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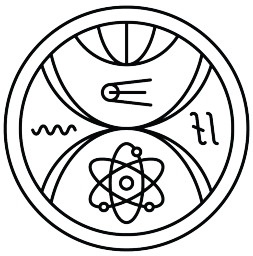

THE IMPACT OF EXCESSIVE SMARTPHONE USE AMONG PRIMARY SCHOOL CHILDREN

Diploma thesis

2026 Mgr. Peter Juriga

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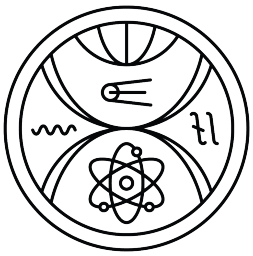

THE IMPACT OF EXCESSIVE SMARTPHONE USE AMONG PRIMARY SCHOOL CHILDREN

Diploma thesis

Study program: Cognitive Science
Supervising department: Department of Applied Informatics
Supervisor: Prof. Dr. Anja Podlesek
Consultant: doc. RNDr. Martin Takáč, PhD.

2026 Mgr. Peter Juriga

Univerzita Komenského v Bratislave
Fakulta matematiky, fyziky a informatiky

ZADANIE ZÁVEREČNEJ PRÁCE

Meno a priezvisko študenta: Mgr. Peter Juriga
Študijný program: kognitívna veda (Jednoodborové štúdium, magisterský II. st., denná forma)
Študijný odbor: informatika
Typ záverečnej práce: diplomová
Jazyk záverečnej práce: anglický
Sekundárny jazyk: slovenský

Názov: The Impact of Excessive Smartphone Use Among Primary School Children
Dôsledky nadmerného používania smartfónov deťmi na základných školách

Anotácia: Cieľom štúdie je prispieť k lepšiemu pochopeniu toho, ako používanie digitálnych zariadení ovplyvňuje kognitívny a emocionálny vývoj mladých adolescentov. Konkrétne sa zaoberá vzťahom medzi nadmerným používaním smartfónov, závislosťou od smartfónov, pozornosťou a psychickou pohodou u žiakov 5. a 9. ročníka základnej školy. Zozbierané údaje budú použité na určenie, či vyššia miera používania smartfónov a závislosť od nich súvisia s horšou pozornosťou a nižšou psychickou pohodou.

Cieľ: 1. Zozbierať údaje od žiakov 5. a 9. ročníka základnej školy: (A) Týždenný čas strávený pred obrazovkou zaznamenaný ich smartfónmi spolu s informáciami o socioekonomickom zázemí a fyzickej aktivite, (B) Test náchylnosti k závislosti od smartfónov pre mládež, (C) Test pozornosti d2 na hodnotenie selektívnej a trvalej pozornosti a index psychickej pohody WHO-5.
2. Pomocou korelačného dizajnu preskúmajte, ako súvisia vzorce používania smartfónov s kognitívnymi a emocionálnymi výsledkami u detí a adolescentov.

Literatúra:
Brickenkamp R., & Zilmer E. (1998). d2 test of attention. Seattle, WA: Hogrefe and Huber Publishers.
Topp C. W. et al. (2015). The WHO-5 Well-Being Index: a systematic review of the literature. Psychotherapy and Psychosomatics, 84(3), 167-176.
Kim D., Lee Y., Lee J., Nam J. K., & Chung Y. (2014). Development of Korean smartphone addiction proneness scale for youth. PloS one, 9(5), e97920.

Vedúci: prof. Dr. Anja Podlesek
Konzultant: doc. RNDr. Martin Takáč, PhD.
Katedra: FMFI.KAI - Katedra aplikovanej informatiky
Vedúci katedry: doc. RNDr. Tatiana Jajcayová, PhD.

Dátum zadania: 10.05.2025

Dátum schválenia: 11.03.2025

prof. Ing. Igor Farkaš, Dr.
garant študijného programu

.....
študent

.....
vedúci práce

Comenius University Bratislava
Faculty of Mathematics, Physics and Informatics

THESIS ASSIGNMENT

Name and Surname:	Mgr. Peter Juriga
Study programme:	Cognitive Science (Single degree study, master II. deg., full time form)
Field of Study:	Computer Science
Type of Thesis:	Diploma Thesis
Language of Thesis:	English
Secondary language:	Slovak

Title: The Impact of Excessive Smartphone Use Among Primary School Children

Annotation: The study aims to contribute to a better understanding of how digital device use affects the cognitive and emotional development of young adolescents. Specifically, it explores the relationship between excessive smartphone use, smartphone addiction, attention, and psychological well-being among primary school students in the 5th and 9th grades. The collected data will be used to determine whether higher levels of smartphone use and addiction are associated with poorer attention performance and lower well-being scores.

Aim: 1. Collect the following data from primary school 5th and 9th graders: (A) Real weekly screen time as recorded in their smartphone settings, along with socioeconomic background information and physical activity, (B) Smartphone Addiction Proneness Scale for Youth, (C) d2 Test of Attention to evaluate selective and sustained attention and the WHO-5 Well-Being Index.
2. Employing a correlational design, examine how smartphone usage patterns relate to cognitive and emotional outcomes in children and adolescents.

Literature:
Brickenkamp R., & Zilmer E. (1998). d2 test of attention. Seattle, WA: Hogrefe and Huber Publishers.
Topp C. W. et al. (2015). The WHO-5 Well-Being Index: a systematic review of the literature. Psychotherapy and Psychosomatics, 84(3), 167-176.
Kim D., Lee Y., Lee J., Nam J. K., & Chung Y. (2014). Development of Korean smartphone addiction proneness scale for youth. PloS one, 9(5), e97920.

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Department:	FMFI.KAI - Department of Applied Informatics
Head of department:	doc. RNDr. Tatiana Jajcayová, PhD.
Assigned:	10.05.2025
Approved:	11.03.2025

prof. Ing. Igor Farkaš, Dr.
Guarantor of Study Programme

Student

Supervisor

Declaration

I declare on my honour that I wrote this diploma thesis, 'The Impact of Excessive Smartphone Use Among Primary School Children', independently, using the cited literature and the DeepL tool to correct the grammar and language.

Acknowledgements

I would like to thank my supervisor, Professor Dr. Anja Podlesek, for her support and guidance throughout this project.

I would like to thank RNDr. Martin Takáč, PhD., for encouraging my ideas and supporting me throughout my CogSci studies and this project.

I would like to thank Mgr. Xenia Daniela Poslon, PhD.; Mgr. Lenka Valuš, PhD.; Mgr. Ing. Matúš Tuna, PhD., and Mgr. Filip Bračok, for their valuable insights and advice on this project.

Finally, I would like to thank all the excellent tutors I have had the good fortune to meet during my CogSci studies.

Abstract

Over the last decade, smartphones have become part of people's everyday lives. Children become familiar with these devices at an early age, and almost every adult and adolescent owns a smartphone. Smartphones have become devices we use to communicate, consume entertainment content, and perform tasks necessary for our working lives. Smartphones make many activities easier and allow us to perform them almost anywhere in the world. However, in addition to the positives, smartphones can also pose certain risks, especially for children, whose prefrontal cortex and executive brain functions are not yet fully developed. There are not many studies that collect real data on how much time users spend on their smartphones. We therefore decided to collect this data from a sample of 614 children attending the fifth and ninth grades of elementary schools in Slovakia. In addition to screen time, we also focused on other psychological instruments focused on well-being, smartphone addiction, and more. This data serves our research purposes and also as a reference point for the future. Our findings illustrate the behavior patterns of fifth and ninth graders in relation to their smartphones, offer a comprehensive view of this issue, and provide recommendations for educators and parents.

Keywords: smartphone, problematic smartphone use, screen time, well-being

Abstrakt

Za posledné desaťročie sa smartfóny stali súčasťou každodenného života ľudí. Deti sa s týmito zariadeniami zoznamujú už v ranom veku a takmer každý dospelý a adolescent vlastní smartfón. Smartfóny sa stali zariadeniami, ktoré používame na komunikáciu, konzumáciu zábavného obsahu a vykonávanie úloh potrebných pre náš pracovný život. Smartfóny uľahčujú mnoho činností a umožňujú nám ich vykonávať takmer kdekoľvek na svete. Okrem pozitív však smartfóny môžu predstavovať aj určité riziká, najmä pre deti, ktorých prefrontálny kortex a exekutívne funkcie mozgu ešte nie sú úplne vyvinuté. Neexistuje veľa štúdií, ktoré zozbierali reálne údaje o tom, koľko času používatelia trávia na svojich smartfónoch. Preto sme sa rozhodli zozbierať tieto údaje od 614 detí, ktoré navštevujú piaty a deviaty ročník základných škôl na Slovensku. Okrem času stráveného pred obrazovkou sme sa zamerali aj na ďalšie psychologické nástroje zamerané na well-being, závislosť od smartfónov a ďalšie. Tieto údaje sme zbierali pre naše výskumné účely a zároveň ako referenčný bod pre budúcnosť. Naše zistenia ilustrujú vzorce správania piatakov a deviatakov vo vzťahu k smartfónom, ponúkajú komplexný pohľad na túto problematiku a poskytujú odporúčania pre pedagógov a rodičov.

Kľúčové slová: smartphone, problematické používanie smartfónu, čas pred obrazovkou, well-being

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Introduction

Technological advances have brought computing power comparable to that of a personal computer to almost every pocket. And with easily accessible internet, an incredible horizon of opportunities arose. On both sides, for users and companies alike. Currently, we are living in a digital environment where many services are free. Or at least, we think so. In reality, we pay with our time.

Personally, I experienced compulsive behaviour towards video games. It took me years to change my habits. The difference is that I started to use computer around the age of twelve. In contrast, babies nowadays have their first smartphone interaction within the first twelve months of life. Although smartphones are very useful devices, problematic smartphone use can have negative consequences for individuals. For babies, it's very tempting because our brain structure is very alert to salient stimuli, helping us to survive. Smartphones are exactly that: flashing lights and various sounds. It's not uncommon to see children crying and screaming in public spaces who then stop once a caregiver gives them a device with a display offering some sort of entertainment. Adolescence is another risky period, when parents tend to relax their restrictions and teenagers undergo challenging emotional development. This topic is gaining increasing attention in both research and business circles. While researchers are trying to understand the effects it has on individuals, companies are developing products to help people limit or stop problematic smartphone use.

The use of the digital environment has proliferated over the past two decades. This is understandable when we consider the many benefits it offers to simplify life. It has therefore become an integral part of daily life and a vital tool for communication, information and entertainment. Consequently, the amount of time that adolescents spend online has nearly doubled in many countries over the past decade (Smahel et al., 2020). According to the same report, the most popular digital media activities among adolescents include watching videos, communicating with family and friends, visiting social networking sites, playing online games, and listening to music.

Adolescence is a dynamic period of development, making it particularly important for understanding the potential risks associated with today's digital environment. Our research focuses on adolescents. Specifically, primary school students in grades fifth and ninth. The fifth grade marks an important transition towards adolescence. It introduces a new school structure in Slovak primary education system and is also typically the age at which

children receive their first personal smartphone. By contrast, ninth graders are typically around fifteen years old and have already entered puberty, displaying more established patterns of digital media use.

As there has been little research involving quality data in Slovakia, we decided to map the behaviour of primary school students in relation to smartphones. We also aim to identify the links indicated by the current literature regarding problematic smartphone use. Our aim is to raise awareness of this topic by providing quality data. This will help to reflect the current situation and provide caregivers with guidelines on how to create healthier digital habits for their children.

1 Adolescence

The World Health Organization defines adolescence as the stage of life between childhood and adulthood. It is a unique period in human development that is important for laying the foundations for a good life for the individual (World Health Organization, 2020). Adolescence is a critical period in development, as it is a transition from childhood, characterized by strong dependence on parents, to adulthood, in which maturity and independence are expected (Corne & Dahl, 2012). Adolescence is considered a particularly crucial period in human development. During adolescence, certain biological and psychological changes occur in an individual's life. Making it a sensitive phase during which the overall quality of the physical, psychological, and social environment can influence the development and health of adolescents later in life (Patton et. al, 2018).

Adolescence is a developmental period characterised by the development of a sense of identity, an increasing need for independence, and the prioritisation of relationships with peers. One of the key developmental goals of adolescence is the maturation of personality and a development of a firm sense of self-identity (Meeus, 2016). Another developmental goal linked to psychosocial development is exploring peer relationships. In other words, adolescents develop autonomy and intimacy by prioritising their relationships with their peers over time spent with their family. They also became more involved in romantic relationships (Catalano & Hawkins, 1996).

Some individuals exhibit an increase in problematic behaviour when parental control decreases during adolescence (Liu et al., 2019). It is important to note that problematic behaviour is a normal part of adolescence for almost everyone, although it varies in degree, range and scope of risk (Gore, et al., 2011). Some perspectives view this behaviour as beneficial, providing an opportunity to acquire the skills and characteristics necessary for adult life, such as independence, autonomy, self-knowledge and an awareness of the boundaries between conformist and nonconformist behaviour. This leads to self-exploration and autonomy (Çakar & Tagay, 2017). Several theories have already been proposed to explain problematic behaviour in adolescents. We can describe two psychosocial frameworks that are often used to explain the development and nature of excessive digital media use as a form of problematic behaviour. These are the Social Development Model (Catalano & Hawkins, 1996) and the Problem Behaviour Theory (Jessor & Jessor, 1977). Beyond psychosocial frameworks, problematic behaviour can also be connected to neurodevelopmental factors. Compared to adults, adolescents have a less developed cortical

system and their cognitive abilities, including working memory and executive functions, are less developed (Casey & Caudle, 2013).

1.1 The Social Development Model

The Social Development Model (Catalano & Hawkins, 1996) is a general theory which describes human behaviour, integrating research into protective and risk factors associated with problematic behaviour within a coherent framework. According to this model, social development is affected by three factors that predict antisocial behaviour: position in the social structure, individual characteristics, and external constraints. These constraints may be imposed by family, peers, school, or the wider community. These are social reactions to behaviours, and they affect problematic behaviours such as excessive use of digital media. They may affect the likelihood of such problems occurring and decrease the likelihood of the prosocial or antisocial path leading to them. The external constraints described by the model (peers, school, family and community/neighbourhood) have already been studied in relation to digital media and its excessive use (Boniel-Nissim & Sasson, 2018). The Social Development Model provides a developmental perspective, distinguishing four stages: preschool, elementary, middle school and high school. Social constraints differ according to the developmental stage of the individual. While family is the most significant factor for younger children in the preschool phase, for example, peers become an increasingly prominent factor for older individuals in the middle or high school phase. According to the theory, individuals who associate with peers who engage in problematic behaviour are more likely to initiate it themselves.

