IEEE *Access*
Multidisciplinary : Rapid Review : Open Access Journal

Cyber-Syndrome and Its Formation, Classification, Recovery and Prevention

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ABSTRACT The revolutionary change in information and communication technology has made the people's lives much convenient more than ever before. But it has affected the human's physical and mental health as well as community's social connectivity. Cybersyndrome is the physical, social, and mental disorders that affect the human being due to the excessive interaction with the cyberspace. Many previous works have discussed the role that the technology plays in the development of specific disorders, such as Internet addiction disorder or gaming addiction disorder. However, none of these works have explored the effects of excessive interaction with the cyberspace on the people's lives as a whole and its impact on the social connectivity of the community. Therefore, in this paper, we have presented the formation stages, classification, recovery, and prevention methods of cybersyndrome. We have explored the impact of cybersyndrome in physical, social, and thinking spaces and its future implications and complications.

INDEX TERMS Cyber-syndrome, cyberpsychology, cyber-physical systems, cyberbullying, Internet addiction, gaming addiction, cyberspace, cyber-enabled spaces.

I. INTRODUCTION

Information and communication technology (ICT) has definitely made our lives easier and enabled us to make enormous advancements in different fields and domains. However, the cost of such advancements is the appearance of many physical, social and mental disorders, that affect the users at the individual level, as well as the community as a whole. Recently researchers have estimated that 6 percent of the world's population is addicted to the internet [1], not to mention other forms of addiction brought by excessive usage or misusage of technology, such as gaming addiction and cyberbullying. In addition to that many trending computing paradigms are making the human the center of the computing architectures, such as internet of people (IoP) [2], people-centric computing [3], people-centric internet of things [4], human crowd sensing [5], body area networks (BAN) [6]. Thus, exposing the human to an immense amount of radiations, and putting him in a perilous position in the front line against serious health risks.

Many modern technologies, like image processing, data science and cyber-physical systems have boosted up the modern healthcare systems, not only by hardware inventions

TABLE 1. Example of cyber related disorders.

Disease/Disorder name	Cyber-related counterpart
Hypochondria	Cyberchondria
Phobia	Nomophobia
Obsession	Selfitis
Pareidolia	Phantom vibration syndrome
Addiction	Internet addiction disorder
Chronic neck pain	Text neck syndrome
Thumb arthritis	Texting thumb

but also at the software level. For example, data sciences have helped the healthcare community by offering diagnosis, assessment and treatment systems. It has been done by analyzing the medical data using data analysis, machine learning [7] and deep learning [8] mechanisms. On the contrary, due to the technology advancement, a new type of physical, social and mental disorders associated with cyberspace have appeared. In Table 1, examples of conventional diseases and disorders along with the new cyber-related counterparts are presented.

From the first giant computers to the most sophisticated modern tiny devices, the way we interact with the devices has evolved over the time. If we observe the size changes of these devices, one can notice that the electronic devices are becoming smaller and ubiquitous over the time. The devices downsizing has a positive correlation with the user-device distance and negative correlation with the device usage time. Due to the emergence of many near-user devices, such as smartphones, smartwatches, tablets and other smart devices, the time people spent plugged-in the cyberspace is more than the time that they spent in the physical world.
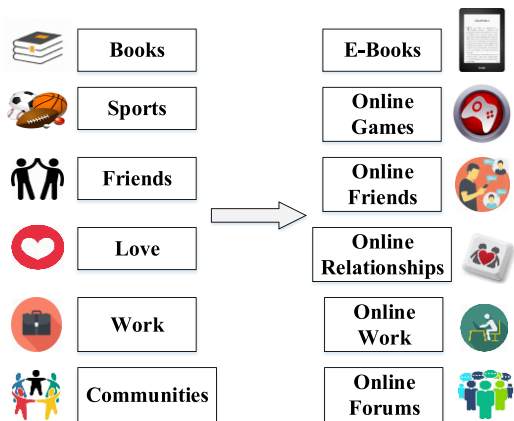

FIGURE 1. Conventional concepts and Cyber counterparts.

The revolution of ICT not only changed our way of life but also changed our basic concepts and perceptions. Things and concepts that existed for hundreds of years, now are barely mentioned in our daily conversations, and new associated cyber counterparts have replaced these concepts as illustrated in Figure 1. Such changes have also brought up many new diseases and disorders. Many countries and organizations started addressing these problems, however, in many cases the investigation focus only on specific problem, such as internet addiction or cyberbullying, neglecting the fact that these problems are interrelated and they exist at the first place as a result to the changes that happened in our lives due to the excessive interaction with the cyberspace.

