

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

**ASSOCIATIONS BETWEEN CHILDREN'S SCREEN
TIME, SOCIODEMOGRAPHIC AND LIFESTYLE
CHARACTERISTICS, AND FAMILY OBESITY**

STUDIES AMONG CHILDREN AGED 6-9 YEARS
IN SIX EUROPEAN COUNTRIES

by Sándor Istvánné Radó MSc
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DOCTORAL SCHOOL OF HEALTH SCIENCES

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The PhD Defense takes place at the Lecture Hall of Bldg. A,
Department of Internal Medicine, Faculty of Medicine,
University of Debrecen, on 24 March, 2026 at 14.00 p.m.

Background and objectives of the doctoral thesis

The prevalence of childhood and adolescent obesity has been increasing globally. While obesity rates have doubled among adults since 1990, they have quadrupled among adolescents (WHO, 2025). This increase is particularly marked in low- and middle-income countries. Overweight and obesity is considered one of the most important global health problems causing non-communicable diseases affecting 1.9 billion adults and nearly 400 million children and adolescents worldwide today.

In the WHO European Region, the prevalence of childhood obesity also varies significantly between countries (WHO, 2022).

The risk factors for obesity are complex and multifactorial at the individual, family, community and societal levels, which marks them challenging to identify and address. Although several prevention programs at individual and community levels have been developed and implemented, their effectiveness is limited and strategies with proven long-term effectiveness have not emerged yet (Vu Thi et al., 2019).

In light of research evidence, there is a clear case for implementing structured prevention interventions at the levels of the child, family, community and society (Hillier-Brown, 2014; WHO, 2017).

In 2015, *Families across Europe following a healthy lifestyle for Diabetes prevention* (F4D-Feel4Diabetes), a school-based intervention program running in six countries to prevent type 2 diabetes, was launched in Hungary. The University of Debrecen, led by the Department of Family Medicine and

Occupational Health, has taken an active role in the implementation of this project in Hungary.

Objectives of our research

The main aim of our study is to investigate the sociodemographic and lifestyle characteristics that influence family obesity and screen time among children aged 6-9 years, using data from six European countries involved in the *Feel4Diabetes*; the study was launched with Belgium and Finland of higher income, Greece and Spain being under economic austerity measures at the time, and with the poorer Eastern European countries Bulgaria and Hungary).

The objectives of the research and this thesis include:

- Identify sociodemographic and lifestyle characteristics that influence family obesity rates
- Identify and determine the proportion of families at high risk of developing type 2 diabetes based on the results of the *FINDRISC* questionnaire,
- Identify the countries in the study with the highest levels of screen time for children,
- To assess the nutritional status (BMI) and physical activity levels of children and parents,
- Identify sociodemographic and lifestyle factors that may be associated with children's screen time.

Research questions

In our study, we sought to answer the following research questions:

1. What factors influence the risk of obesity in families?
Are there differences in the economic situation of the participating countries?
2. What statistical method can be used to examine the relationship between the amount of time children spend in front of screens and the likelihood of their parents developing diabetes mellitus, and how strong is this relationship?
3. In the studied countries, what proportion of children corresponds to the recommended screen time?
4. What are the differences in screen time for children among the studied countries?
5. What is the relationship between children's screen time and parents' education, age and family income?
6. Is there a link between parents' BMI, physical activity levels and children's screen time?
7. Regarding screen time, is the gender and physical activities of the child an influential factor?
8. Is there a demonstrable link between children's nutritional status and the amount of time they spend in front of a screen?

Description of material and method

For the present study, only relevant sociodemographic data (age, gender, education, and the family's living circumstances), and data on children's and parents' screen time and physical activity were used from the baseline data of the Feel4Diabetes study.

To assess parents' educational attainment *International Standard Classification of Education* (ISCED) index was used. We grouped respondents into categories of educational attainment based on the completed years of schooling if at least one parent had achieved it. Therefore the categories of primary (9 years or less); secondary (10-14 years); and tertiary (15 years or more) were used for grouping.

To assess families' living circumstances a 6-grade Likert scale based on self-report was used, with a range of 1 to 6 from 1 "Very difficult" to 6 "Very easy". Based on this, respondents were classified into 3 categories, such as "Low"; "Medium"; and "High"; income status families.