1.2 Problem Behaviour Theory

This theory is based on the assumption that behaviour is a result of an individual's interaction with their environment (Jessor & Jessor, 1977). It is psychosocial in nature and does not consider biological or genetic factors. Problem behaviour is defined as behaviour that does not comply with societal norms and evokes some form of negative feedback from society, ranging from disagreement to imprisonment. Problem Behaviour Theory suggests that problematic behaviours co-occur and share the same determining factors. Engaging in one problem behaviour increases the likelihood of engaging in others. Excessive digital

media-related behaviours also frequently co-occur (Marino et al., 2021). Problem Behaviour Theory comprises three systems of psychosocial influences: personality (including expectations, beliefs, values, and attitudes towards oneself and others); perceived environmental systems (including family and peer social support and social control); and the behaviour system (including problem and conventional behavioural structures). The personality and perceived environmental systems directly determine behaviour. Demographic and socialisation factors affect behaviour indirectly via these systems. Each variable in these systems can be considered a risk or protective factor in problem behaviour. In each system, certain variables either stimulate problem behaviour (risk factors) or prevent it (protective factors). Together, these factors determine the probability of problem behaviour occurring, a state referred to as „proneness“ (Jessor & Jessor, 1977). If the pathways leading to excessive digital media use were identified, it would be possible to prevent and reduce their occurrence. However, using digital media in itself is not necessarily problematic behaviour. It provides adolescents with opportunities such as communicating with friends, playing games and educating themselves.

1.3 The Use of Smartphone in Adolescence

1.3.1 Younger School Age

When children start school, new social roles arise. Children must adapt to school conditions, find close friendships, and learn new skills. Some children receive their first phones in their early school years, others at the onset of puberty (Pearlman, 2022). The author of First Phone: A Child’s Guide to Digital Responsibility, Safety & Etiquette, Catherine Pearlman, emphasizes that it is not so important at what age a child gets their first cell phone, because they have access to digital technologies long before that. Many children have their own tablets or meet friends at school who already have their own cell phones, or have older siblings with their own devices. Digital technology thus accompanies all children from an early age. It is important for parents and children to communicate about technology so that children understand the principles of safe use and retain this concept into the future. On average, children receive their first cell phones at the transition from early school age to adolescence (Pearlman, 2022). Children must be mature enough for their first smartphone so that they can use it without becoming absorbed by it. They need to know what information

to share on the internet, who they can and cannot text, what content to search for, and what to avoid. In many ways, this depends on the parents and the depth of the child's emotional bond with their parents (Kubíková, 2019).

Regulating the amount of time children spend (not only) on their mobile phones should be the responsibility of parents at every stage of development. It has been shown that parenting style, behavior, and attitudes toward technology are key to preventing problematic use (Gladkaya et al., 2018). If a parent exhibits excessive behaviour towards digital technologies, there is a high probability that their child will follow habit (Jeong et al., 2022). In their study, Hiniker, et al. (2015) observed parents who were at the playground with their children. When a parent used a phone, their ability to respond to their child's needs was significantly reduced compared to parents who did not use a phone. Of the 32 parents observed using a phone at the time, a total of 18 did not speak to their child when they demanded attention, nor did they look away from the screen. Kushlev and Dunn (2019)came to similar conclusions in their experiment examining the social relationship between parents and preschool-aged children while the parents were using their cell phones. They found that frequent cell phone use caused parents to feel distracted, which diverted their attention away from feeling socially connected to their children.

1.3.2 Older School Age

Adolescence is characterized by significant changes not only in the physical realm, but also in the emotional, cognitive, and social realms. Peer relationships are very important for children of this age, as they help them form their own identity. The goal is to achieve autonomy and detachment from parents. Although the relationship between child and parent is changing, when the adolescence begins, quality interaction continues to play an irreplaceable role (Thorová, 2015). Adolescents aged 15-16 spend the most time on their cell phones, twice as much as children aged 9-11. Although they may seem resistant to the risks of the internet, they are a vulnerable group. On the internet, they may encounter risks such as online aggression and cyberbullying, exposure to potentially harmful content, experiences of data abuse, excessive internet use, sexting, and exposure to sexual content (Smahel, et al., 2020).. Adolescents of this age are more at risk of developing addiction or problematic mobile phone use, compared to adults. More than half of American teenagers aged 13-17 admitted that it would be really difficult for them to give up social media (PewResearch, 2022).

It has proven difficult to determine whether mobile phones and associated social networks have a clearly negative or positive influence on adolescents. Given the importance of peer groups, activity on mobile phones, and thus on social networks, can have a positive influence. Online communication with peers promotes a sense of belonging and self-disclosure in some adolescents. On the other hand, there is a certain threat to identity, as constant connectivity can affect adolescents ability to develop an autonomous sense of self (Davis, 2012). The use of some social networks has been associated with greater family satisfaction and recreation (e.g., the ability to communicate more often despite greater distance or watching videos together), but in some cases it has reduced the amount of time spent with the family, impaired attention during face-to-face interactions, and raised concerns about the development of social skills in children (Sharaievska & Stodolska, 2016). One of the most important protective factors against the negative effects caused by excessive mobile phone use by adolescents is open communication between parents and adolescents and the associated quality family relationships (Smahel, et al., 2020).

1.4 Brain Development in Adolescence

The brain is made up of a vast number of cells called neurons. Each neuron has dendrites, a cell body containing a nucleus and axon. Neurons communicate with one another at synapses, typically via chemical messengers known as neurotransmitters. When a neuron becomes active, an electrical impulse travels along its axon to the synapse, where neurotransmitters are released into the small space between cells. These chemicals then bind to the next neuron, passing on the signal. Billions of these connections form dense neural networks that underlie processes such as memory, thought and emotion (Greenfield, 2014). The neurotransmitter that interests us in relation to mobile phone use is called dopamine. Dopamine is released into the brain when we experience positive emotions and plays an important role in the reward system, among other things. The brain remembers this moment and motivates the person to repeat the activity. This is the principle behind most addictions (Wise & Robble, 2020).

The human brain undergoes major changes in the postnatal period. While the gray matter in the primary sensorimotor cortex reaches its maximum density first, the prefrontal cortex matures last. The maturation of the brain during adolescence also depends on stimuli from the external environment that stimulate the development of the relevant functions.

During this period, neural connections become more efficient, enabling faster information processing and activation of different areas. Adolescents contribute to this developmental process by deciding for themselves what they will do, thereby strengthening certain synaptic connections. Another important change is in the production of neurotransmitters, notably an increase in dopamine levels in the prefrontal cortex and limbic system, which experts believe is one of the reasons why adolescents seek out risky situations and exciting experiences. The prefrontal cortex, the center of decision-making and control of various behaviors, such as impulse control, which matures during this period, has a significant impact on the thinking and behavior of adolescents. Its proper development is a prerequisite for the development of cognitive abilities because it allows the processing of larger amounts of information and the selection of those that are significant. The limbic system, as the center of emotional experience, also matures rapidly during adolescence, causing an increase in the tendency to react emotionally and an increase in the intensity of an individual's emotional experiences. Problematic for the experience of adolescents is the fact that different areas mature at different rates, and so, for example, changes in the limbic system occur earlier than those in the prefrontal cortex, causing difficulties in controlling emotions and associated behavior, which can lead to impulsive or risky responses. (Konrad et al., 2013)

Some experts e.g., (Blatný, et al., 2006)speak of an alarmingly high prevalence of risky and antisocial behavior among adolescents. The tendency to seek out extreme situations and emotions is also reflected in German statistics (Konrad et al., 2013), according to which 62% of deaths among people aged 15-20 are the result of traumatic injuries. The uneven development of the cerebral cortex also affects the way problems are processed: although adolescents have developed logical thinking and the ability to consider multiple aspects, they are only capable of doing so in situations that are not emotionally significant to them (Vágnerová, 2012).

2 Smartphones as Parts of Our Lives

A smartphone could be defined as a small pocket-sized electronic device, that uses an advanced application interface and operating system that allows programs to be installed or modified, while also enabling connection to the Internet. It is a device that enables wireless communication, the acquisition of new knowledge, a certain form of socialization, access to healthcare services, and a source of entertainment. It allows us to call, send and receive emails, listen to music, watch movies, shop online or read books. The first attempts at creating smartphones date back to 1992, when IBM introduced a prototype called the Simon Personal Communicator, which had many more features than previous mobile devices. (Kirvan & Provazza, 2023) However, it was the first iPhone prototype in 2007 that sparked the popularity of the smartphones we know today (Rafalski, 2025). Year 2010 is considered a breakthrough year for modern smartphones due to the growing popularity of Android smartphones and upgraded iPhones. The era around iPhone 4 is regarded as the device that prompted the general public to switch from classic phones to smartphones.

Currently, only two operating systems dominate smartphones market. These are Android and iOS. In the past, there were other operating systems, but their market share is now practically zero. According to Statcounter, in November 2025, 71.9% of Slovak smartphone users had Android as their operating system. 27.7% had iOS, and the rest were distributed among several other systems (Statcounter, 2025). iOS is a mobile operating system developed by Apple Inc. for phones and tablets of the same name. iOS is constantly being developed, with individual versions designated by a numerical series. iOS version 1 was introduced together with the first Apple iPhone in 2007 (Rafalski, 2025). Android is a mobile operating system used not only in mobile phones, but also in tablets, smart TVs, and other devices. It is based on the Linux OS kernel. It is developed by the Open Handset Alliance consortium led by Google. Android is, of course, constantly being modified and updated, with individual versions numbered and named alphabetically after sweets (e.g., version 4.4 KitKat, version 5.0 Lollipop, version 6.0 Marshmallow, etc.). The naming after sweets was later abandoned (Geeksforgeeks, 2025).

In terms of global smartphone sales, the main boom took place between 2009 and 2015. While only 172 million smartphones were sold in 2009, by 2015 this figure had risen to almost 1,424 million. In seven years, the number of smartphones sold increased eightfold. In the last four years, sales have remained relatively stable at around 1.4 billion per year (Elagina, 2025). In 2023, around 85% (6,71 billion) of the world's population owned a

smartphone, compared to only about 46% (3,57 billion) of people worldwide in 2016 (Elagina, 2025).

2.1 Frequently Used Smartphone Applications

Nowadays, social networks and online games play a key role in the daily lives of people of all ages, with their influence being particularly noticeable among younger generations. The growing importance of different apps in modern society is reflected in the increasing amount of time people spend on it, as it has become the primary tool for communication, entertainment, and information gathering. Below, we briefly introduce a few applications that are considered the most popular among current adolescents.

Instagram

Instagram American is a social network focused on sharing photos and short videos. Users can edit their images using filters and tools, add likes and comments to other users posts, and follow their profiles. Key features include Instagram Stories, which allow users to share content that is visible for 24 hours, and Instagram Reels, which are short videos similar to those on TikTok. Instagram provides an easy and visually appealing environment for expression and interaction, accessible via both a mobile app and a web browser.

Tik Tok

TikTok is a Chinese mobile app focused on creating and sharing short videos ranging from 15 to 60 seconds in length. Users can edit videos using various tools such as filters, music, and effects. The platform is characterized by highly personalized content thanks to a good algorithm that analyzes user interactions and displays videos that may be of interest to users. Key features of TikTok include the ability to create "duets," where users respond to other users' videos, and the creation of viral trends through challenges and creative videos. TikTok is also a pioneer of so called „reels“. Reels are short, vertical videos, typically 15-90 seconds, featuring music, effects, and fast-paced editing.

YouTube

YouTube is the world's largest online video sharing platform, which since its inception has significantly influenced the ways in which people consume, create, and share

content on the internet. It serves not only as a space for entertainment, but also for education. YouTube also offers content creators various options for monetizing their work, such as through advertising, YouTube Premium subscriptions Premium subscriptions, or the sale of merchandise. Video creators can communicate with their fans and followers through comments and live chats, building a community around their channel.

Snapchat

Snapchat is a unique social network that stands out for its main feature, sent messages and photos are automatically deleted after a certain amount of time. This concept reflects the idea that not all digital experiences should be permanently preserved. Snapchat is also a pioneer of so called „stories". Snapchat's main focus is on "the present." Users can send photos and videos, called "snaps," which are automatically deleted after viewing. The "Stories" feature allows users to share photos and videos with all their friends, with this content disappearing after 24 hours. Snapchat also offers various creative tools such as filters, stickers, and Bitmoji, which allow users to personalize their shared experiences.

WhatsApp

WhatsApp is a communication platform that allows users to send text messages, photos, videos, and voice messages. It is known for its simple interface and the ability to create group chats, making communication with friends, family, or colleagues quick and organized. WhatsApp also supports voice and video calls, which can be made both one-on-one or in groups. An important feature is end-to-end encryption, which ensures that conversations remain private. The app is available on mobile devices and also offers a desktop version for easier messaging.

Roblox

Roblox is an online platform and game creation system that allows users to play games created by other players or design their own using simple development tools. It stands out for its large community and endless variety of user-generated content, ranging from adventure games to simulations and role-playing worlds. Players can customize their avatars and interact with others, creating a social experience in addition to gaming. For creators, Roblox Studio offers tools to build games and even earn real money through in-game purchases. The platform is accessible on multiple devices, making it popular among younger audiences.

Clash Royale

Clash Royale is a fast-paced mobile strategy game developed by Supercell, combining elements of tower defense, card collecting, and real-time battles. Players use decks of cards featuring characters and spells to compete against opponents and destroy their towers. The game is known for its short, intense matches and a ranking system that places players into different arenas based on their skill level. Clash Royale encourages strategic thinking, as players must decide when and where to deploy their units during a match. The game also allows players to join clans, participate in special events, and collect chests that contain rewards to upgrade their cards.

