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The impact of the COVID -19 pandemic on the health behaviour of Hungarian secondary school students during the distance learning period

Doctoral (Ph.D.) Dissertation

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Introduction

As a physical education teacher and coach, I have chosen the physical and mental education of Hungarian youth as my vocation. Over the years, I have noticed in my own five children and in many of my students that the higher levels of physical activity in early childhood seem to decline by the secondary school years. I have noticed that their average daily activity has increased the amount of time spent in front of a screen in physical inactivity. PCs, then laptops and smartphones with a range of virtual games to keep their attention and curiosity occupied. Part of their free time was increasingly spent on these devices, and screen time replaced their outdoor activities.

My experience was not unique, many contemporary parents and researchers have reported similar results. Bradley et al (2011) showed a linear decline in MVPA between the ages of 9 and 15. According to a recent WHO recommendation, 5-17 year olds should do an average of at least 60 minutes of moderate to vigorous intensity, mainly aerobic physical activity per day over the course of a week, and should also do vigorous intensity aerobic and muscle and bone strengthening activities at least three days per week (WHO, 2020).

Global pre-pandemic data show that a low proportion of adolescents, around 20%, meet the physical activity guidelines. According to a WHO study, 81% of young people aged 11-17 years worldwide did not meet the WHO's 2010 recommendation of at least 60 minutes of moderate to vigorous physical activity (MVPA) per day in 2016 (WHO, 2016). Young people did not reach the recommended PA level before the world was hit by pandemic COVID-19 in March 2020 (WHO 2020).

The COVID-19 pandemic hit the world in 2020. Most countries around the world, including Hungary, introduced measures restricting people's daily lives, including distance learning and quarantine, which were only gradually lifted when the first wave of the pandemic subsided by the summer of 2020, but restrictions, including distance learning, were reintroduced during the second wave of the pandemic in the autumn and winter of 2020. The aforementioned restrictions, quarantine and the introduction of distance education further hindered the free PA of young people. (Champeaux et al., 2022) Under the measures introduced on 26 November 2020, digital timetables were introduced in Hungarian secondary education from grade 9 onwards. Educational institutions were instructed to switch to online e-learning (Government Decree 484/2020).

Around the world, the pandemic has disrupted normal daily routines: including school attendance of children and adolescents, and the level of vulnerability in all age groups. The COVID-19 2020 restriction has completely changed the daily behaviour of individuals worldwide, including young people in Hungary (Katona et al., 2022).

This doctoral thesis describes many aspects of the lives of Hungarian secondary school students during the second wave of the pandemic in Hungary, during the period of distance learning.

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Objectives and hypotheses

The study will examine (1) different types of physical activity among adolescents and young adults, (2) sleep duration (changes in sleep habits), (3) time spent in front of a screen, (4) frequency and quality of physical activity in the community (peer group), and (5) subjective well-being before and during the pandemic. The aim of this thesis is to describe and evaluate physical activity before and during the pandemic:

1. the different types of physical activity (aerobic and muscle strengthening movements, team sports) and their variations.

2. changes in time spent in front of a screen - their physical inactivity.

3. subjective assessment of their sleep time and health,

4. their mental health, especially loneliness and hopelessness.

Also, to answer the question of whether there is a correlation between the above (changes in physical activity, screen time, self-rated health, sleep time and well-being).

a.) by gender, b.) by age group, c.) by geographic region for the above aspects before and during the pandemic, during distance learning among Hungarian adolescents and young adults (secondary school students).

5. A further sub-objective of the study was to identify the group(s) at risk of mental health problems among adolescents and young adults who face serious challenges in society and education.

The following hypotheses can be made:

Hypothesis 1: It is assumed that all types of PA activity in the cohort under study decreased during the distance learning period.

Hypothesis 2: Assume that total time spent in front of a screen has increased among secondary school students.

Hypothesis 3. Suppose that their sleep time increased during distance learning.