Many previous empirical studies have investigated the effect of technology on the human health. They mostly focus on a specific disorder, such as internet addiction disorder, gaming disorders, social media disorder, pornography addiction disorder and other technology related disorders. However, such a shallow discrete exploration of the effects of cyber activities will not uncover all the consequences of immoderate connectivity with the cyberspace. Therefore, in this work, Cyber-syndrome is discussed, which is the physical, social and mental statues that affect a person as a result of immoderate interaction and regular connectivity with the cyberspace. Our contributions can be summarized as follows:

1) Discuss the concept of Cyber-syndrome and its formation stages

2) Propose a classification of Cyber-syndrome related disorders
3) Present the recovery methods and the recommendations of prevention from Cyber-syndrome
4) Discuss the limitations and challenges of prevention and recovery mechanizes.

The rest of the paper is organized as follows: Section II provides a review of related works. Section III explores the formation stages of Cyber-syndrome and how it initiates and grows. Section IV presents classification of Cyber-syndrome's related disorders. In section V, we have discussed Cyber-syndrome's recovery and prevention methods along with limitations, requirements and challenges. Section VI concludes our work.

II. LITERATURE REVIEW

Many works have addressed the effects of excessive usage of internet and gaming and other cyber activities on the user's physical and mental health. Zheng *et al.* [9] have investigated the association between the frequency of internet usage and individual's physical health. The most common effects were dry eyes, cervical pain and decreased vision. The positive Pearson correlation coefficient was found between the level of physical disorders and the frequency of internet usage. In [10], a theoretical framework that addresses the etiologic models and causal factors associated with the development of internet addiction is presented. Andreassen [11] presents a review on social media addiction (SMA), where one of the conclusions was that SMA shares many similarities with other types of addictions, including salience, tolerance, relapse, withdrawal, conflict and mood modification Siddiqi and Memon [12] have discussed the relationship between the internet addiction with time management, and its impact on students' academic performance, in addition, they analyzed the gender differences among subjects of internet addiction. The work in [13] presents a review on the literature of epidemiologic, neurocognitive, and brain imaging studies of internet gaming disorder (IGD). Kaptsis *et al.* [14] have reviewed gaming withdrawal symptomatology, given the importance of withdrawal in positioning the disorder as a behavioral addiction. In [15], Internet sex addiction (ISA) is investigated, ISA typically involves viewing, downloading, and trading online pornography in unreasonable amount, the authors argue that due to widespread of online explicit sexual materials, ISA becomes the most common behavioral disorder among netizens, the authors have examined the risk factors that lead to ISA for a new user, and presented a model that shows how the progressive stages of development underlying ISA and how the Internet enables sexually explicit behaviors to develop. Gainsbury [16] provides an overview of the recent findings relevant to internet gambling addiction (IGA), IGA rate had increased due to the high level of accessibility, immersive interface and ease at which money can be spent as compared to conventional gambling. In [17], the relation between cyberbullying and suicidal risk is explored. It highlights that students that have experienced

cyberbullying, had more suicidal thoughts and more likely to commit a suicide than those who had not experienced cyberbullying. The study has also proved that victims were more related to suicidal thoughts and behaviors than offenders. It suggests that adolescent peer aggression must be taken seriously both at school and at home.

However, the above-mentioned works focus only on specific problems, such as internet addiction or cyberbullying. And neglect the fact that these problems are interconnected and they exist at the first place as a consequence of the changes that happened to our lives as a result of our excessive interaction with the cyberspace. Such immoderate interaction with the cyberspace has a huge impact on the physical, social and mental status, and might be as severe as a syndrome.

III. CONCEPT AND FORMATION

In this section, the concept and formation stages of Cyber-syndrome are explored.

A. CYBER DEFINITION

The prefix cyber is mostly used to describe network of computers or internet, this growing prefix originated from the Greek word cybernetics [18] which means the study of communication and electronic systems to replace humans and living beings by machines, and was borrowed to English by Wiener [19]. Since then, the meaning of the word cyber had changed over the time [20]. Many researches have mentioned that we are living "the cyber age" because modern cyber usage is more related to internet usage like cyberspace, cyber-attack, cyber-crime, cyber-bullying, and cybercafé, etc.

The cyber prefix had taken many forms and meanings as the early use was related to the science of governance and political studies, it all started with the word cybernetics when Wiener [19] borrowed the word cybernetic in the 1940s for his book cybernetics and described his futuristic idea, a computer that can control humanity or a self-governing system that can run the world. After that the word cyber was used in cyberpunk [21] movement in the early 1980s in many novel and movies. But during the 1990s and 2000s the word cyber had been associated with many new concepts. Nowadays the prefix cyber is frequently related to the negative side of the internet and new technologies and concepts. Such as cyber war, cyber security, cybercrime, cyber terrorism and cyberbullying.