2.2 Smartphone Usage in Slovakia

Students at Faculty of Mass Media Communication of University of Ss. Cyril and Methodius in Trnava conducted research to find out how much time we spend on our mobile phones. A total of 267 respondents took part in the survey. The data was collected through an anonymous questionnaire and the Screen Time app. The results showed that users spent an average of four hours and six minutes a day using mobile devices. Respondents spent the most time on mobile devices on Wednesdays. The most used apps on mobile devices were Instagram (an average of 26 minutes per day), followed by Messenger (21 minutes per day) and YouTube (20 minutes per day). Overall, respondents spent two hours and three minutes a day on social networks. They spent 42 minutes watching movies, TV series, or listening to music. Respondents under the age of 19 spent the most time on mobile devices. On average, this was five hours and 15 minutes per day. The difference between this age group and respondents in the over 40 age category was more than two hours. An interesting finding is that the average high school student spent about ten minutes more using their smartphone than a university student. Employed respondents spent the least amount of time on their mobile phones (an average of 3 hours and 44 minutes). University students spent the most time playing games. Surprisingly, men spent more time on mobile devices. Compared to women, this was an average of 13 minutes more per week. Women spent the most time on social networks Instagram, Messenger, and YouTube. For men, Instagram was the most popular, followed by YouTube and finally Messenger. An interesting finding is that men preferred gaming apps, unlike women, who used apps focused on creativity and productivity more. The most used app among high school students and employees was YouTube. It was followed by Instagram and Messenger. University students used Instagram the most, but Facebook and Messenger were also popular among them. (Styková & Madleňák, 2020)

Being offline for a while can be very beneficial. In 2018, students in Kráľová pri Senci experienced this firsthand when they participated in the Bezinternetu (No Internet) project and did not use the internet for a month. The questionnaires showed that during the month without the internet, the children played more, read books, communicated with their parents, played with their siblings, and participated more often in household chores. They also spent more time with their parents and siblings. Questionnaires showed that during the month without the internet, the children played more, read books, communicated with their parents, played with their siblings, helped with household chores more often, were more active and creative, went outside more, took an interest in family events, etc. About 80% of

parents said they would be against the use of cell phones in schools, whether during class or during breaks. During the project, the students kept diaries in which they recorded the course of their month. One student said that on the fourth day without her phone, she read her first book. She also writes that without her cell phone, she communicates better with her friends and that she has discovered which friendships are real. She began to pay more attention to her surroundings, play sports, read, and her grades improved. At the end of the month, she was looking forward to getting her cell phone back, but in the end, she didn't really care about it, and she even deleted some of her social media accounts. (eSlovensko, 2018)

2.2.1 Smartphones in School - Slovak legislation

Since the beginning of 2025, the use of smartphones in primary schools has been regulated by education law. In elementary schools and in the first four grades of eight-year secondary schools, the use of mobile phones and other personal communication devices is prohibited during class, except for those belonging to or administered by the school. This prohibition applies in full to students in grades 1 to 3 of elementary school. Pupils in grades 4 to 9 of primary school and pupils in grades 1 to 4 of eight-year grammar schools may only use mobile phones or other devices if they serve educational purposes and help to meet the standards of the state education program, or if the teacher of the subject in question expressly permits such use. If a student uses a communication device in violation of these rules, the school may temporarily confiscate it. (MŠVVaM SR, 2008)

2.2.2 Screen Time

Screen time is a term that is often mentioned in connection with the use of digital technologies. However, there is no single definition of the term, as everyone understands it slightly differently and, as a result, it is not studied in a uniform manner. The term screen time is generally related to the time spent watching a screen (regardless of the type of screen), but sometimes researchers only track the time spent watching TV, computers, or phone screens. At the same time, the method of data collection often varies. Either it is an estimate by participants, or the time is monitored by researchers for a certain period. In our research, we refer to screen time as the amount of time children spend using their smartphones.

3 Effects of Digital Technologies on Adolescents

Digital technologies can facilitate positive self-expression and self-presentation, as well as experimentation in the development of a sense of self-identity (Twomey & O'Reilly, 2017). From a social perspective, digital media provide an opportunity to support adolescents developmental needs. For instance, social media enables adolescents to maintain relationships and connect with their peers (Kuss & Griffiths, 2017). However, while some use digital media to support their relationships, others use it to compensate for unmet social needs.

Stiglic and Viner (2019) confirm the link between longer screen time and negative effects in children and adolescents in their review study. Users are at greater risk of obesity, depressive symptoms, and poorer quality of life. In this review study, screen time was examined as time spent on any screen. As mentioned above, individual studies differed in how they collected information about time (self-reported or measured). Research conducted by Ngantcha et al. (2018), states that the negative effects of screens on young children appear when they exceed 2 hours of viewing per day. They observed a decline in life satisfaction, a greater tendency to bully at school and poorer school performance. At the same time, they identified the socioeconomic status of children as a significant predictor of screen time. Adolescents also tended to copy how much time their parents spent on screens.

Greenfield (2015) describes how social networks provide instant gratification because they are immediately accessible via mobile phones and can be used to contact anyone right away. Second, they offer anticipatory excitement. It has been found that dopamine begins to be released in anticipation of the experience even before, for example, the person obtains the thing in question. People thus experience greater excitement before they receive the reward (O'Doherty, et al., 2002). The unpredictability offered by social networks is also significant for human brain. People don't know what feedback they will get after posting a comment or photo, they don't know who just sent them a message when they hear the "ping." Each time, a small amount of dopamine is released, which makes the human brain feel so good that the activity can become compulsive (Greenfield, 2015). It is precisely these short-term satisfactions that can encourage users to use the network more and more frequently, which can result in more frequent escapes into the virtual world and an inability to resolve conflicts in the real world (Marciano, et al., 2021). In addition to dopamine, our instincts draw people to digital technologies. In the distant past, they primarily helped people survive. As soon as something flashed in the bushes, a person was ready to fight or fly.

Today, people are mostly not concerned with this kind of survival, but human instincts have naturally remained. In modern times, people try to obtain as much information as possible to give themselves the best chance of survival. This is also due to our social instinct, which compels us to know who others are, what they think of us, and what they know in comparison to us. People are ready to focus their attention on something unusual, they want to prove themselves, achieve and create, and they crave relationships. Digital technology attracts us not only with its screens, where something is constantly happening and keeping us on our toes, but also with its unlimited information and opportunities to stay connected. Every time people pick up they cell phone, they can learn something new. This is also why people tend to pick up their cell phones even when "nothing is happening". (Carr, 2015) Frequent cell phone checking has become a habit, resulting in people picking up their cell phones aimlessly. Sometimes they want to check the time, so they look at their phone, but in the end they don't know what time it actually is (Fullwood, et al., 2017)

Attention is one of the key cognitive functions that enables children to perceive stimuli, concentrate on assigned tasks, and filter out various distractions. In preschool age, the development of attention is very dynamic. Children learn to maintain their attention for longer periods of time, switch between stimuli, and focus on what is important (Ruff & Rothbart, 2001). Research shows that children who are frequently exposed to fast-paced and dynamic digital stimuli, such as animations with frequent cuts, flashing lights, sound effects, or so-called hyperstimulating videos designed to grab attention, may show a reduced ability to maintain attention on less stimulating activities such as listening to stories, drawing, or working at a desk (Kirkorian, et al., 2009). Highly stimulating digital content typically does not require any deeper processing of information. According to George and Odgers (2015), it is possible that the plasticity of the adolescent brain allows for the optimization of performance for new digital environments. On the other hand, excessive digital exposure may also pose a risk of damaging cognitive abilities and overall performance. This can lead to changes in the brain (both temporary and permanent). It is important to recognize that technology can provide new experiences and stimuli for children's brains. At the same time, it can affect their ability to concentrate, pay attention, and interact socially. Given that early childhood and adolescence are critical periods for brain growth and reorganization, it is important for children to have balanced access to technology. For optimal brain and cognitive development, it is essential that they are exposed to diverse experiences and environments (Limone & Toto, 2021).

3.1 Problematic Smartphone Use (PSU)

The availability of modern technology raises many questions and closely related concerns about the physical and mental health of the adolescent population. The ever-growing rise of modern technology has attracted the attention of many experts, as a growing trend in the use of smartphones and related social media has been identified (Carr, 2015). Smartphones have become part of the daily lives of the adolescent population (Orben, 2020). The use of smartphones differs from the normal use of the internet on laptops. Smartphones, as small pocket electronic devices, allow the user continuous access to the internet regardless of time or place (Montag, et al., 2021). Researchers in the United Kingdom have found that the average time spent on smartphones among the adolescent population is 4 to 5 hours per day (Shen, et al., 2024). The same amount of time spent on smartphones was also found in the US (Radesky, et al., 2023) and Europe (Smahel et al. 2020). Almost half of smartphone users in developed countries believe they use their phones excessively. And only half of those who try to reduce their screen time say they are successful in doing so (Deloitte, 2019).

To a large extent, people use smartphones primarily for their own convenience. Many of them reach for their cell phones immediately after completing another activity, such as getting off the bus or sitting down in a caffeteria, just to check often unimportant messages or calls. The device itself is not addictive until we start using it to escape our problems. Such behaviour often appears in early childhood, when parents allow their children access to modern technology from around the age of 3. Children thus learn to seek entertainment on their smartphones rather than outside with friends or playing games. Mostly, it is young people without meaningful leisure activities and quality social relationships who are attached to their phones. (Krejčí, 2019)

The topic of smartphone use has been linked to the term problematic smartphone use or even smartphone addiction. The term smartphone addiction is often used by experts who believe that the behavior of individuals partly meets the criteria for addiction (Yan, et al., 2008). The term problematic smartphone use is more commonly used and is supported by experts who believe that the difficulties that arise are not directly related to the development of addiction. The term problematic smartphone use is usually used after the manifestation of specific physical or psychological problems, that can interfere with daily life, disrupt social functioning, and lead to psychological or behavioral problems (Panova & Carbonell, 2018). The problems that arise include study difficulties, reduced self-esteem and reduced ability to regulate emotions (Wacks & Weinstein, 2021). There is a relationship between excessive

smartphone use in the evening and emerging problems with insufficient sleep and problems related to falling asleep (Ghekiere, et al., 2019). Several studies have found a negative impact of phones use on the working memory of adolescents (Thomas, et al., 2010).

The estimated rate of problematic smartphone use among the adolescent population is approximately 10-30% of the population (Elhai, at al., 2019) Among Chinese university students, the prevalence of PSU was estimated at 21.3%, with students from high-income families and those experiencing higher levels of perceived stress considered to be at greater risk (Long, at al., 2016).

In addition to the above mentioned problems, a recurring problem with social interaction in connection with smartphone use has also been identified. The term social interaction can be understood as a meeting between at least two people. During the meeting, they pay attention to each other and adapt their behavior to the situation (Reis, et al. 1980). PSU has been associated with feelings of isolation, impaired communication, and reduced interpersonal relationships (Stevic, et al., 2021).

Similar term used to describe the psychological condition of excessive smartphone use is nomophobia. The term was first introduced around 2008 by the UK research organisation YouGov. The aim of their study was to evaluate whether anxiety disorders could occur as a result of excessive mobile phone use. Nomophobia is therefore used to describe the psychological condition of fearing separation from one's mobile phone or loss of network signal. (Bhattacharya, et al., 2019)

3.2 Doom-scrolling

Scrolling, another phenomenon associated with excessive smartphone use, brings with it many pitfalls, especially when it comes to „doom-scrolling“. This term refers to scrolling through social media with exclusively negative content. Excessive viewing of negative-focused pages and messages is closely linked to increased levels of depression, anxiety, emotional exhaustion, and reduced sleep quality (George, et al., 2024). However, the negative impact of scrolling is not exclusively related to negative content, but also to following male or female ideals, various influencers, and outwardly perfect-looking people. Adolescents and young adults often compare themselves to many internet ideals, which may trigger feelings of envy, which in turn leads to problems with low self-esteem. Scrolling

through such content and subsequent comparison increases feelings of anxiety and inadequacy in individuals, which cause depressive states (Holmgren & Coyne, 2017).

Scrolling is particularly dangerous in terms of addictive behaviour. Its mechanism is designed to create a constant flow of new, never-ending content that motivates individuals to continuously view interesting posts. While scrolling through interesting, new, and appealing content, dopamine is released, creating a feeling of reward and pleasure. The release of this neurotransmitter causes the individual to want to experience this feeling again, which leads to more frequent scrolling, which in turn creates an endless cycle that often leads to PSU (Alter, 2017).

3.3 Self-control

The results of several studies show that people who have higher self-regulation and self-control skills are more resistant to excessive use of (not only) mobile phones (Yang,et al., 2021). Self-regulation is a lifelong process during which we develop cognitive and metacognitive skills and we get to know ourselves and learn to control our behaviour. We learn the ability to regulate ourselves from an early age, when we are influenced not only by our personality, but also by social and environmental factors. Self-regulation is a cyclical process in which we use our thoughts, feelings, and actions to achieve personal goals (Zimmerman, 2000).

Failure of self-regulation during a smartphone use, can reduce a person's self-confidence, lead to stress, and motivate a person to use a mobile phone to ease these negative feelings (Deursen, et al., 2015). According to Stuart Shanker, the goal of self-regulation is not to label a behaviour as something that needs to be resisted or controlled, but to find the reason why I feel the urge to engage in that behaviour. Then self-regulation can become an effective tool for achieving positive and lasting change (Shanker, 2017)

4 Preliminary Research

4.1 Research Approach

Research Aim

The research aim was to examine, whether participants with better attention and inhibition abilities spend less time on their smartphones. Also, as research shows, excessive screen time leads to a more sedentary lifestyle (Xiang, et al., 2020). Another indication was therefore to look for a connection between the average number of steps and the time spent in front of the screen. We were also interested in the difference between estimated self-reported screen time and actual screen time.

Another goal of preliminary research was to obtain the necessary knowledge and information on how the individual variables are approximately related. We also wanted to gain experience in how difficult it is to collect real data on smartphone use. And to obtain feedback on how to adjust the data collection design before the research. The preliminary research consisted of a similar research design to that subsequently used in this study.