Hypothesis 4: It is hypothesized that their subjective ratings of mental health in the domains of loneliness and hopelessness worsened and they felt "lonelier" during the distance learning period.

Methods, subjects

Our research was based on a complex questionnaire designed to be completed online by the secondary school students in the study in November and December 2020. The Hungarian secondary school students were selected from state and church schools cooperating in the research. The schools were selected through personal contacts and with the help of the National Faculty of Education (NPC) and the Hungarian Benedictine Congregation. The research was made available to students after approval by the school principals or heads of institutions. Pupils completed the questionnaire mainly during online physical education lessons. Information about the purpose of the survey was provided online and parental consent was sought before completion. We surveyed 66 secondary school students (N = 2556) from 66 public schools in 37 cities in nine regions of Hungary.

The survey

For our study, we designed a cross-sectional self-report questionnaire (see Appendix 1 of this dissertation for the questionnaire) using some of the thematic items from the Health Behavior in School-aged Children (HBSC) (Roberts et al. 2007) and CDC Youth Risk Behavior Surveillance System (YRBSS) (Grunbaum et al. 2004) questionnaires, as well as physical activity data from the YRBSS questionnaire. Some questions were modified to create pairs of questions before and during the distance learning period of the COVID-19 pandemic.

By "at least 20 minutes" we mean at least 20 minutes of moderate-to-vigorous physical activity (≥3 MET or 60% HR-max). Changes in moderate-to-vigorous physical activity were assessed by asking respondents a series of paired questions such as, *"On how many days per week did you exercise or participate in at least 20 minutes of physical activity that involved sweating and restricted breathing - such as basketball, soccer, running, swimming, fast cycling, fast dancing, or similar aerobic activity - before the distance learning period?"* and *"On how many days per week did you exercise or participate in physical activity involving sweating and increased breathing - such as basketball, football, running, swimming, fast cycling, fast dancing or similar aerobic activity - for at least 20 minutes during the distance learning period*?". Similarly, changes in muscle strengthening exercises (performing targeted muscle strengthening workouts, push-ups, sit-ups, pull-ups) and participation in team sports were measured by a pair of questions. Each question was answered on a 0-7 point scale. For the subjective perception of health - "I feel less well now during the distance learning period than before the distance learning period" - response options "yes - no - same" were provided. For the question *"What did you think about your health before the introduction of distance learning during the normal school period?"* and *"What did you think about your health now, since the introduction of distance learning, during the period of distance learning"?* there were three possible answers: 'very healthy, healthy, not completely healthy'. For the statement "I feel less well now during the period of distance learning than before the period of distance learning", the response options were "yes - no - same".

Analysis of the data

Descriptive analysis, shift tables and relative frequency distributions were used to describe the data. Data are presented as mean ± SD or frequencies and proportions. Sample characteristics were analysed by age group and sex using independent samples T-test, Fisher's exact test and Pearson's chi-square test. To examine the effect of gender (women vs. men) and/or age groups (adolescents vs. young adults) on reported changes in physical activity (measured by measures of aerobic exercise and muscle strength) and time spent in front of a screen. A 2×2 factorial ANCOVA was used in this model. The dependent variable (reported changes) was calculated as the difference between the number of days/week during and before distance learning. Factors were gender (females vs. males) and age group (adolescents vs. young adults). Finally, the Z-score of body mass index (BMI) was used as a covariate

in this model. BMI was hypothesized to be associated with reported changes in physical activity and screen time (dependent variable) (Heinonen et al., 2013; Ding and Jiang, 2020), and BMI was also hypothesized to be associated with gender and age (Nevill and Metsios, 2015). The significance level was set at 0.05 a priori. Statistical analysis and visualization were performed using IBM SPSS Statistics for Windows version 25.0 (IBM Corp. released 2017. Armonk, NY, USA: IBM Corp.).

