (e.g., prior knowledge, ability), which promoted equal opportunities to acquire knowledge, favourable attitudes, and health behaviour. Further, students were able to access useful websites and telephone applications that provided reliable information learned and practiced during the sessions, regardless of space, people, or time outside of school, thus providing safe guidance for developing appropriate health behaviours. Given the elements of the program that have taken place, we can assume that, with the coordination of a public

health professional or trained teachers, our program can be used in other schools based on the capabilities of each school and its students.

Evaluation

On the negative side, some students dropped out over the years, reducing the size of the already relatively small sample, which limited the study's statistical power.

Within the limits of our study, in some cases, we could not identify differences due to the absence of adequate statistical power. We could not perform stratified data analysis due to the nature of the sample and the relatively low sample size. The shortcomings resulting from the low statistical power are nuanced by the fact that we corrected the statistical metrics obtained during the analysis for sociodemographic factors; therefore, the indicators show the connection between the dependent and independent variables without the effect of sociodemographic confounders.

5.4 Conclusions

Our first study concludes, that both social support and healthy lifestyle are important protective factors against mental health problems among adolescents, so interventions should focus on these factors regardless of the socioeconomic status of the participants, with special attention given to girls. Taking into consideration previous intervention studies, it can be stated that the development of effective interventions is a challenge; therefore, any kind of study which is able to add one piece to this puzzle can be meaningful.

Our second study concludes, that although appropriate knowledge is necessary, in many cases it is not sufficient by itself to change behaviour; adolescents' living context and school setting are also important. Schools are cost-effective settings for health education programs and are critical areas for developing children's and adolescents' health-related knowledge. Based on the COM-B model, these programs can be most successful if they not only cultivate the target group's knowledge regarding a healthy lifestyle but also the group's skills, thus motivating the group's members, and operate in a supportive social and physical environment with the group over time. Therefore, in 2016, we tried to take all these factors into account when planning our school education program. For several years, our intervention study sought to shape students' knowledge, skills, attitudes, health behaviour, and health in a positive direction using a variety of interactive methods and digital tools, and to monitor the effectiveness of our health promotion program at regular intervals.

Our intervention also achieved positive results in terms of knowledge transfer and, in some cases, changes in health behaviour.

Prior research has not identified a clear connection between nutritional knowledge and healthy eating or exercise-related knowledge and physical activity. Relatedly, in childhood and adolescence, the parents are mostly responsible for providing the food consumed and ways of spending one's free time (e.g., sports funding), so adolescents can control these behaviours the least, as opposed to smoking or alcohol consumption.

Previous studies have also shown that adolescents' demographic and socioeconomic background (gender, parents' education levels, family affluence) and the social environment

can affect their health-related knowledge, attitudes, health behaviour, and health status. Hence, we cannot ignore these factors when designing health promotion programs for school-age children. Greater involvement of parents and teachers in the health promotion program, and the creation of a supportive school environment, can greatly contribute to its success. In the spirit of a comprehensive school, health promotion programs should include all segments of a healthy lifestyle, affect all students and faculty members in the school, involve other organizations in addition to parents, and keep sustainability in mind. The Balassagyarmat Health Education Program and the Buda Region Health Program (2018–2030) are good examples from Hungary, but these programs were started after our intervention, and their effectiveness has not yet been evaluated. The Balassagyarmat Health Education Program is a complex school-based health education program with peer helpers that places special emphasis on students' own knowledge, creating an environment that promotes positive health behaviour and deepens motivation. The Buda Region Health Program (2018–2030) aims to support and strengthen health promotion and prevention activities at the local level with the involvement of local and regional authorities, health care providers, non-governmental organizations, academia, and government. The program's main objective is to promote children's health in a complex way by creating an environment that is conducive to healthy choices, the development of health services, the improvement of children's health behaviours and education, the involvement of schools and families, and the transfer of experience. Due to the limiting factors described earlier, as well as the goal of making the program sustainable without external funding, it was not possible in the present research to implement such a complex intervention.

In support of complex programs, there is also a need for well-designed health promotion programs to be given more space in schools' pedagogical programs, taking into account the infrastructure, community, the school's unique features, and possibilities provided by the settlement where the school is located.

Teachers can play a key role in knowledge transfer about healthy lifestyles and in shaping students' attitudes and lifestyles in a positive direction. In addition to imparting knowledge about healthy lifestyles, such skills may include integrating the topic of health into individual subjects, knowing and presenting about credible sources of information, planning, and organizing topic weeks and programs for healthy lifestyles, or involving peer helpers. It is also vital to shape educators' attitudes in a positive direction, as they also have a great responsibility, since the development of students' health includes having the teacher himself/herself be credible in his/her role as a health promoter.

6. New Results, Experiences, Recommendations

1. *Social support and healthy lifestyle are important protective factors against mental health problems among adolescents.*
2. *Appropriate knowledge is necessary, but in many cases, it is not sufficient by itself to change behaviour; enhancing general resistance resources and improving adolescents' mental health are also important.*
3. *All three studies of the thesis, which were based on different statistical methods, showed that adolescents' sociodemographic background (gender, parents' education, material assets of the family) and social environment may affect their health knowledge, attitude, health behaviour, and health status.*

The importance of this result is that these factors cannot be ignored when designing health promotion programs for school-age children.