The preliminary research consisted of two parts. The first part was conducted in the form of a questionnaire. The second part focused on collecting real data on screen time and average number of steps per day. Participants in this study were my friends, whom I personally asked to participate in the preliminary research. For the sake of consistency in the data on screen time, only participants with Apple smartphones were included in the research. The preliminary research was conducted between April 22 and 27, 2025. The results were subsequently presented at the MEi:CogSci student conference.

First Part of Preliminary Research

The first part of the research design was carried out between April 22 and 26, 2025. Participants filled in a questionnaire contained basic demographic data (age, gender, education, country of residence), followed by questions asking whether they were aware of how much time they spent on their smartphones and whether they had ever tried to limit it, how they feel about how much time they spend on their smartphone and how much time they estimate they spend on their smartphone each day. The last, concluding part of the questionnaire was based on a psychological instrument focused on self-control, the Effortful

Control Scale. Two specific scales from this instrument were used: Inhibitory Control and Attention Control (Atherton, et al., 2020).

Since participants were instructed in the first part of the study to try to estimate how much time they spend on their phones, it was necessary to ensure that the questionnaire was completed by everyone before the second part.

Second Part of Preliminary Research

In the second part of the study, we focused on collecting real screen time data and statistics on the average daily number of steps taken by our participants. Participants took screenshots of their smartphone settings, screen time, for each week and uploaded the images to secure storage. The Apple Screen Time app only provides a four-week history, with each week starting on Monday and ending on Sunday. In order to obtain the most relevant data and to be able to correlate it with steps on a monthly basis, we decided to collect screenshots on Sunday afternoon, April 27. The screenshot contained the average daily time for the past week and the subsequent breakdown of time between individual categories (social media, entertainment, etc.). We preferred to collect time by category rather than by specific applications for privacy reasons. The second piece of data we collected was the average number of steps per day over the past month. Participants also took a screenshot of this data in the Apple Health app.

Participants

Participants were recruited through personal contact and were my friends. Therefore, it was not a randomized and well-distributed group across the population. The inclusion criterion was that they had to use an Apple smartphone. All participants were properly instructed and voluntarily participated in the research. A total of forty-three participants (18 women and 25 men) took part in the study. Twenty-two participants (11 women and 11 men) completed the second part of the study. The average age of the participants was 31 years. The vast majority of participants were Slovak nationals and lived in Slovakia.

4.2 Results

Of the 43 participants, 75% said they were aware of how much time they spent on their phones. When asked how they felt about how much time they spent on their smartphones, the results were mixed. Roughly half felt positive and half felt negative. A very similar distribution was found for the questions of whether they had ever tried to limit the time they spend on their phones and whether they use or have used an app to limit screen time. For both questions, participants were divided between 51% answering no and 49% answering yes. The final question concerned the estimated time spent on smartphones. The average result of 43 participants was 3 hours and 3 minutes, while the average time of 22 participants who also took part in the second part was 3 hours and 16 minutes. Real data showed that the average screen time for the group of 22 was 3 hours and 56 minutes, which is 40 minutes higher than the participants estimated. Over the course of a year, this 40-minute difference represents about 10 days of pure time. The preliminary research also showed that the lowest average time over 4 weeks was 80 minutes and the highest was 363 minutes.

As already mentioned, only 22 participants took part in the second part, but only 18 of them shared their data on the average number of steps. A total of 84 weeks of screen time was collected, as 4 participants only shared data for 3 weeks. Out of 84 weeks, social networks were the most used apps in 67 weeks. In the remaining 17 weeks, social networks were always in second place. At the same time, for 14 participants, social networks were always in first place in all weeks. Other categories of applications used were: entertainment, games, travel, and so on. The social networking category includes applications such as Instagram, TikTok, Messenger, Facebook, WhatsApp, and others. The entertainment category includes applications such as YouTube, Netflix, Voyo, and others. The travel category includes applications such as online maps, navigation, and others.

The first hypothesis, more screen time, fewer average steps per day, was not confirmed. The average of the 18 participants who shared data on the number of steps was 8,867 steps per day. The shortcomings of this study was that it was not a randomized group that would better cover the distribution of the population, as almost all participants involved in the survey are very physically active and many of them practice some sport on a daily basis. This resulted in a situation where participants with a relatively high average daily screen time also had a high average number of steps, and it was therefore not possible to confirm the hypothesis that more screen time causes a sedentary lifestyle.

The second hypothesis sought a connection between screen time and psychological instruments focused on inhibition control and attention control. Figure 1 shows a correlation between higher screen time and poorer self-regulation results. Specifically, poorer results on the inhibition and attention control scales. Higher scores in both cases were related to lower average screen time per day. The correlation matrix between average screen time and the sum of inhibition and attention scores for a total of 22 participants, with degrees of freedom (df) of 20, showed a Pearson correlation coefficient of -0.188. This indicates a negative linear relationship between higher screen time and lower effortful control, with a weak association strength. The p-value was 0.403, indicating that these results are not significant.

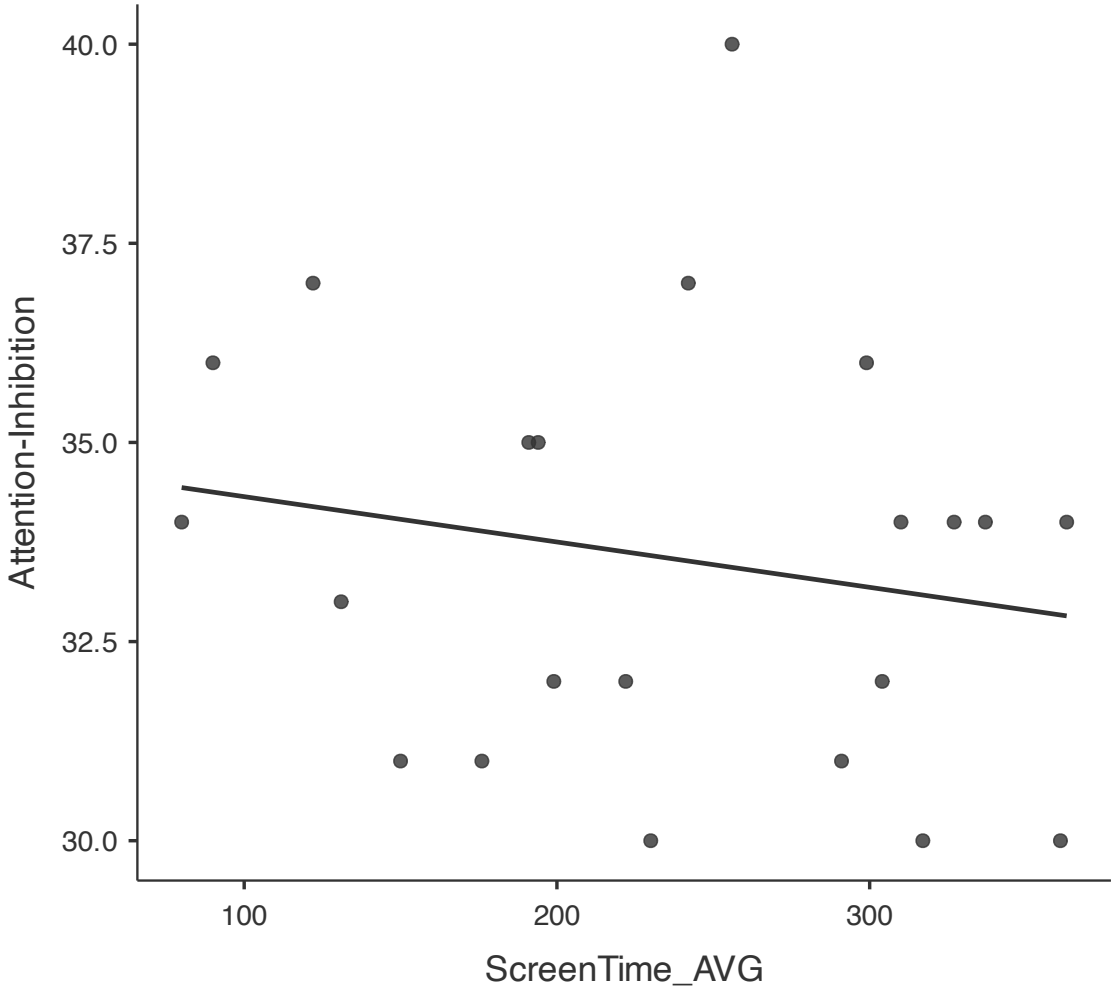

Figure 1 Relationship between Screentime and Effortful Control Scale

Although 75% of participants stated that they were aware of how much time they spent on their smartphones, the difference between self-reported and actual screen time was as much as 40 minutes. We were unable to find a link between a sedentary lifestyle and

screen time, which may have been due to an inappropriate selection of participants. We found a small positive but insignificant link between a psychological instrument focused on self-regulation and screen time.

The preliminary research was very beneficial as it helped us to better select questions for the main study. This allowed us to avoid redundant questions that cannot be easily compared with each other. At the same time, it clearly showed us that for statistical significance, it is necessary to have a larger sample of participants that better reflects the real population. Last but not least, we need to select psychological instruments that better reflect our research scope. It turned out that using a scale focused on self-control is not entirely appropriate, as its scope is relatively broad. For more accurate results, it is necessary to use a more narrowly specified scale, which, for example, focuses on problematic smartphone use.

5 Methodology

5.1 Research Approach

There are currently a large number of studies examining the impact of smartphones on the population, but only some of them work with real data on how much time users spend on their smartphones. Across studies, it has been shown, as we have also demonstrated in our preliminary research, that self-reported screen time is not an entirely relevant metric. If we want to connect this variable with other indicators, it is necessary to record it as accurately as possible.

In our work, we decided to use a less standard research approach. Our goal was not to have clearly defined research hypotheses in advance, but to choose the right research tools and then look for connections between them.

For these reasons, we chose objective screen time as the primary variable of interest, also because it is a clear and easily measurable quantity that we can pair with other data. We decided to collect screen time data using official applications: Screen Time on Apple devices and Digital Wellbeing & Parental Control on Android devices. These apps are relatively new compared to when the first iPhone was introduced. Android was the first to offer the option to limit screen time in 2017, using Family Link, where a parent device could decide how much time child devices could spend on the screen (Perez, 2017). This was an initial version that had several shortcomings. The progress accelerated in the following year, specifically on January 19, 2018, when Jana Partners and the California State Teachers' Retirement System, investors in Apple, wrote an open letter based on scientific studies showing how excessive smartphone use can be harmful to children. They asked Apple to create better parental tools to regulate screen time. They also asked Apple to educate parents and provide regular reporting on this issue (Sheehan, 2018). Apple's response came relatively quickly. Later that year, Apple announced a new "screen time" feature at its WWDC (Worldwide Developers Conference) with the arrival of iOS 12 (Apple, 2018).

Since then, these features have developed significantly in both systems. Currently, both systems allow you to manage multiple devices under one account and thus one limit across devices. With Android, this includes smartphones and tablets, while with Apple, it includes smartphones, tablets, and personal computers.

Screen time apps provide a whole range of information, such as how much time you spent on which app or website, how often you opened your smartphone during the day, and which app was the first one you opened. At the same time, they give parents a lot of flexibility in setting individual limits. The limit can vary from day to day, it can be lowered or increased during the day, and it is also possible to preselect which apps will or will not be affected. Data from those applications are therefore a very accurate metric (Android, 2026; Apple, 2026).

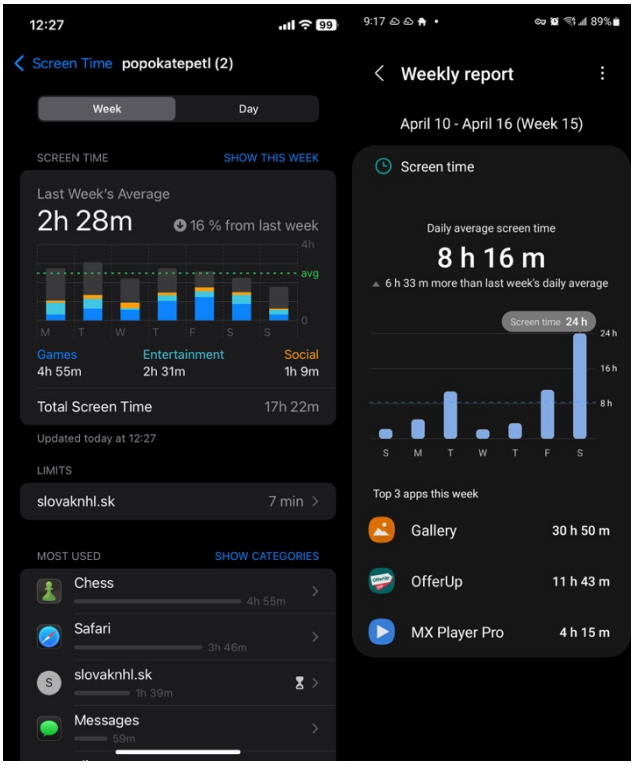

Figure 2 Print screen of the Apple Screen Time application on the left and the Android Digital Wellbeing application on the right

Many studies point to the fact that smartphones have the most negative impact on adolescents. On the one hand, this is because they are a vulnerable group in terms of development. On the other hand, early adolescence, i.e., around the age of 10, is the age when children get their first smartphone. Therefore we included in our study primary school children, specifically those in grades fifth and ninth. We were interested in analyzing the difference between fifth grade, when parental boundaries are still relatively strict, and ninth grade, when parental boundaries in many areas begin to be relaxed or ignored. This is a period that significantly shapes an individual, which is why we decided to focus on this age group as well.

The age group around 10 years old is not always completely self-sufficient when it comes to assignments and may sometimes have problems with comprehension and semantics. For this reason, we decided to adapt the research questionnaire and its individual parts so that it would be easily understandable for this age group. We had one version of the questionnaire for both age groups, so we formulated the questions and selected psychological instruments with the younger ones in mind. In the end, the questionnaire consisted of six pages, none of which asked for personal identification data. The final version of the questionnaire was also duly approved by the Ethics Committee of Faculty of Mathematics, Physics and Informatics at Comenius University in Bratislava. The entire questionnaire was pen and paper, and it took about 45 minutes for fifth graders and about 30 minutes for ninth graders to complete.