Results

Sample characteristics

Based on their age, students were divided into two groups: adolescents (A, 56.3% age min-max = 14-17 years) and young adults (YA, age min-max = 18-21 years). Age groups showed no significant association with gender, but did show a significant association with BMI category. Thus, BMI Z-score was an appropriate covariate for analysis. Table 1 shows the descriptive statistics for the sample. The mean age of respondents was (17.27±1.3) years. The age of respondents shows the lowest average in Budapest, followed by the West-Hungary region. Central Hungary and Eastern Hungary have the highest age, but these regions differ minimally from each other. The regional distribution shows a relative balance between the geographical areas of Hungary. 57% of respondents were girls and 43% were boys. Male respondents are slightly over-represented in the West-Hungary region, while female respondents dominate in the other three regions.

Table 1. Sample characteristics.

Variables	Study Sample (N = 2508)					
	Adolescents (*n* = 1413)	Young Adults (*n* = 1095)	*p*	Males (*n* = 1072)	Females (*n* = 1436)	*p*
gender, Male *n* (%)	621 (43.9)	451 (41.2)	0.167 [a]	N/A	N/A	N/A
age (M ± SD)	16.3 ± 0.7	18.6 ± 0.6	N/A	17.3 ± 1.3	17.3 ± 1,3	0.167 [b]
Weight (kg)	63.3 ± 13.6	66.6 ± 14.5	N/A	71.4 ± 14.7	59.8 ± 11.3	N/A
Height (cm)	171.2 ± 9.3	171.9 ± 9.5	N/A	178.6 ± 7.7	166.2 ± 6.5	N/A
BMI categories [1], *n* (%)						
underweight	89 (6.3)	40 (3.7)		55 (5.1)	74(5.2)	
normal weight	1146 (81.1)	856 (78.2)		817 (76.2)	1185(82. 5)	
overweigth/obese **	123 (8.7)	131 (11.9)	<0.001 [c]	142 (13.3)	112(7.8)	<0.001 [c]
obese	55 (3.9)	68 (6.2)		58 (5.4)	65(4.5)	

Comments. 1 BMI categories are based on BMI %iles for 2-19 year olds, BMI score for ≥20 year olds, ** "overweight/obese" terminology: Barlow SE and Committee of Experts 2007, a Fisher's exact test for the relationship between gender and age groups, b Independent samples T-test for differences between men and women, c Pearson's chi-square test for the relationship between gender/age groups and BMI categories, N/A statistical analysis not applicable.

Physical activity before and during distance learning

Physical activity was assessed before and during distance learning using self-reported levels of aerobic exercise (AE) and muscle strengthening (MS). To ensure an unbiased analysis of the data, we excluded inactive students (i.e., those who did not perform AE or MS before or during distance education) (n = 41).

Aerobic exercise (AE)

Nearly three quarters of students reported a change in their AE level, with 1,485 students (60.9%) reporting a decrease and 350 (14.4%) reporting an increase in AE. 55% of students completed one to three fewer days of AE per week during distance education than before (Table 2).

Table 2. Shifts in aerobic exercise levels before and during distance learning.

		AE days/week during distance learning								Total
		0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	
AE days/week before distance learning	0	31 *	6	8	6	5	1	1	7	65
	1	34	**39**	18	22	6	2	1	3	125
	2	59	121	**81**	33	18	12	1	6	331
	3	69	133	157	**143**	38	38	10	8	596
	4	31	85	173	103	**112**	34	24	8	570
	5	31	30	71	146	60	**122**	17	11	488
	6	3	1	13	22	27	38	**50**	6	160
	7	6	3	10	16	12	21	10	**54**	132
Total		264	418	531	491	278	268	114	103	2467