The BMI of the parents was calculated from their self-reported anthropometric data provided in the questionnaire then categorized according to the World Health Organisation (WHO) criteria: normal up to 24.9 kg/m^2 ; overweight up to $25-29.9 \text{ kg/m}^2$; obese over 30 kg/m^2 . Children were measured in schools by research assistants. The resulting data were used to calculate a z-score for the under-18 age group based on *the International Obesity Task Force* (IOTF) recommendations. Based on the FINDRISC results, families who completed the questionnaire were classified as *High-risk-HR* if at least one

parent had a FINDRISC score of 9. (Given the younger age of the parents, a lower limit value was used.)

Familial obesity was defined according to the WHO criteria of a body mass index (BMI) of 30 kg/m² or more. For families participating in the Feel4Diabetes study, a family was considered obese if it was found to be obese in at least two family members (e.g. both parents, or the child and one of the parents).)

Information on the physical activity of parents and children was assessed by the following questions. About adults: "In the past week, how many times a day did you get at least 30 minutes of physical activity?" About children: "In the past week, how many times a day did your child get at least 1 hour of physical activity?" In both cases, the question was asked separately for the weekend and weekdays. The response options for weekdays ranged from 1= for never to 6=for five times a day, while for weekends a 3-grade scale was used with 1=never and 3=two days per weekend. The analysis was based on recommendations from the WHO, the Canadian Sedentary Behaviour Guidelines and the Canadian 24-Hour Movement Guidelines for Adults.

We looked at children's and adults' screen time (excluding time spent at school or work) on weekdays and at weekends. Responses ranged on a scale of 1-10 for both weekdays and weekends, with the least being 'Never' and the most being '7 hours a day'. The categories were analyzed using recommendations from the WHO, the IDEFICS study, and the *American Academy of Pediatrics* (AAP). They suggest that the maximum acceptable level of screen time for adults and children should not be more than 2 hours/day.

Statistical methodology

Continuous variables with normal distribution were presented as means and standard deviations (SD), while variables with non-normal distribution were presented as medians and interquartile ranges. Categorical variables were presented in percentages (%).

The significance of the relationship between categorical variables in the constructed database was tested using Pearson's chi-square (X^2) test.

Univariate logistic regression analyses were conducted to examine the associations between family obesity (dependent variable) and family sociodemographic characteristics and lifestyle factors (independent variables) by the total sample and by the economic classification of countries. Variables that showed a significant association with family obesity were further examined using the multivariate logistic regression model.

Also, a multivariate logistic regression model was used to identify the factors influencing screen time in the study group. We analyzed the interactions between the explanatory variables and found six potentially significant pairs.

Results are presented as adjusted odds ratios (OR) and p-values. Model fit was checked using the Hosmer-Lemeshow test. Statistical analysis was performed using Stata statistical software (version 13.0, Stata Corp, College Station, TX, USA) and $p < 0.05$ was considered significant.

Results

In the original 2016 survey, 12280 families completed both parts of the *Feel4Diabetes* (F4D) questionnaire. The distribution of responding families were as follows:

Belgium 1800 (15%), Bulgaria 3059 (25%),
Finland 1506 (12%), Greece 2287 (19%),
Hungary 1921 (16%), and Spain 1707 (14%).

Examining the prevalence of family obesity in the total sample and after categorizing by economic classification of the country, we found that 6,6% (628) of families in the total sample were obese. Countries under economic austerity measures had the highest prevalence of family obesity with 244 (7,6%), followed by low-income countries with 270 (7%), while high-income countries had the lowest prevalence of family obesity with 114 (4,5%).

By country stratification, the highest prevalence of obesity was shown in the south-east of Europe, with 168 (9,2%) in Greece, followed by Hungary with 123 (8,6%) and Bulgaria with 147 (6,1%). The lowest rates of family obesity were in the north-west of Europe, with 52 (3,5%) in Belgium, 62 (6%) in Finland, while it was 76 (5,6%) in Spain.

The age distribution for the total sample of mothers (11,787) is: <45 years with 10651 (90%), between 45-54 years with 1,113 (9%), between 55-64 years with 18 (0,8%), and over 64 years with 5 (0,2%). Regarding the age of the fathers in the total sample (10,153 persons), the results were: <45 years with 7,885 persons (78%), between 45-54 years 2,066 persons (20%), between 55-64 years 182 persons (1,8%), and over 64 years with 20 persons (0,2%).

The self-reported body mass index of the mothers in the sample was normal weight ($<25 \text{ kg/m}^2$) in 7,778 (67%) and overweight or obese ($\geq 25 \text{ kg/m}^2$) in 3,870 (33%). Fathers' self-reported BMI was in the normal category ($<25 \text{ kg/m}^2$) in 3,146 (32%), while 6,828 (68%) were in the overweight or obese category ($\geq 25 \text{ kg/m}^2$).