5.2 Questionnaires and Research Instruments

First Page

The first page of the questionnaire consisted of basic demographic questions (grade, age, and gender), followed by a question about the activities that students engage in at least once a week. They had a choice of several activities: reading books, making music, playing sports, creating art, playing board or logic games, or the option that they do not engage in these activities at all. Based on those answers regarding the leisure activities they have been engaged in, we created another variable. We called it 'Activities'. We calculated Activities as follows. Each activity in which a participant was engaged was given one point. We then summed all raw scores. This gave us a new variable ranging from 0 to 5. Five represented engagement in all leisure time activities, while zero represented non-engagement.

The next question asked participants how often they engage in sports or active movement on a 5-point scale from every day to never engaging in movement or sports (every day = 1; 3-5 times a week = 2; 1-2 times a week = 3; rarely = 4; never = 5). This was followed by two questions. The first focused on learning or attention disorders (dysgraphia, dyslexia, ADHD) and the second on health disadvantages that hinder learning or everyday life. The last question on the first page was of a socio-economic nature, asking students whether their family had enough of the things they needed for everyday life (we have everything we need for everyday life and more; we have everything we need for everyday life; we have most of

the things we need for everyday life; sometimes we lack the things we need for everyday life; we often lack the things we need for everyday life).

The socio-economic question or scale was probably ambiguous, poorly explained, or the students provided inaccurate information. As many as 313 out of 610 students reported that their family had everything they needed and more. The second most popular answer was "we have everything we need," which was selected by 229 students. Since the socioeconomic distribution we received from the students does not reflect the statistical income distribution of households in Slovakia, we decided not to work with this variable any further (Trend, 2022).

Second Page

The second page of the questionnaire contained the first psychological instrument, namely the WHO-5 Well-Being Index (World Health Organization, 2024). We chose this instrument because it is a short, non-invasive questionnaire with high clinimetric validity, which tap into the subjective well-being of the respondents. At the same time, the WHO-5 is one of the most widely used psychological instruments focused on well-being, as evidenced by its translation into 25 world languages. There is no official Slovak language version, so we used a back-translated English version into Slovak for our purposes.

The WHO-5 was developed by the World Health Organization during the 1990s, with its first publication in 1998. The questionnaire consists of five questions that can be answered on a six point scale (all the time = 5; most of the time = 4; more than half of the time = 3; less than half of the time = 2; some of the time = 1; at no time = 0) (Topp, et. al., 2015).

Evaluating the questionnaire is very practical. All responses were added up. The raw score ranges from 0 to 25, with 0 representing the worst possible mental well-being and 25 representing the best possible mental well-being. A raw score below 13 has been suggested as a cut-off for poor mental well-being and as an indication for further assessment for the possible presence of a mental health condition (e.g., depressive disorder) (World Health Organization, 2024).

The bottom half of the second page contained the question, asking whether the student had their own smartphone. This was followed by a question asking whether they remembered at what age they got their first smartphone. And two questions about smartphone hygiene. The questions asked whether participants use their smartphones 10

minutes before going to sleep and within 10 minutes after waking up. Based on those two questions, about whether they use their smartphone in the morning or in the evening, we created another variable. We called it ‘SP_Habits’ - smartphone habits. We calculated SP_Habits as follows. We converted the yes and no answers to questions about smartphone use in the morning and evening into numbers. Yes represents the number 1 and no represents 0. We then summed both rows. This gave us a new variable on an interval of 0 - 2 and 3 possible variations. The value 0 represents students who do not use a smartphone either before bedtime or immediately after waking up. The value 1 represents the possibility that the student uses a smartphone in the morning or evening. And the value 2 represents students who use a smartphone in the evening and also in the morning. In the last question, participants were asked to estimate how much time they think they spend using their smartphones each day.

Third Page

The third page was entirely devoted to another psychological instrument, namely the Korean Smartphone Addiction Proneness Scale for Youth, abbreviated as SAPS (Kim, et al., 2014). SAPS was developed from an original 29 preselected questions that were used on a sample of 795 elementary, middle, and high school students across South Korea. Of the original 29 questions, 15 were selected according to the reliability test results. The final scale indicated a high reliability with Cronbach's α of .880. Support for the scale's criterion validity has been demonstrated by its relationship to the internet addiction scale, KS-II ($r \fallingdotseq .49$) (Dong-il, 2008; Kim, et al., 2014). An important criterion in the selection was the validity and relative shortness of the instrument. The original version of the Smartphone Addiction Scale (SAS) has up to 48 questions, and the shortened version for adolescents has 33 (Kwon, et al., 2013). In the context of our research design, we still considered this number of questions to be relatively high. The SAPS was administered as part of a broader questionnaire that included several other instruments. Given the questionnaire's overall length and cognitive demands, we assumed that a longer smartphone addiction scale could lead to mental fatigue, particularly among younger respondents. This could reduce concentration and response accuracy, thereby negatively affecting the reliability and validity of the data collected. For this reason, we considered a shorter yet psychometrically valid instrument to be more appropriate for our target population. Furthermore, as there was no officially validated Slovak version of the SAPS available, we used an English version that

was translated into Slovak using a back-translation procedure. This approach was chosen to ensure semantic consistency between the original and Slovak versions, and to minimise potential distortion of item meaning.

Fourth and Fifth Pages

The fourth and fifth pages included the last psychological instrument, namely the d2-R Test of Attention. The academic community points out that excessive smartphone use can have a negative impact on individuals attention and concentration abilities. For this reason, we decided to incorporate an attention test into our research and attempt to examine if excessive smartphone use is related to results in the attention test. The d2 test was first introduced in 1998 and has been regularly updated since then (Hogrefe, 2026). In 2010, the d2-R (2014 Czech version) was introduced (Hogrefe, 2026). The d2-R is the latest standardized version of this test with excellent validity. This test has not been officially translated into Slovak by the test publisher, so we used the Czech version for our research. The use of the Czech version was unproblematic, as the d2-R test is not a language-dependent task and the instructions were given in Slovak before the task.

On page four, participants had a sheet with instructions clearly marking which symbols to look for during the actual test. Each character consists of a letter, 'd' or 'p' marked with one, two, three, or four small dashes. The respondent is required to scan the lines and cross out all occurrences of the letter 'd' with two dashes while ignoring all other characters. The fourth page contained two tasks where students could practice crossing out the correct answers.

Fifth page contained 14 lines with 57 symbols in each line. The students' task was to mark all the correct "d" symbols in the relevant line as quickly and accurately as possible. The students had 20 seconds per line.

The d2-R test measures several variables, but we were interested in Concentration Performance (CP). CP is the number of correctly processed items minus errors. Errors can be either missing characters that should have been crossed out or crossing out characters that should not have been crossed out. This score cannot be distorted by such tendencies as haphazardly skipping over sections of the test or crossing out all letters without discriminating among them (Brickenkamp & Zilmer, 1998).

Sixth Page

The last sixth page was used to record actual screen time from the phone settings. Students first indicated whether they had a smartphone with an Android or iOS operating system and then entered the average daily time per week for the last four weeks in the table below. As mentioned above, data is always recorded from Monday to Sunday. For this reason, the fourth and final week was incomplete, which biased the average value. The fourth week was thus ultimately excluded from the analysis. Some participants entered data for a maximum of one week, sometimes just a few days, while others entered data for at least two weeks, usually three. Therefore, we categorised the inputs to enable us to distinguish between these two groups if necessary, as partial and full data.

5.3 Participants

The research was conducted in the city of Banská Bystrica, Slovakia, and its surrounding villages. In order to maintain a representative distribution of participants, selected municipal schools, private schools, as well as municipal and village schools were included in the research. The total number of pupils in each school varied significantly. For this reason, we set a maximum number per school, specifically a maximum of two classes from each grade and a maximum of four classes in total.

Ten elementary schools participated in the research with a total final number of 614 participants, of which 296 were boys, 311 were girls, 7 pupils indicated "I don't know - I don't want to say" for gender. The largest number of participants came from Sitnianska Elementary School (89) and the smallest number from Nemecká Elementary School (24). The average age of fifth graders was 10.4 and ninth graders 14.3 years; a total of 334 fifth graders and 280 ninth graders participated. The survey was conducted after proper agreement with school representatives. We did not collect any personal identification data, so it was not necessary to obtain informed consent from parents separately. At the beginning of each school year, every parent signs an informed consent form that covers research or classroom observation by future teachers. Parents were notified about the research via edupage and had the opportunity to refuse to allow their child to participate in our research. Similarly, before the research began, students were informed that they could refuse to participate in the research or withdraw from it at any time without giving a reason. Several students took advantage of this option. This procedure was also approved by the Ethics Committee of

Faculty of Mathematics, Physics and Informatics at Comenius University in Bratislava. All schools participated in the research voluntarily. Before the research and their confirmation of participation, they were presented with a questionnaire and the method of research administration.

Data collection was conducted in person in paper form. I was personally involved in the administration of the research at all schools. The ninth-grade students worked independently, while for the fifth-grade students, we chose a procedure where Peter Juriga read the individual questions aloud and the fifth-graders had to answer them independently, but within a single time window. This strategy prevented discrepancies in the speed of work of individual students and allowed us to better regulate the administration of questionnaires in the fifth grade. The research was preceded by several weeks of preparation, during which schools were contacted using cold calling marketing and the questionnaire was iterated into its final form. The first day of the research administration in schools was October 27, 2025, and the last was November 21, 2025.

6 Findings

6.1 The influence of Leisure Activities on Screen Time

Ten elementary schools participated in the research, with a total of 614 participants. Of the participants, 244 pupils regularly read books at least once a week, 152 pupils regularly played music, and 487 pupils regularly played sports or exercised. Artistic creation was practiced by 263 students, board or logic games by 205 students, and 28 students did not engage in any of these activities or did not engage in them at least once a week.

Table 1 Participation in leisure activities

Grade	Gender	Participants	Reading books	Music	Sport	Art	Logic games	No activity
5	Chlapec	161	55	38	134	50	61	10
5	Dievča	169	100	59	143	115	71	3
5	Neviem	4	2	0	3	2	1	0
9	Chlapec	135	29	23	110	24	44	5
9	Dievča	142	57	32	95	71	27	9
9	Neviem	3	1	0	2	1	1	1

As shown by the overall data and the table above, participants most often engaged in physical activity or sports among all the activities listed. This activity is distributed almost evenly across grades and genders. Among fifth graders, 83.2% of boys and 85.2% of girls engage in sports. Among ninth graders, the figure is 81.5% for boys. Among ninth-grade girls, this percentage is slightly lower, at 67%. Pupils are least involved in music. On the contrary, artistic creation is more popular than reading. The question about artistic creation also included photography. Reading has long been one of the activities that are becoming less popular (Getting, 2024). The worst result was recorded among ninth-grade boys. Only 21.5% said they read books regularly at least once a week. Logic or board games were a more frequent choice for boys.

We also examined the impact of leisure activities on other variables. It turned out that students who reported not engaging in any of the listed activities (reading, music, art, sports, logic or board games) had slightly worse average results in all the other variables. It should be noted that the main activities that made a difference were reading books, making music or singing, and board or logic games. Sports were reported by 79.3% of all

participants, so the averages did not differ much for this activity. Similarly, the averages did not differ much for artistic creation.

We observed an average increase of 1 to 2 points for d2-R variable for students who engaged in reading, playing games, or music. For students who engaged in all three activities, the average d2-R score was as high as 101 points, with a global average of 96. For the WHO instrument, the global average score for those having some activity was 14.8, regardless of grade level. Students who did not engage in any activity achieved an average of 11.1, while the combination of three activities (books, music, games) achieved a result of up to 16.5. We achieved similar results with the SAPS instrument, where students without activities achieved an average score of 32, the global average was 27, and students with a combination of three activities had an average of 22. For these three instruments, the sample size was a global average of at least 586 students, with 28 students with no activities and 43 in the triple combination. For screen time, the results were a global average of 321 minutes, without activities 302 (10 students), and with triple combination 287.5 (15 students).

Table 2 Correlation matrix between Activities and other variables

Activities	WHO 5 sum	SAPS sum	d2-SS	ScreenTime_AVG
df	612	612	584	276
Spearman	.108	-.239	.171	-.173
p	.007**	<.001***	<.001***	.004**

As the Table 2 shows, all correlations between Activities and the examined variables are statistically significant. However, the magnitude of these associations is weak, as indicated by the Spearman's rho correlation analysis. As the Activities variable is ordinal, we used Spearman's rho correlation coefficient for our analysis.

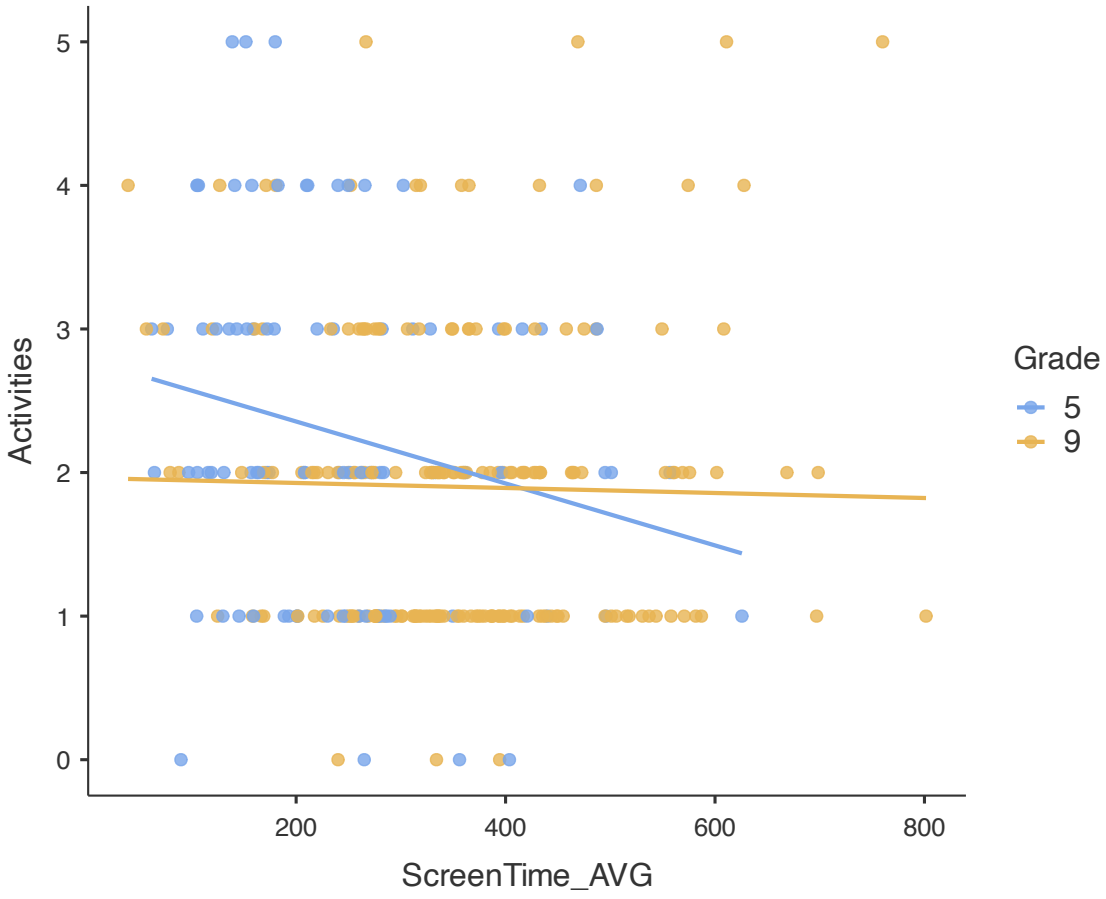

Figure 3 Relationship between Screentime and Activities

Figure 3 shows a possible correlation between higher screen time and fewer leisure activities among fifth-grade pupils, and almost no correlation among ninth-grade pupils.