Comments. AE: aerobic exercise level is the number of days/week of aerobic exercise. No AE is performed during and before distance education, bold: no change in the level of physical activity, i.e. AE days/week during distance education = AE days/week before distance education, light grey: increased AE level, i.e. AE days/week during distance education > AE days/week before distance education, dark grey: decreased AE level, i.e. AE days/week during distance education < AE days/week before distance education. To test for gender and age differences in AE level change, we excluded students who did not complete AE (n = 31) or reported no change (n = 601). The factorial ANCOVA model showed a non-significant main effect (F(1,1830) = 6.034, p = 0.014, η2p = 0.003). Men reported a greater reduction in AE levels (M = -1.45, SD = 2.09) than women (M = -1.19, SD = 1.85). Age, non-x age and covariate were not significant.

Muscle Strengthening (MS)

Around 70% of students showed a change in their MS level, with 1,041 students (44.5%) reporting a decreased level and 530 (22.6%) reporting an increased level (Table 3). 35% of students completed one to two fewer days of MS per week during distance learning than before.

Table 3. Shift table of muscle strength (MS) levels before and during distance learning.

		MS days/week during distance learning								Total
		0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	
MS days/week before distance learning	0	127 *	33	24	16	8	10	9	7	234
	1	112	**150**	48	31	13	10	6	6	376
	2	96	175	**209**	64	43	21	9	6	623
	3	64	108	119	**186**	40	33	11	7	568
	4	16	26	59	47	**78**	29	14	10	279
	5	22	14	38	40	27	**84**	7	14	246
	6	3	1	4	12	14	12	**27**	1	74
	7	3	2	3	10	7	4	3	**35**	67
Total		443	509	504	406	230	203	86	86	2467

Comments. MS: level of muscle strengthening is the number of days/week of muscle strengthening * no MS during and before distance learning, bold: no change in the level of movement, i.e. MS days/week during distance learning = MS days/week before distance learning, light grey: increased MS level, i.e. MS days/week during distance learning > MS days/week before distance learning, dark grey: decreased MS level, i.e. MS days/week during distance learning < MS days/week before distance learning. To investigate gender and age differences in MS level change, we excluded students who did not complete MS (n = 127) or reported no change (n = 769). Based on a 2 × 2 ANCOVA model, gender and/or age showed no significant effect on MS level change.

Screen time (ST) before and during distance learning

To ensure unbiased analysis, we excluded students who reported "day zero" screen time in the evenings before and during distance learning (n = 26). For changes in ST, 42.4% of students showed no change, and more than half (54%) reported increased ST (Table 4). During distance learning, 42.4% of students sat in front of a screen one to three more days per week in the evening than before (see Figure 2C).

Table 4. Shift table of screen time (ST) levels before and during distance learning.

		ST days/week during distance learning								Total
		0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	
ST days/week before distance learning	0	0 *	8	12	12	13	12	4	25	86
	1	0	**19**	8	25	19	16	9	19	115
	2	0	10	**41**	48	49	58	40	64	310
	3	2	1	8	**64**	71	127	57	85	415
	4	0	0	6	5	**63**	62	72	98	306
	5	0	0	5	3	6	**87**	76	160	337
	6	0	0	3	1	4	7	**56**	91	162
	7	1	2	2	2	8	7	7	**722**	751
Total		3	40	85	160	233	376	321	1264	2482

Comments. ST: screen time in the evening is the number of days in front of the screen per week, * "zero days" is the time spent in front of the screen during and before distance learning in the evening, in bold: no change in ST level, i.e. ST days/week during distance learning = ST days/week before distance learning, light grey: increased ST level, i.e. ST days/week during distance learning > ST days/week before distance learning, dark grey: decreased ST level, i.e. ST days/week during distance learning < ST days/week before distance learning.