In terms of educational attainment, 952 (8%) mothers had primary education, 4,003 (36%) had secondary education, and 6,373 (56%) had tertiary education (college or university). Regarding the fathers, 4540 (46%) of them, had tertiary education, while 4379 (44%) had secondary education, and 954 (10%) had primary education.

High-income countries had the highest proportion of parents with tertiary education, with 63% of mothers and 48% of fathers having more than 14 years of education. In contrast, low-income countries and countries under economic austerity measures had the lowest rates of maternal and paternal education attainment.

After analyzing the FINDRISC questionnaires completed by the families, 2763 (22%) families were classified as high risk, and 9517 (78%) as low or less at risk of T2DM.

When examining the living circumstances of families, we found that 5703 (50%) families self-assessed themselves as belonging to low-income status, 3302 (29%) to middle-income status, and 2501 (21%) to high-income or well-off status.

Based on the physical activity characteristics of the parents who completed the questionnaire, 4098 families (45%) meet the recommended 150 minutes per week, while 4958 families (55%) do not meet the recommendations according to their self-report.

The average age of the 12,047 children in the survey was 8,21 years (Mdn=8,16 [7,46-8,93]), and the sex ratio was 6,180 (51%) girls and 6,031 (49%) boys. Their distribution of body mass index (BMI z-score classification) averaged 0.56 (Mdn=0,47 [-0,19-1,29]).

Examining the physical activity of children, 5683 (62%) do at least 1 hour of physical activity per day, while 38% 3412 do not meet the minimum amount.

Our research showed that the prevalence of obesity in families with one obese parent and one obese child was significantly higher in countries being under austerity measures 109 (3,4%) and in low-income countries 131 (3,4%) compared to 33 (1,3%) in high-income countries ($p < 0,001$).

When examining the association between sociodemographic characteristics and family obesity, we found that, compared to families with parents younger than 45 years, the probability of family obesity was 50% higher in the total sample if the mother was 45 years or older. The likelihood of family obesity was 55% higher in low-income countries and 173% higher in high-income countries if the mother was 45 or older. When examining the age of fathers, only families in high-income countries were found to have a 123% higher probability of family obesity for fathers of 45 or older. When looking at educational attainment across the whole sample, the likelihood of family obesity was lower in families where parents had tertiary education.

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When examining the association between lifestyle factors and family obesity, we found that in high-income countries being under economic austerity measures, the likelihood of family obesity increased by 10% for every hour spent in front of the screen, compared to a 9% reduction for every day of the week when the family met the physical activity recommendations.

Among children aged 6-9 years in the six countries we studied, 47% of the respondents (n=4283) said they adhered to the recommended screen time, while in Belgium (n=771) 57% of the children, in Finland (n=734) 57% of them and in Bulgaria (n=1298) 59% of them did not adhere to the recommended screen time ($p < 0.001$).

Of the children whose families were not considered to be at high risk for T2DM, according to the FINDRISC questionnaire (n=7031 people), 3358 (48%) spent acceptable time in front of the screen, while 3673 (52%) spent more time. However, no significant difference was found between the two groups ($p = 0.192$).

Spending longer time in front of the screen was significantly higher in overweight or obese mothers (56%; n=1507), while for children having a mother with normal BMI (51%; n = 3029) it was lower ($p < 0.001$).

The proportion of children with 'too long screen time' was also significantly lower for children having a mother and father with tertiary education ($p < 0,001$).

We also found a significant correlation between the economic categories of families and children's screen time. The proportion of children with a screen time of more than 2 hours per day was lower among families in the high and medium income status categories compared to children in families in the lower income category ($p = 0,035$).

Examining the screen time of the children by the examined country compared to the screen time of the Hungarian children, 86% of the Belgian children ($OR = 1,86, p < 0,001$), 76% of the Finnish children ($OR = 1,76, p < 0,001$), and 91% of the Bulgarian children ($OR = 1,91, p < 0,001$) had a significantly higher chance of having an unfavorable (too much) time spent in front of the screen.

Regarding the relationship between the age of the parents and the time of the children in front of the screen, we found that children whose mothers belonged to the 45-54 age group had a significantly lower chance ($OR = 0,81, p = 0,033$) of spending more than 2 hours in front of the screen than those whose mothers belonged to the younger age group, under <45. In the case of fathers, no significant correlation was found in this context.