6.2 The influence of Frequent Sporting Activities on Screen Time

In the next question of the questioner, we asked how often participants practice sport. The results show that, according to their own statements, students participate in sports relatively often. As many as 61% of all students participate in sports at least three times a week. Only 12.5% of students participate in sports rarely or not at all. This is most common among girls in the ninth grade. In this section, we looked at how the frequency of sports participation correlate with other variables.

Table 3 Frequency of sport

Grade	Gender	Participants	Každý deň	3–5 dní v týždni	1–2 dni v týždni	Len zriedka	Vôbec
5	Chlapec	161	48	63	37	9	4
5	Dievča	169	47	65	43	12	2
5	Neviem	4	1	0	2	0	1
9	Chlapec	135	27	58	33	13	4
9	Dievča	142	24	38	48	27	5
9	Neviem	3	2	1	0	0	0

Table 4 Correlation matrix between Sport frequency and other variables

Sport	WHO 5 sum	SAPS sum	d2-SS	ScreenTime_AVG
df	612	612	584	276
Spearman	-.216	.136	-.004	.123
p	<.001***	<.001***	.930	.041*

All correlations between the frequency of sports and the scores of the other variables in Table 4 shows a rather weak association. None of the correlations reached a Spearman's rho of at least 0.3, indicating a moderate correlation. The statistical significance was also low. Three out of four variables were statistically significant. As the Frequency of Sport variable is ordinal, we used Spearman's rho correlation coefficient for our analysis.

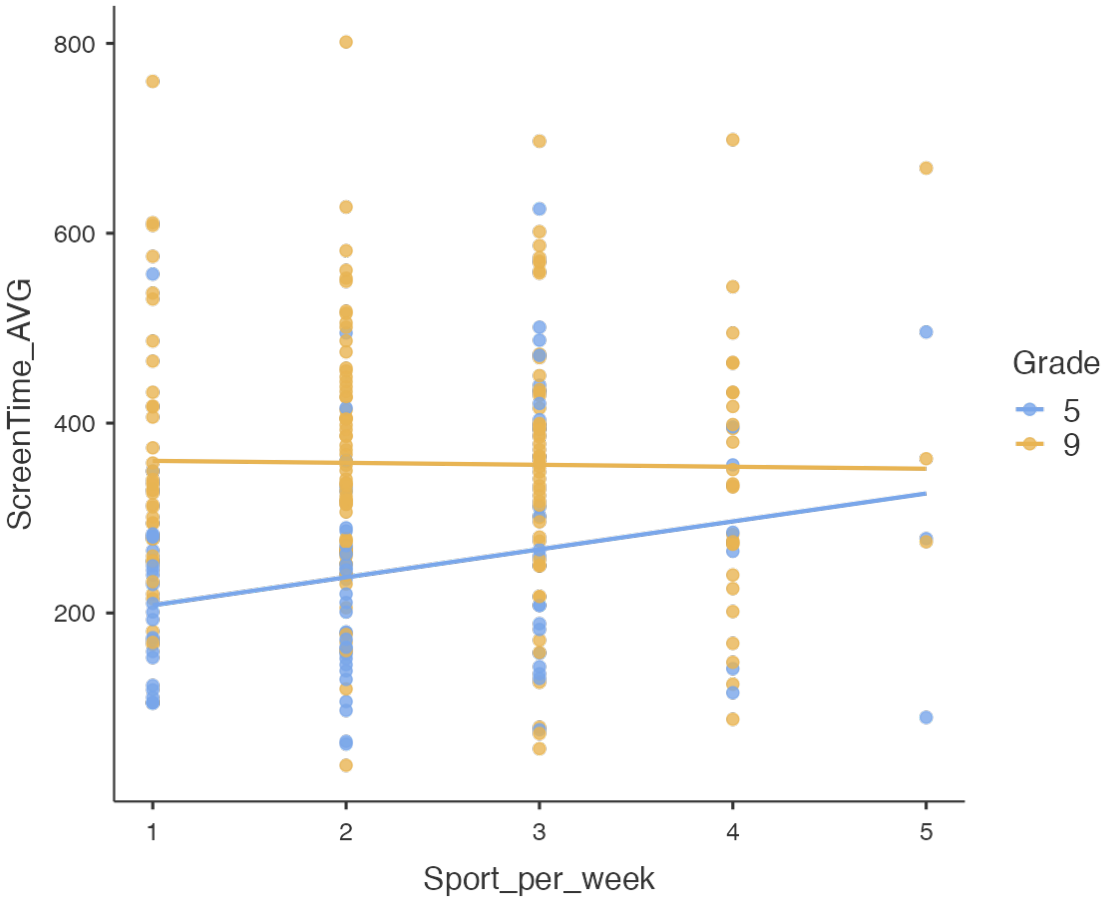

Figure 4 Relationship between Screentime and Sport frequency

As mentioned in the methodology, number 1 indicated the highest frequency, 'every day'. Figure 4 plots a possible correlation between higher screen time and lower sports participation frequency among fifth-grade pupils, and almost no correlation among ninth-grade pupils.

6.3 The influence of Screen Time on Well-being

All questions in the WHO-5 instrument were completed by 600 students. To evaluate this instrument, it is necessary to add up the individual answers, so if a student missed even one answer, they had to be excluded from the analysis. As many as 178 students scored below 13. According to the official manual, a score below 13 may indicate poor mental well-being. These were primarily girls in the ninth grade (63), girls in the fifth grade (43), boys in the fifth grade (39), and boys in the ninth grade (30). A score of 5 or less was achieved by 11 girls in the ninth grade, 8 girls in the fifth grade, 7 boys in the fifth grade, 2 boys in the ninth grade, and 1 unknown ninth grader. The average WHO score for fifth-grade girls was 15.7 and for boys 15.7. For ninth-grade girls, it was 12.7 and for boys 15.3. When comparing all four groups, we can see a more significant decrease in the average score for ninth-grade girls. Its average value is also below the point that is considered a threshold in the manual, which may imply poor mental well-being.

We also performed a correlation analysis on the other variables. As Table 5 below shows, none of the variables had a moderate or strong association according to the Pearson's r analysis. Apart from d2-R, all results were statistically significant.

Table 5 Correlation matrix between WHO 5 and other variables

WHO 5 sum	SAPS sum	d2-SS	ScreenTime_AVG
df	612	584	276
Pearson's r	-.154	-.008	-.208
p-value	<.001***	.840	<.001***

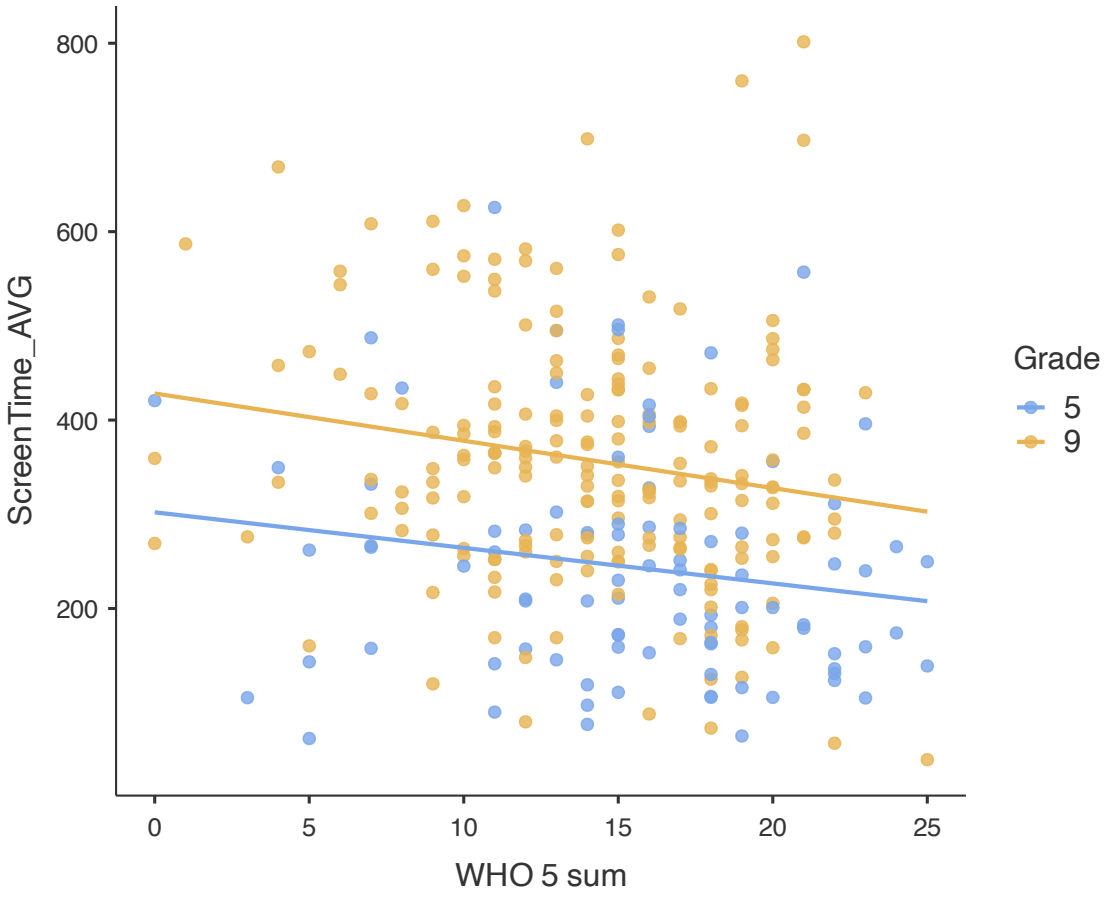

Figure 5 Relationship between Screentime and WHO 5

Figure 5 plots a possible correlation between higher screen time and lower well-being index among both fifth-grade pupils and ninth-grade pupils.

6.4 The influence of Screen Time on Sleep Hygiene

Up to a third of students, specifically 197, said they wake up and fall asleep with their smartphones. Ninth graders make up the larger group in this sample, with 70 girls and 57 boys. In the fifth grade, there were 29 girls and 39 boys. Immediately after waking up, 248 of all students use their phones, and before falling asleep, 339 do so.

We created a correlation matrix for the SP_habits variable and the other variables. As SP_habits is an ordinal variable, we performed a Spearman's rho correlation analysis. As shown in Table 5, there was a moderate strength association between Activities, SAPS sum and ScreenTime_AVG and SP_habits. All correlations were statistically significant.

Table 6 Correlation matrix between Smartphone Habits and other variables

SP_habits	Activities	Sport	WHO 5 sum	SAPS sum	d2-SS	ScreenTime_AVG
df	612	612	612	612	584	276
Spearman	-.382	.150	-.197	.479	-.131	.389
p-value	<.001***	<.001***	<.001***	<.001***	.002**	<.001***

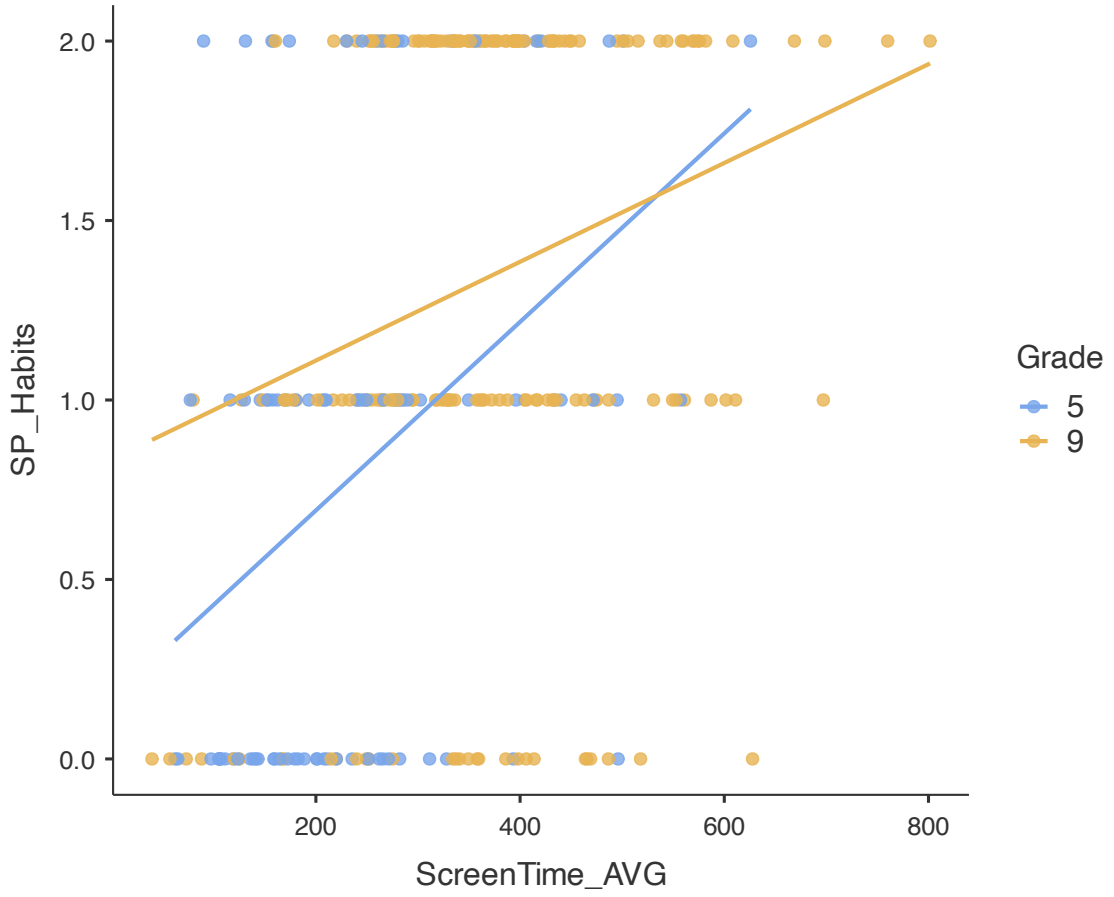

Figure 6 Relationship between Screentime and Smartphone Habits

Figure 6 plots a possible correlation between higher screen time and pupils sleep hygiene among both fifth-grade and ninth-grade.