Sleeping time (ST) before and during distance learning

Analysis of our data shows that self-assessment of health has deteriorated in all age groups studied. They perceived their health as worse during distance learning compared to face-to-face learning. In all cases, girls' averages were found to be worse than boys' averages in their age group, suggesting that boys perceived their health deterioration to be less significant. Distance learning has consistently increased significantly for both sexes in all regions. This may be due to the relative later wake-up time due to not going to school. Among respondents, girls slept less on average than boys. As a result of increased sleep time, they felt less tired during distance learning, but their self-assessment of health nevertheless deteriorated.

Figure 1: Changes in sleep time by region before and during the introduction of distance education (Katona, Rikk, Ihász 2021).
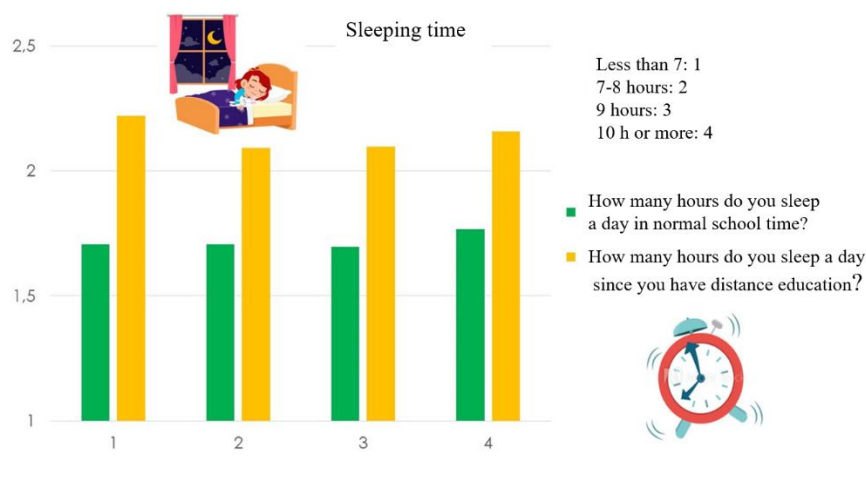
Subjective assessment of health status

The subjective assessment of health status before and during distance learning showed a statistically significant relationship ($\chi 2$ (4, N = 2508) = 1023.408; p & lt; 0.001). Overall, 68.1% (n = 1707) of the subjective assessment of health status showed unchanged health status. 23.1% (n = 580) reported worse health and 8.8% (n = 221) reported better health during distance education compared to before distance education. This variation was observed regardless of gender, age and region.

The relationship between physical activity and subjective assessment of health status

The change in physical activity and the change in subjective assessment of health status showed a significant relationship for all three types of physical activity (aerobic exercise: χ2 (4, N = 2436) = 292.573; p

Table 5. Change in subjective assessment of health status during distance learning compared to before distance learning (white: no change, light grey: better, dark grey: worse.)

	A távoktatás óta, n (%)			
	Nagyon egészséges	Egészséges	Nem teljesen egészséges	Összesen
Nagyon egészséges	251 (10,0)	180 (7,2)	45 (1,8)	476 (19,0)
Egészséges	86 (3,4)	1224 (48,8)	355 (14,2)	1665 (66,4)
Nem teljesen egészséges	17 (0,7)	118 (4,7)	232 (9,3)	367 (14,6)
Összesen	354 (14,1)	1522 (60,7)	632 (25,2)	2508 (100)

(Row label on the left axis: A távoktatás előtt, n (%))

Kereszttábla-elemzés (Pearson-féle khi-négyzet-statisztika):
*Aerob típusú testmozgás: $\chi^2(4, N = 2436) = 292{,}573$; p<0,001
**Izomerősítés: $\chi^2(4, N = 2340) = 282{,}936$; p<0,001
***Csapatsport: $\chi^2(4, N = 2113) = 38{,}537$; p<0,001

Hopelessness and loneliness in distance learning

Overall, nearly half of the students experienced mild hopelessness (57.2%, n=1435) and moderate loneliness (59.8%, n=1500). Furthermore, nearly a fifth of students were characterised by moderate/severe hopelessness (18%, n=451) and a quarter by high loneliness (24.9%, n=624). There were significant differences in the gender proportions among adolescents. There were higher rates of moderate/severe hopelessness and moderate/high loneliness among adolescent females than males (Table 6).