4. *The COM-B model can be used as a theoretical framework for the design of complex school health promotion programs.*
5. *Our intervention for a healthy lifestyle among Hungarian high school students can positively shape students' knowledge of health and in some cases, their health behaviours. The intervention focused mainly on the development of knowledge and skills, addressed several segments of a healthy lifestyle, and partly involved the health sector.*
6. *When planning and implementing a school health education program, needs to be considered the prior knowledge, abilities, and skills of the target group and shape the planned class accordingly.*

During the implementation of our program, the sessions were carried out taking into account the specifics of each class (e.g. prior knowledge, ability), which promoted equal opportunities to acquire knowledge, favourable attitudes, and health behaviour. Sometimes we devoted more lessons to the processing of a topic than planned in each class, due to the different abilities of the students, the replacement of the missing prior knowledge, or due to several questions that arose.

7. *The school health education program, which was planned into classrooms, coordinated, and implemented by a public health professional, taking into account the capabilities of the school and its students, is well implementable.*

In this context, the regular consultation with teachers and reminders before the day of the sessions are justified. Sometimes some teachers forgot about a previously agreed time, which was not only inconvenient for the teacher, it was also unfortunate in terms of keeping the sessions and further scheduling them.

8. *If the professional implementer and coordinator of the school health promotion program regularly consults with schoolmasters, form-masters, and teachers about class and measurements, and participates in the community life of teacher offices, it*

improves the program's feasibility, teachers' receptivity, and smooth collaboration with them.

During our health education program, the public health professional coordinating and implementing the program not only stayed in the classrooms during the sessions and surveys, but also took part in the community life of the teachers' offices during the holes, breaks, and after classes, regularly consulted with the teachers regarding the planned intervention sessions and measurements. She asked for their opinions, discussed the possibilities with them, and thus helped to develop the planned sessions. Thanks to this presence, the school's teachers became more open to the program, and some teachers volunteered for a session (e.g. a former smoker teacher for smoking prevention).

9. *The system for anonymous individual tracking of students in the study (individual code provided by the student and answers to questions based on a password reminder for e-mail accounts) not only worked well for follow-up, but also facilitated the anonymous use of NETFIT data and datasheets (health behaviour questionnaire, knowledge test).*
10. *Our study pointed out that when designing multi-year school intervention studies, it is worth striving for a larger sample size, as this may increase the statistical power of the study. At the same time, it is to be expected that some students will be excluded from the study over the years, as with other follow-up studies.*

7. Summary

Many factors can influence the health behaviour during adolescence, and the lifestyle of the adolescents is associated with the health behaviour during adulthood. So their behaviour can determine not just the present, but also the later health status. Due to this reason, we aimed to (1) assess the association among socioeconomic status, social support, health behaviour and adolescents' mental well-being, (2) investigate the relationship between health-related knowledge and health behaviour, and (3) develop an intervention program to improve high school students' health behaviour, and evaluate its effectiveness.

Data collection was carried out with self-administered, anonymous questionnaires. Multivariate multiple regression was used to analyse the main determinants of mental well-being. The relationship between knowledge and behaviour was investigated with structural equation modelling adjusted for gender, age, and socioeconomic status. Generalized estimating equations were used to evaluate the effectiveness of our health promotion program.

The boys' mental well-being was favourable compared to girls; lower subjective family wealth was associated with poor mental well-being. Good mental well-being was positively related to healthy eating, social support, and physical activity. Unhealthy eating, sedentary lifestyle, and lower social support were associated with poor mental well-being. The higher level of health knowledge was correlated with moderate-vigorous physical activity and parent's higher level of education, and the latter was also associated with favourable health behaviours. Our health promotion program had a positive effect on the students' health-related knowledge and, in some cases, also on their health behaviour (unhealthy eating, moderate to vigorous physical activity, alcohol consumption).

Based on our studies, it can be said that both social support and a healthy lifestyle seem to be protective against mental health problems among adolescents; appropriate knowledge is necessary but not sufficient to improve adolescents' behaviour; and school health promotion can be effective in knowledge transfer and lifestyle modification. In order to achieve a more positive effect on health behaviour, preventive actions have to focus on the determinants of health behaviour using a complex approach during implementation.

8. List of publications



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Registry number: DEENK/428/2021.PL
Subject: PhD Publication List

Candidate: Gabriella Nagy-Pénzes
Doctoral School: Doctoral School of Health Sciences
MTMT ID: 10068439

List of publications related to the dissertation

1. **Nagy-Pénzes, G.**, Vincze, F., Bíró, É.: Contributing Factors in Adolescents' Mental Well-Being: the Role of Socioeconomic Status, Social Support, and Health Behavior.
Sustainability. 12 (22), 1-17, 2020.
DOI: <http://dx.doi.org/10.3390/su12229597>
IF: 3.251
2. **Nagy-Pénzes, G.**, Vincze, F., Sándor, J., Bíró, É.: Does Better Health-Related Knowledge Predict Favorable Health Behavior in Adolescents?
Int. J. Environ. Res. Public Health. 17, 1-12, 2020.
DOI: <http://dx.doi.org/10.3390/ijerph17051680>
IF: 3.39





List of other publications

3. Vighné Arany, Á., **Nagy-Pénzes, G.**, Bíró, É.: Preventív szemléletű iskolai egészségfejlesztés II.: Jó gyakorlatok, Debrecen.
In: Csillagfényben : Neveléstudományi megelőzés : Kapcsolódó hatásgyakorlatok / Czákó Kálmán Dániel, Magyar Pedagógiai Társaság, Budapest, 284-299, 2020.
4. **Nagy-Pénzes, G.**, Bíró, É.: Egészségfejlesztő program középiskolások körében: az alapállapot felmérés eredményei = health promoting programme among high school students : the result of the baseline survey.
Egészségfejlesztés. 59 (4), 7-16, 2018.
DOI: <http://dx.doi.org/10.24365/ef.v59i4.291>

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