6.5 The influence of Screen Time on SAPS

The SAPS instrument was completed by 571 students. The average score was 28.9. Among fifth graders, the average score for girls was 26 and for boys 25. Among ninth graders, the average score was 32 for girls and 27 for boys. Unlike the WHO-5, the lower the score, the better. The SAPS scale ranges from 15 to 60 points. A score above 42 points indicates that there may be problematic smartphone use (Yoo, et al., 2022).

It is encouraging that only 35 students scored above 42 points, from the ninth grade, 13 girls and 2 boys. From the fifth grade, 9 girls, 10 boys, and 1 unknown.

Table 7 Correlation matrix between SAPS and other variables

SAPS sum	WHO 5 sum	d2-SS	ScreenTime_AVG
df	612	584	276
Pearson's r	-.154	-.147	.248
p-value	<.001***	<.001***	<.001***

As shown in Table 7, there is statistical significance in all cases, but the associations between the analysed variables are all weak.

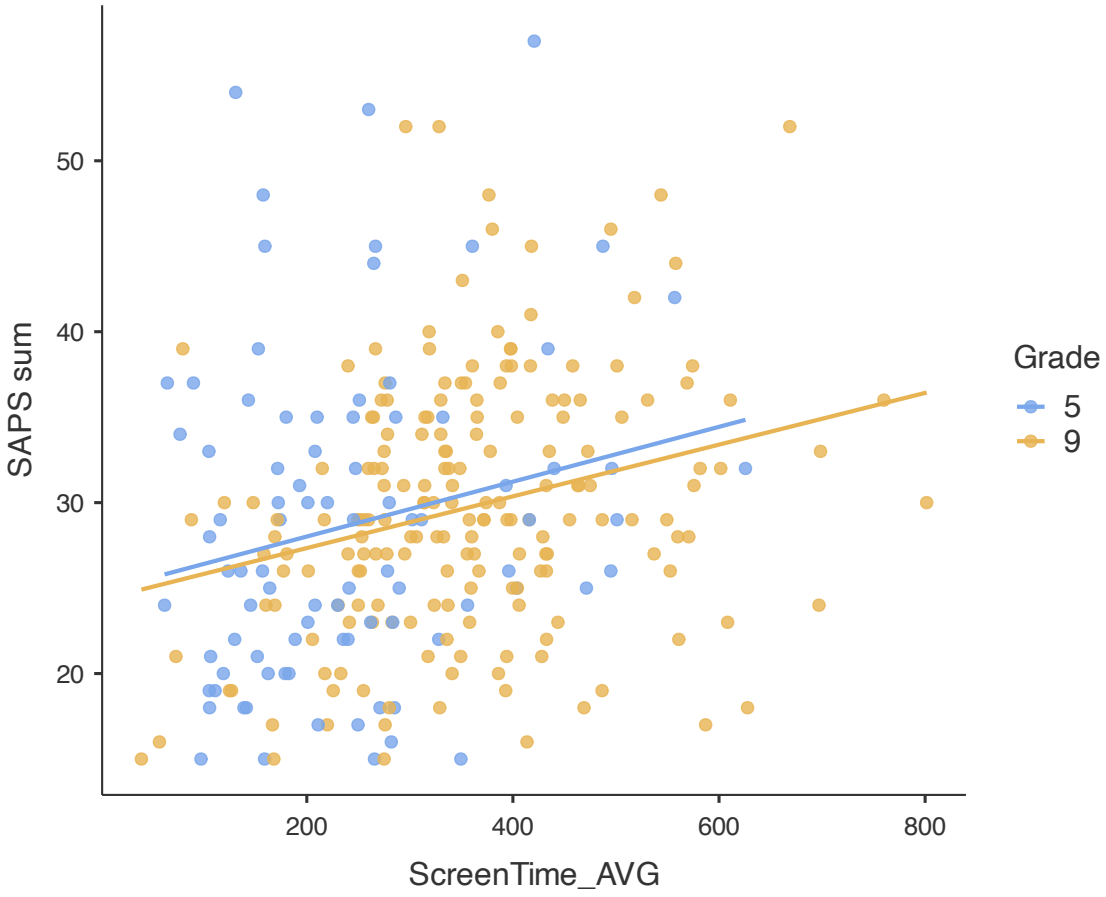

Figure 7 Relationship between Screentime and SAPS

Figure 7 may suggest a correlation between higher screen time and a higher SAPS score. A high SAPS score may indicate problematic smartphone use.

6.6 The influence of Screen Time on d2-R

A total of 612 students completed the d2-R attention test, but only 586 could be evaluated, of which 275 were fifth graders and 311 were ninth graders. This was either due to a high error rate, where it was not possible to calculate the Concentration Performance, or because the students turned the d2-R upside down, making it impossible to evaluate the responses. The average standardized score was 95.6 for fifth graders and 97.1 for ninth graders. To get standardized scores, we used norms designed for 11-12 year olds and 15-16 year olds.

Table 8 Correlation matrix between d2-R and other variables

d2-SS	WHO 5 sum	SAPS sum	ScreenTime_AVG
df	584	584	276
Pearson's r	-.008	-.147	.043
p-value	.840	<.001***	.481

The correlation matrix for the d2-R variable in Figure 8 shows weak results in terms of both strength of association and statistical significance.

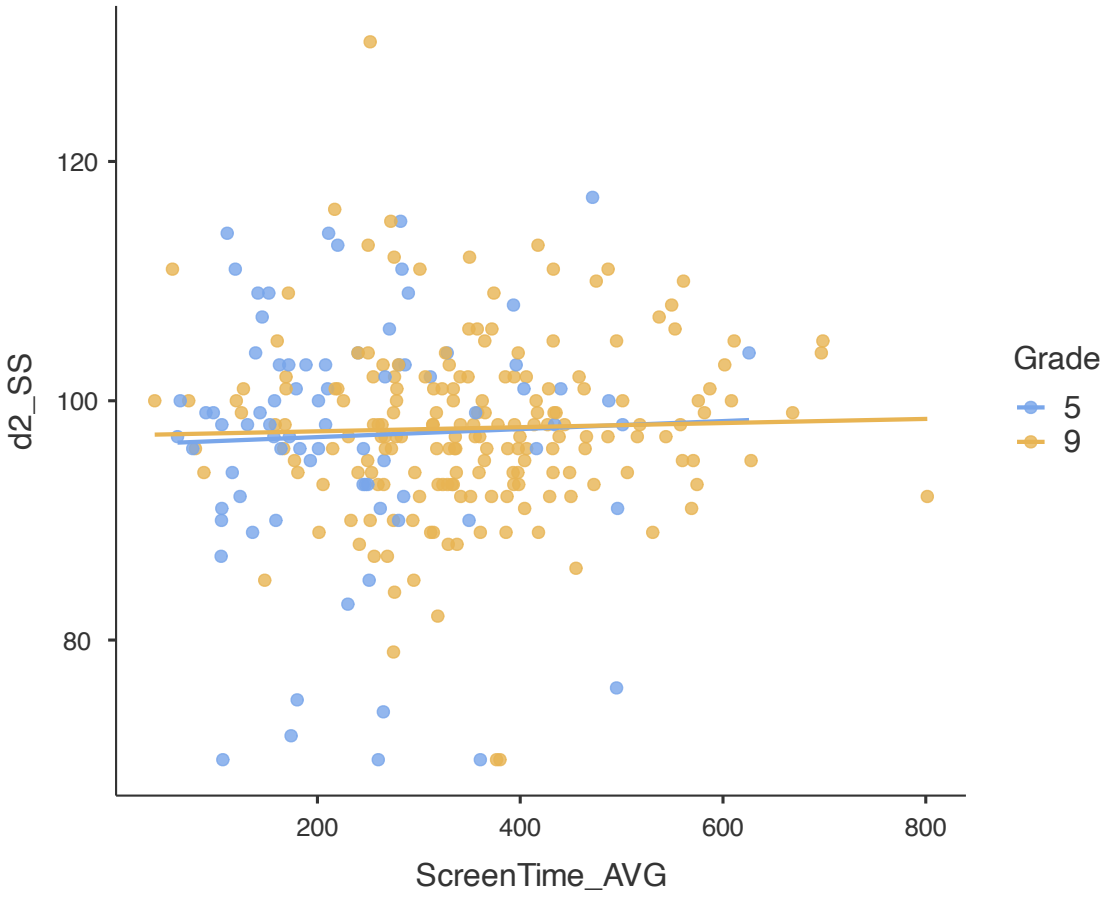

Figure 8 Relationship between Screentime and d2-R

Figure 8 shows that there are no real correlations between the d2-R instrument and the objective screen time score.

6.7 Screen Time

The variable we collected in our questionnaire was the actual time spent on screen. This data was filled in by 278 students. We further divided this variable into partial data, which refers to students who filled in a maximum of one week of data about their screen time. This group represents 74 students and an average screen time of 287 minutes per day. Full data represents students who filled in at least two weeks of data on their screen time, with most filling in up to three weeks. This group includes 204 students and an average daily screen time of 333.8 minutes. As we consider the full-data indicator to be more accurate, we will work with this indicator in the following section of this study. Of the 204 students, there were 36 girls from the fifth grade with a daily average of 219 minutes and 24 boys with a daily average of 260 minutes. From the ninth grade, there were 66 boys with a daily average of 357.6 minutes and 76 girls with a daily average of 390.6 minutes.

When recording screen time, we also recorded the three most used apps during the week. The most frequently used apps were TikTok, Instagram, YouTube, WhatsApp, Snapchat, Clash Royale, Roblox, and the internet browser. TikTok and Instagram were significantly ahead of the other apps. Among the top three apps, LLM chatbot apps and apps with AI virtual personas also appeared several times.

On a positive note, out of the 218 fifth graders who had a smartphone at school during the research, 116 of them had parental controls set up. The average parental limit time for our participants was 129.4 minutes.

6.7.1 Screen Time - Full Data

A total of 186 students were selected for this comprehensive analysis. These were students who had full screen time data, completed d2-R, and fully completed WHO and SAPS instruments. There were 52 fifth-grade students, including 31 girls and 19 boys, and 134 ninth-grade students, including 70 girls and 64 boys.

The average age of the fifth-grade group was 10.5 years, the WHO average was 15.1, the SAPS average was 27, the average age at which they received their first smartphone was 7.1, the average standard score d2-R was 98, and the average screen time was 230.1 minutes. We can therefore conclude that this group does not differ significantly from the overall group in terms of the average values of individual parameters.

The average age of the ninth-grade group was 14.3 years, the WHO average was 14.4, the SAPS average was 30, the average age at which they received their first smartphone was 8.7, the average standard score d2 was 98, and the average screen time was 367.5. As with the fifth graders, we can conclude that this group does not differ much from the overall group in terms of the average values of individual parameters.

Table 9 Correlation matrix between Screen Time and other variables

ScreenTime_AVG	WHO 5 sum	SAPS sum	d2-SS
df	184	184	184
Pearson's r	-.248	.248	.043
p-value	<.001***	<.001***	.662

Even with the most accurate data, we were unable to establish a strong association between screen time and the other analysed variables. There is a weak indication that higher Screen Time is associated with a lower Well-being index and higher SAPS scores. Nevertheless, the connection between screen time and the d2-R instrument for assessing attention remains unclear.

7 Discussion

This study examined the relationships between objectively measured smartphone screen time, problematic smartphone use, attention and psychological well-being among primary school children in fifth and ninth grade. Using real screen time data recorded directly from smartphones contributes to the growing evidence-based studies, emphasising the importance of objective measures over self-reported estimates, which might be inaccurate.

Screen Time and Attention

No significant relationship was found between smartphone screen time and attention, as measured by the D2-R Test of Attention (Pearson's r = .043, p = .662). This suggests that higher overall smartphone use, when assessed as total daily screen time, is not directly associated with poorer selective or sustained attention in this age group. One possible explanation for this is that attention is a multifaceted cognitive construct shaped by factors such as task novelty, fatigue, and individual differences in cognitive development. As the d2 test measures focused visual attention under structured conditions, it may not fully capture the types of attentional difficulties hypothesised to arise from excessive smartphone use.

Screen Time and Well-being

In contrast to attention, a weak but significant negative correlation was found between screen time and psychological well-being, as measured by the WHO-5 Well-Being Index (Pearson's r = -.248, p <,001***). While the strength of this relationship was modest, it suggests that children exhibiting higher levels of screen time may experience reduced subjective well-being. The relatively weak Pearson correlation coefficient suggests that screen time is likely to be just one factor among many influencing well-being in children and adolescents. Psychological well-being during adolescence is shaped by the interaction of various factors, including biological changes, social relationships, academic stress and the family environment. Considering population context, even a weak association is meaningful, particularly given the high prevalence of smartphone use and adolescents developmental vulnerability.