Table 6. Hopelessness and loneliness by gender

| | Total sample (N =2508) | | | | | |
| Variables | Adolescents (n=1413) | | | Young adults (n=1095) | | |
	Males (n=621)	Females (n=792)	p [ES]	Males (n=451)	Females (n=644)	p [ES]
Beck Hopelessness Scale, M±SD	5.5±3.1	6.0±3.5	0.004 [0.15]	5.9±3.4	6.3±3.5	0.070 [0.12]
normal range, n(%)	172(27.8)	205(25.9)		103(22.8)	142(22.0)	
mild	353(56.8)	448(56.6)	0.047 [0.08]	269(59.7)	364(56.7)	0.461 [0.05]
moderate	89(14.3)	112(14.1)		65(14.4)	116(18.0)	
severe	7(1.1)	27(3.4)		14(3.1)	21(3.3)	
UCLA Loneliness Scale, M±SD	35.9±9.6	37.9±10.1	< 0.001 [0.20]	37.4±10.1	38.0±9.6	0.376 [0.06]
no/low, n(%)	130(20.9)	111(14.0)		68815.1)	75(11.6)	
moderate	344(55.4)	485(61.2)	0.003 [0.09]	263(58.3)	408(63.4)	0.153 [0.06]
high	147(23.7)	196(24.8)		120(26.6)	161(25.0)	

There is a significant, positive, moderate correlation between hopelessness and loneliness regardless of gender and age (rho(2506) = 0.458, p < 0.001).

Univariate and multivariate analysis of hopelessness and loneliness

Binary logistic regression models were constructed to analyse the relationship between physical activity (aerobic exercise/muscle strengthening), time in front of a screen, self-rated health, self-rated sleep duration, well-being, number of close friends and self-rated loneliness and hopelessness or loneliness adjusted for gender, age and BMI.

In the final multivariate analysis of hopelessness and loneliness, reduced time in front of a screen, fewer friends, feeling lonely often/very often increased the likelihood of moderate/severe hopelessness or high loneliness. The model explained 15% of the variance in hopelessness (Nagelkerke R2) and correctly classified 83.6% of cases. The model explained 27.4% of the variance (Nagelkerke R2) for loneliness and correctly classified 80.7% of cases.

Multinomial logistic regression model for mental health risk

Participants were divided into four categories based on their hopelessness and loneliness scores. The first group (n=1693, 67.5%) is considered "mentally healthy" in the sense of having no, low/moderate loneliness AND normal/moderate hopelessness. The second group, the "hopelessness" group, participants have moderate/severe hopelessness AND no, low/moderate loneliness (n=191, 7.6%). The third group was the "loneliness" group, which included people with high levels of loneliness AND normal/severe hopelessness (n=364, 14.5%). Finally, people with high levels of loneliness AND moderate/severe hopelessness were a group at particular risk of mental health problems.

A multinomial regression model was used to determine the effect of the outcomes and mental health groups studied. The results showed that lower number of close friends, reduced self-rated health and feeling lonely often/very often were associated with high loneliness. Reduced sleep duration, reduced well-being and feeling lonely were often/very often associated with moderate/severe hopelessness. Students who have fewer friends, spend less time in front of a screen, and feel lonely often/very often are more likely to suffer from moderate/severe hopelessness with high loneliness (Figure 1). The model explained 25.8% of the variance in mental health (Nagelkerke R2) and correctly classified 70.7% of cases, with a correct classification of 39.3% for the specific at-risk group with moderate/severe hopelessness and high loneliness.