Examining the relationship between the parents' BMI and the children's pre-screen time, we found that the proportion of children with a longer pre-screen time was significantly higher among mothers with a high BMI compared to parents with a normal BMI ($OR = 1,15, p = 0,013$). However, regarding the fathers, no significant association was detected.

Children of mothers with tertiary education were significantly less likely to belong to the group with excessive screen times than those whose mothers had primary education.

Compared to families with low income status, high- and middle-income families had a significantly lower chance of children not corresponding to the recommendations regarding the time spent in front of the screen ($p = 0,003$; $p = 0,014$).

No significant association was found between adult physical activity, children's gender, and children's screen time.

Children who did not correspond to the recommended level of physical activity ($OR = 0,85$, $p = 0,004$) were also significantly 15% less likely to exceed the recommended screen time so this could not be the reason for less movement.

No significant association was found between children's screen time and parents' risk exposure to T2DM ($p = 0,099$).

The gender ($p = 0,559$), age ($p = 0,884$), and BMI z-score ($p = 0,294$) also showed no significant relationship with children's screen time.

In the breakdown by country, a significant correlation was found in both groups (overweight/obese, obese) only in Spain ($p=0,008$, $p=0,008$) between children's screen time and nutritional status, while in the other countries studied, the relationship was not statistically significant.

Summary

In our study, we looked for correlations between the socio-demographic and lifestyle characteristics of families raising children aged 6-9, family obesity, and the amount of time children spent in front of screens each day. The data required for statistical processing were provided by a study conducted in six European countries as part of the European Union's Horizon 2020 program. The data in the study came from anthropometric measurements, the lifestyle and social situation of families, their eating habits, and the FINDRISC questionnaire, which indicates a family's risk of diabetes mellitus.

It was performed in countries having better economic conditions (Belgium and Finland). Here, for a better comparison disadvantaged populations were chosen. Other participating countries (Spain and Greece) were under economic restrictions at time of the project-application. Bulgaria and Hungary were also involved in the project. Different statistic models were used to analyze the data.

Altogether 12,280 families and 12,211 children participated in the study. Their mean of age was 8,21 year and their distribution was 6180 girls (51%) and 6031 boys (49%). The ratio of children who correspond to the recommendation (daily screen-time less than 2 hours) was 47%. Wide variations were observed between countries.

The average of screen-time was less where mothers were between 45-54 years of age, having higher level of education and normal BMI. Higher living standard was associated with lower screen-time. The ratio of families with at least one children and one parents living with obesity was higher in Greece, in Spain and in Bulgaria. The ration of obesity in the

family was higher when the mother was above 45 years of age and had lower level of education. The physical activity was the smallest in Greece and Spain, and the shortest screen-time was also registered in these countries. The occurrence of obesity in the family was the lowest in countries having higher income, and having higher ratio of more educated parents. The less was the physical activity, the less was the screen-time. No relation was found between the physical activity of parents and their children, between genders and screen-time. Children's screen time and nutritional status showed a significant correlation only in Spain.

Based on the findings, targeted interventions are needed to decrease inappropriate screen-time, with more focus on families with smaller income and on mothers with the lower education level.

New findings from our study

- Our research results show that the prevalence of family obesity was significantly higher in families with one obese parent and one obese child in Greece and Spain, as well as in Bulgaria and Hungary. Protective factors included mothers under the age of 45 and high levels of education.

-There were significant differences in children's screen time between the countries we studied.

-Shorter screen use habits were observed among children whose mothers had a higher education, were middle-aged, and whose families had higher incomes. At the same time, maternal overweight or obesity increased the likelihood that the child would spend more than two hours a day in front of a screen. Interestingly, lower physical activity reduced excessive screen use in some cases.

-Of the six countries participating in the study, only Spain saw a significant increase in the likelihood of both overweight and obesity among children who spent a lot of time in front of screens.

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List of publications related to the dissertation

1. Radó, S. I., Molnár, M. J., Széll, R. F., Szöllősi, G. J., Törő, V., Shehab, B., Manios, Y., Anastasiou, C. A., Iotova, V., Tsochev, K., Chakarova, N., Giménez-Legarre, N., Miguel-Berges, M. L., Schwarz, P. E. H., Rurik, I., Sárváry, A.: Association between Screen Time and Sociodemographic Factors, Physical Activity, and BMI among Children in Six European Countries (Feel4Diabetes): a Cross-Sectional Study.
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DOI: <http://dx.doi.org/10.3390/children11040458>
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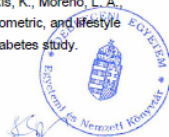


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Total IF of journals (all publications): 68,742

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