Screen Time and Problematic Smartphone Use

The same results were observed for problematic smartphone use and screen time. A weak but significant positive correlation was found between screen time and problematic smartphone use, as measured by the Smartphone Addiction Proneness Scale - SAPS (Pearson's r = .248, p <,001***). This suggests that children who spend more time using their smartphones are also more likely to exhibit addictive patterns of use. However, the modest strength of this association indicates that screen time alone does not fully capture the complexity of problematic smartphone use, which likely depends on additional psychological and contextual factors.

Grade and Gender Differences

This finding aligns with developmental theories and previous studies indicating that smartphone use tends to increase with age, as parental supervision decreases and communication with peers becomes more important. Ninth graders are also more likely to use smartphones for social networking, a practice that has been linked to more compulsive usage patterns.

While no significant differences in attention performance were observed between grades, notable differences in psychological well-being emerged. Ninth graders, particularly girls, reported poorer well-being compared to other subgroups. This result is consistent with existing literature indicating that adolescent girls are at increased risk of emotional difficulties during puberty, potentially due to heightened social comparison and body image of which may be amplified by social media use (Papageorgiou, et al., 2022)

High Average Screen Time

A key finding of this study is the generally high average screen time observed among participants (minutes average per day: fifth graders = 235, ninth graders = 374). While there are no strong associations with attention, such levels of smartphone use are still concerning due to potential time displacement effects, such as reduced physical activity, sleep disruption and fewer opportunities for offline social interaction. Therefore, high screen time may represent a broader lifestyle factor that indirectly affects development.

Limitations

These findings should be interpreted with several limitations in mind. First, we cannot draw causal conclusions due to the correlational design. It is not possible to determine which is the cause and which is the consequence. Secondly, while screen time was measured objectively, other variables relied on self-report measures, which may have been influenced by social desirability or limited self-awareness, particularly among younger participants.

7.1 Conclusion

Taken together, these findings suggest that, while smartphone screen time was not significantly associated with attention performance, there was a weak but meaningful relationship between problematic smartphone use, well-being index and screen time. Older students, particularly ninth graders, demonstrated higher screen time and slightly higher problematic smartphone use, and adolescent girls in the ninth grade reported the poorest well-being.

Future research should adopt longitudinal designs to better understand causal relationships and developmental trajectories. More attention should also be given to the qualitative aspects of smartphone use, such as content type and usage context in which it is used, as well as to moderating factors, such as gender and family environment. From a practical perspective, the results of generally high levels of screen time observed, highlight the importance of parents, educators and policymakers encouraging adolescents to use their smartphones in a healthy and reflective way, especially during early and middle adolescence.

7.2 Recommendations for digital well-being

One way to avoid problematic smartphone use is to promote digital well-being. This involves the conscious use of digital technologies, education, creating your own control mechanisms and setting up routines or rituals for regular offline time, also known as a 'digital detox'. All of these things are part of actively building digital well-being. Understanding your relationship with digital technologies from an early age makes it easier to maintain this approach into adulthood.

Digital Minimalism

The term digital minimalism was coined by Cal Newport. According to Newport, digital minimalism means using technology in a way that allows you to focus on a small number of carefully selected and optimized activities that benefit the things you value, and to let everything else go with peace of mind (Newport, 2021). Here are three practical tips to help you in your pursuit of digital minimalism.

1. Ignore the insignificant, use the significant.

Think about every repetitive activity you do in apps, social networks, or anywhere else on the internet, and ask yourself what this activity brings you, where it takes you professionally or personally, what new things you learn from it (returns), and then how much time you devote to it (costs). If the costs exceed the benefits, it is not worth continuing with these activities in the long term.

2. Adjust your behavior on social networks.

Use social networks mindfully. Look for communities and groups that enrich you professionally and from which you can learn something new. Use social media mainly for one-way sharing, don't respond to comments, and limit liking and public sharing. Instead of following the crowd, follow only selected leading inspirers in the field you enjoy, follow people who have something to offer you.

3. Do some digital cleaning

Uninstall all apps you don't use and keep only those that help you and move you forward. Move apps you don't use more than twice a day from the home screen to another screen, or organize them into folders and keep only the most important ones on the home screen. Set limits for apps where you spend too much time consuming content or engaging in superficial entertainment. If possible, designate specific devices for specific activities (devices for work, entertainment, etc.).

Digital Regulation from a Parent's Perspective

For parents, parent control apps are the most powerful tool. They connect the child's device to the parents, who can, for example, block certain types of content, track the child's location, or limit the time spent on apps. These applications can be a great help when children start using technology independently and allow parents to exercise gentle control. At later

ages, the emphasis should shift from constant supervision to the transmission of values, open communication and the development of self-regulation.

Digital Regulation from a Teacher's Perspective

Give students tips on how they can use their phones to improve their health, for example, to improve sleep and rest. Tell them how you use your phone and encourage them to try some of these tips. Ask them about their experiences.

Encourage students to share with you which social networks they use most often and how they use them, so that you can gain an understanding of the effect these platforms have on their time and attention. At the same time, find out if some students are overly dependent on social media and if they are exposed to any risks associated with sharing content and information.

Admit how technology affects you and ask students to share their experiences of how technology affects them. Together, think about what you can do to ensure that technology does not control our lives, but is a tool that helps us. (Mašek, 2021)

Digital Self-regulation

When building new digital habits, we recommend using an app that will help you create a kind of external barrier, preventing you from immediately reverting to your old habits if your self-regulation fails. There are many apps that address this issue. Among the best known are the following. Sleep Town, an app that records sleep and its regular cycles. Forest, an app that helps with learning. The more often a person uses their smartphone, the fewer trees they have in the forest. Opal is an add-on to the classic Screen Time app, which significantly limits or even prevents the changing and disruption of individual screen time restrictions that are set.

To change a habit, it is good to have clearly defined steps that a person can follow. As Olson points out in his study, small changes to phone settings or the environment can reduce smartphone use (Olson, et al., 2023). The following ten recommendations encourage healthy smartphone usage and support the development of digital well-being (Healthyscreens, 2022).

1. Make your phone less accessible. Keep it on silent with the vibrate setting off, face down and out of sight and reach when not in use throughout the day.

2. Make it harder to unlock your phone. Disable Touch ID or Face ID and use a password instead.

3. Leave your phone at home when you can. Don't take your phone with you when you don't need it.

4. Keep your phone out of reach while you sleep. Put your phone on silent (with the vibrate setting turned off) and leave it in another room or on the opposite side of the room to where you are sleeping.

5. Reduce notifications. Disable unnecessary notifications, such as sounds, banners and vibrations.

6. Clean up your social media and phone. Delete apps that you don't use anymore, and only follow inspiring accounts on social media.

7. Hide social media apps. Put social media and email apps in a folder off the home screen.

8. Turn on screen time tracking and set limits for specific apps.

9. Reduce screen brightness. Turn down your phone’s brightness and adjust the colour temperature to filter out blue light.

10. Maintain proper posture. Hold the phone at eye level and do not bend over when using it.

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9 Appendix A: Research questionnaire

Ako vnímam a používam svoj smartfón

Milí žiaci, je dôležité, aby ste celý dotazník vypĺňali čitateľne.

Základné informácie

Urob krížik, prípadne doplň základné informácie o sebe.

Do ktorého ročníka chodíš?
☐ 5. ročník
☐ 9. ročník

Koľko máš rokov?

_____

Aké je tvoje pohlavie?
☐ Dievča
☐ Chlapec
☐ Neviem / Nechcem sa vyjadriť

Ktorým z nasledujúcich aktivít sa venuješ aspoň raz za týždeň?
(Môžeš zaškrtnúť viac odpovedí.)
☐ Čítanie kníh
☐ Hudobná tvorba (napr. hra na hudbný nástroj, spev a pod.)
☐ Športovanie alebo pohyb (napr. futbal, bicyklovanie, plávanie, tanec a pod.)
☐ Umelecká tvorba (napr. kreslenie, maľovanie, modelovanie, fotenie, písanie a pod.)
☐ Stolové alebo logické hry (napr. šach, puzzle, kartové hry, hlavolamy a pod.)
☐ Nerobím žiadnu z týchto aktivít alebo ich nerobím aspoň raz za týždeň

Ako často sa venuješ fyzickej aktivite alebo športu, pri ktorej sa viac hýbeš (napr. futbal, basketbal, tanec, plávanie, beh, bicyklovanie, cvičenie)?
☐ Každý deň
☐ 3–5 dní v týždni
☐ 1–2 dni v týždni
☐ Len zriedka
☐ Vôbec sa nevenujem pohybu alebo športu

Máš nejaké ťažkosti s učením alebo pozornosťou (napríklad dyslexia = ťažšie sa mi číta, dysgrafia = ťažšie sa mi píše, ADHD = ťažšie sa mi sústredí)?
☐ Áno
☐ Nie
☐ Neviem / Nie som si istý

Máš nejaké zdravotné znevýhodnenie, ktoré ti sťažuje učenie alebo bežný život?
☐ Áno, uveď aké: _____
☐ Nie
☐ Neviem / Nie som si istý

Má tvoja rodina dostatok vecí, ktoré potrebuje pre bežný život?
☐ Máme všetko, čo potrebujeme, a ešte niečo navyše
☐ Máme všetko, čo potrebujeme
☐ Máme väčšinu vecí, ktoré potrebujeme
☐ Niekedy nám chýbajú veci, ktoré potrebujeme
☐ Často nám chýbajú veci, ktoré potrebujeme

Ako si sa cítil/a počas posledných dvoch týždňov

Zakrúžkuj v tabuľke nižšie, ako si sa cítil/a počas posledných dvoch týždňov. Zakrúžkuj vždy len jednu možnosť v každom riadku.

5 = Celý čas
4 = Väčšinu času
3 = Viac ako polovicu času
2 = Menej ako polovicu času
1 = Len niekedy
0 = Nikdy

Nie je žiadna správna alebo nesprávna odpoveď, každý sa cíti inak.

Tvrdenia	Celý čas	Väčšinu času	Viac ako polovicu času	Menej ako polovicu času	Len niekedy	Nikdy
Cítil/a som sa veselý/á a mal/a som dobrú náladu	5	4	3	2	1	0
Cítil/a som sa pokojný/á a uvoľnený/á	5	4	3	2	1	0
Cítil/a som sa aktívny/a a plný/á energie	5	4	3	2	1	0
Zobudil/a som sa svieži/a a oddýchnutý/á	5	4	3	2	1	0
Každodenný život bol plný vecí, ktoré ma zaujímali	5	4	3	2	1	0

Ako používam svoj smartfón

Urob krížik, prípadne doplň informácie, ako používaš svoj smartfón.

Máš svoj vlastný smartfón?
☐ Áno
☐ Nie

Pamätáš si, kedy si dostal/a svoj prvý smartfón?
☐ Áno, mal/a som ____ rokov (dopíš vek)
☐ Nie

Používaš smartfón do 10 minút po tom, čo sa zobudíš?
☐ Áno
☐ Nie

Používaš smartfón 10 minút predtým, ako ideš spať?
☐ Áno
☐ Nie

Skús odhadnúť, koľko času (hodín, minút) denne tráviš na svojom smartfóne.

_____ (dopíš čas hod., min.)

Ako vnímam svoj smartfón

Zakrúžkuj v tabuľke nižšie, nakoľko súhlasíš s nasledujúcimi tvrdeniami o tom, ako vnímaš svoj smartfón. Zakrúžkuj vždy len jednu možnosť v každom riadku.

1 = Vôbec nesúhlasím
2 = Trochu nesúhlasím
3 = Trochu súhlasím
4 = Úplne súhlasím

Odpovedz tak, ako to najlepšie platí pre teba. Každý používame smartfón inak.

Tvrdenia	Vôbec nesúhlasím	Trochu nesúhlasím	Trochu súhlasím	Úplne súhlasím
Moje školské známky sa zhoršili, kvôli nadmernému používaniu smartfónu.	1	2	3	4
Je pre mňa ťažké robiť to, čo som si naplánoval/a (učiť sa, robiť úlohy), pretože používam smartfón.	1	2	3	4
Ľudia mi často hovoria, že som stále na smartfóne.	1	2	3	4
Keď nemám pri sebe smartfón, som nepokojný/á a nervózny/a.	1	2	3	4
Môj smartfón ma nevyrušuje, keď sa učím.	1	2	3	4
Používanie smartfónu je zábavnejšie než trávenie času s rodinou alebo kamarátmi.	1	2	3	4
Keď nemôžem používať smartfón, mám pocit, že som stratil/a celý svet.	1	2	3	4
Bolo by pre mňa veľmi ťažké, keby som nemohol/a používať smartfón.	1	2	3	4
Rodina alebo kamaráti sa sťažujú, že používam smartfón príliš často.	1	2	3	4
Nie som nervózny/a, keď nemám svoj smartfón.	1	2	3	4
Snažím sa tráviť menej času na smartfóne, ale nedarí sa mi to.	1	2	3	4
Dokážem si strážiť, koľko času som na smartfóne.	1	2	3	4
Aj keď si myslím, že by som mal/a prestať, stále používam svoj smartfón príliš veľa.	1	2	3	4
Tráviť veľa času na smartfóne sa pre mňa stalo zvykom.	1	2	3	4
Panikárim, keď nemôžem používať svoj smartfón.	1	2	3	4

Ak máš vyplnené prvé tri strany, polož pero na lavicu a počkaj na ďalšiu inštrukciu.

Môj čas strávený pred obrazovkou

Môj smartfón je:

☐ Android
☐ iOS (Apple)

Ako zistíš, koľko času trávi na smartfóne:

- Otvor si nastavenia svojho smartfónu.
- Nájdi možnosť - Čas strávený pred obrazovkou (Screen Time).
- Zvoľ si zobrazenie po týždňoch.
- Nájdi, koľko priemerne hodín a minút denne si používal smartfón v každom týždni.
- Zapíš tieto čísla do tabuľky od najstaršieho týždňa po najnovší.
- Pozri sa na 3 aplikácie, ktoré si používal najviac každý týždeň a tie tiež zapíš do tabuľky.

Je v poriadku, či máš veľa alebo málo hodín, každý to má inak.

Dátum - týždeň	Priemerný čas pred obrazovkou (hod., min.)	Tri najpoužívanejšie aplikácie