Summary

In the light of the results, the following conclusions can be drawn. In the Hungarian sample, the prevalence of adolescents and young adults meeting the PA and ST guidelines was low before the COVID-19 outbreak and even worse afterwards during distance learning. The effect of a more sedentary lifestyle on PA decreased and ST increased as a result of distance education. These health effects among young people may have further serious negative public health consequences in the future (Zheng et al., 2020; Dunton et el. 2020).

We pointed out that in all regions, both genders experienced a significant decrease in AE during the introduction of distance education. Before the introduction of distance education, the physical activity of students for at least 20 minutes showed a greater change for boys in all regions, but the same significant decrease as for the less active female groups.

The frequency of AE (day/week) remained unchanged for nearly a quarter of students (24.7%). 61% of the participants reported a decrease in training frequency, with an average of 2 fewer training days per week, and 14.3% reported an increase in frequency, with an average of 2 more training days per week. Our study supports the findings of other reports (Bates et al., 2020; López-Bueno et al., 2020) that nearly half of adolescents report less than optimal physical activity, and that the WHO target of reducing inactivity by 15% by 2030 is at serious risk. Global pre-pandemic data show that a low proportion of adolescents, around 20%, meet the physical activity guidelines (WHO, 2016).

Since the introduction of distance learning, there has been a marked decline in the type of physical activity aimed at developing muscle strength in almost all regions and for both sexes. The type of MS physical activity of pupils before the introduction of distance learning was more notable for boys in all regions, but decreased to a lesser extent for less active groups of girls. The exception is girls in the Budapest region, where the responses indicate no significant change. MS frequency (days/week) did not change for one third (32.9%) of participants. 44.5% of the four regions reported a decrease in the frequency of MS, with an average of 2 fewer days per week of MS, and 22.6% of students reported an increase in frequency, with an average of 2 more days per week of MS. Kovács, Starc, Brandes et. al.

(2021); Biddle, Whitehead, O'Donovan and Nevill, (2005) pointed out that for some groups, such as adolescent girls, poorer time management skills are associated with lower physical activity.

The drastic reduction in team games is very striking for both genders and all regions. It should be pointed out that before the introduction of distance learning, pupils had the opportunity to play team sports at least three times a week during daily physical education lessons, but under distance learning this opportunity has been minimised. During distance learning, responses included those from registered athletes from clubs who were able to play team sports under the restrictions due to the legal exemption. The frequency of team sports (day/week) did not change for 12.9% of students. Unfortunately, as expected, 84.1% of the participants in our study reported a decrease in TS frequency, with an average of 3 fewer days of TS per week, and 3% of 63 participants reported an increase in frequency, with an average of 2 more days of TS per week.

Adolescence is a transitional period in the process of growing up and becoming an adult. Research findings can predict students' future life trajectories and personal development, including how their lives will be influenced by the activities in which they participate (Bandura, 2001). The patterns of behaviour that emerge in their current life situation will determine the extent to which sport and the experience of health-conscious well-being will play a role in their later lives. A decline in physical activity may be reflected in the need for physical activity in adulthood, meaning that poor patterns now emerging may be a concern, particularly for known diseases resulting from inactivity (Tremblay et al., 2011; Gallè F. et al. 2020; Cunningham et al., 2021).

In terms of changes in screen time and physical inactivity, distance learning has not only forced secondary school students to spend more time in front of a screen during study time, but also greatly increased the amount of time spent in the evening. Spending time with friends has changed dramatically, with the online space replacing face-to-face encounters. This finding can be partly explained by curfew restrictions.

However, our results are also consistent with other international research findings where an increase in screen time has been observed (Kovács et al., 2021). These studies report that older children in many countries (Australia, China, France, Germany, Italy, the Netherlands, South Korea, Spain, the UK, the US) spend longer time with digital media during curfew periods (Bergmann et al. 2022; Wong et al. 2020; Sultana et al., 2020).

When looking at subjective assessments of their sleep time and health, distance learning resulted in a uniformly significant increase in sleep time for both sexes in all regions. In our survey, we did not specifically ask about bedtime and wake-up time, but we strongly suspect that the increased sleep time is due to the lack of school attendance and thus the relatively later wake-up time. Among the survey respondents, girls slept less than boys on average. The increased sleep time resulted in them feeling less tired during distance learning, but their self-assessment of their health nevertheless deteriorated.

The subjective assessment of health before and during distance learning showed a statistically significant relationship. On subjective health assessment, 68.1% reported unchanged health, 23.1% reported worse health and 8.8% reported better health during distance learning than before distance learning. This difference was observed regardless of gender, age and region. Their perceived health status was less than 25% worse, with no discernible change during distance learning compared to face-to-face learning. In all cases, girls' mean health scores were found to be worse than boys' in their age group, suggesting that boys perceived their health deterioration to be less significant (Mansfield et. al., 2021)

Changes in physical activity (did not change, decreased, increased) mostly did not affect changes in subjective health ratings (did not change). However, a higher proportion of students reporting a decrease in physical activity also reported a decrease in subjective health: this was the case for about a third and a quarter of students respectively.

In addition, a higher proportion of students who reported a subjective improvement in health were also more likely to report an increase in physical activity: this was the case for almost a quarter of students. Finally, we looked at the gender, age and regional distribution of those who were found to associate reduced physical activity with reduced health. Our results suggest that the sample of rural adolescent girls was a risk group. Hawes and colleagues (2020) report that adolescents and young adults in the United States living in one of the early epicentres of the COVID-19 epidemic experienced increased depressive and anxiety symptoms, particularly among females. Mansfield and colleagues (2021) found similar results in a cross-sectional study conducted in southern England during the first COVID-19 school closure.

The available literature suggests that depressive and anxiety symptoms may have increased during the COVID-19 pandemic and that certain populations (e.g. women and individuals living in areas with high density of COVID-19 cases) are more vulnerable to mental health deterioration during the pandemic (Tolin & Foa, 2008; Torales, O'Higgins, Castaldelli-Maia, & Ventriglio, 2020; Vindegaard & Benros, 2020). Consistent with these international studies, we show that COVID-19 pandemic may be associated with significant mental health problems in the Hungarian adolescent and young adult population studied. The implications of the pandemic situation for mental health in this young population could be significant. It is well known that loneliness and hopelessness are associated with later mental and physical health problems in adolescents and young adults, especially among those who were already at risk of loneliness and hopelessness before the pandemic.

To conclude the thesis and answer the hypotheses, we can conclude that

Hypothesis 1: All types of PA activity decreased during the distance learning period in the study cohort.

Hypothesis 2. The amount of time spent in front of a screen among secondary school students has increased TRUE.

3. Hypothesis. Their sleep time increased during distance learning, this is TRUE.

4. Hypothesis. Subjective ratings of their mental health in terms of loneliness and hopelessness worsened and they felt "lonelier" during the distance learning period, partly - with the distinguishing characteristics reported in Chapters 6 and 7 -IGAZ.

As Kokkonen, Yli-Piipari, Kokkonen and Quay (2019) and Kovacs and colleagues (2021) suggest in their studies, establishing a daily routine by following a regular school timetable and organising the remaining daily time during home learning can be a promising intervention strategy to increase physical activity and limit screen time among children and adolescents. While pre-designed, consistently segmented solutions and parental rules on screens should be promoted to control unhealthy behaviour in younger age groups, persuasion and internalisation of extrinsic motivation should be promoted for older youth, thus making self-motivated PA a lifelong routine.

Active participation in physical activity during the online period could be promoted through the use of electronic applications. Education policymakers should seek to make it compulsory for schools to develop online PE programmes and age-specific curricula if distance learning is reintroduced. Schools should build up their distance learning capacity using physical education, which should be given priority over other theoretical subjects.

LIST OF PUBLICATION

Publications related to this dissertation

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