Although that the prefix e- that standing for electronic is also widely used and related to the internet like e-commerce, e-banking, e-mail. However, unlike the word cyber, the usage of the prefix e- had not been associated with the negative effects of the internet [18].

B. SYNDROME DEFINITION

The word syndrome is defined as a set of concurrent things or a group of signs and symptoms that occur together and mark a particular pattern or a condition [22]. The word syndrome comes from the Greek word "sundromē" that combines the root "dramein" (to run) with the prefix "sun" (together). In other instances, a syndrome is not related to only one disease; for example, Down syndrome is a known disorder with identifiable pattern, so it is more than just a set of signs and symptoms, regardless of the syndrome nomenclature [23]. In medicine, the word syndrome has a broad definition and can describe a combination of symptoms and findings without associating them to a particular abnormality. But in medical genetics the term has more accurate use and can be only used if the primary genetic cause is known and can be described [24]. In biology, the word has a more sense to describe a features or character sets in various contexts. In psychological the word syndrome refers to pattern of behavioral or psychological signs and symptoms knocking multiple life parts and creating distress to a person going through these symptoms [25].

C. CYBER-SYNDROME CONCEPT AND DEFINITION

The internet was originally designed to assist academic and military researches. Later, it had been developed by dozens of scientists, engineers and programmers. that contributed in different features and technologies and with the course of time, it becomes the internet that we know today [26]. The number of netizens is rapidly increasing as showing in Figure 2, more than 3.5 billion people worldwide are connected to the internet by 2016 [27]. The internet had become an integral part of our lives, and all our daily task depends on it. From learning and research to gaming and entertainment passing by shopping, multimedia serving, and geographic navigation. It involves people from all around the world at different ages and cultures and has rationalized the way we communicate, work, and live. Similarly, devices such laptops, tablets, and phones are taking a big part of our lives, pointing mobile phones in particular, statistics show that 60% of internet traffics come from smartphones, and around 4.9 billion people have a phone as shown in Figure 3. Internet and mobile terminals are changing our way of living and transforming society in all aspects and levels, as people getting more and more addicted to the technology, some
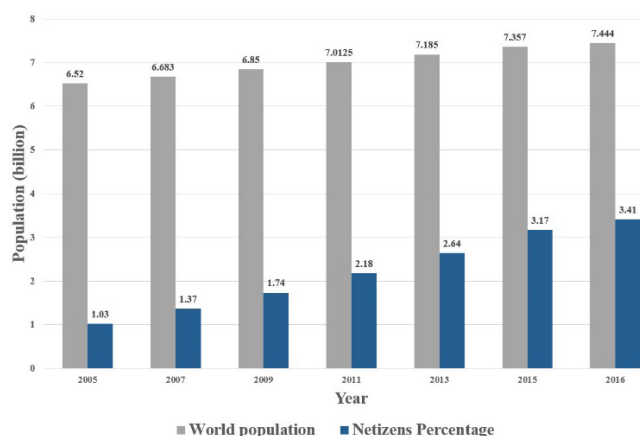
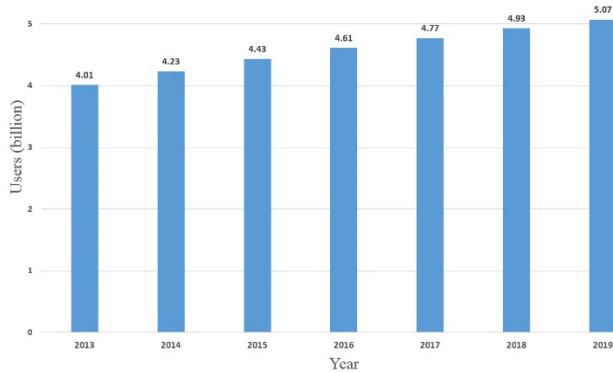**FIGURE 2.** Netizens number in the last decade.

FIGURE 3. Number of phone users in the world by years [29].

negative effects start showing up not because of the technology only but also because of the excessive use of it.

Cyber-syndrome is the physical, social and mental disorders that affect the human being due to the misusage of technology or the excessive interaction with the cyberspace. Cyber-syndrome is closely related to following four components that should be considered to identify subjects that suffer from Cyber-syndrome [28];

1) The excessive interaction with the cyberspace, which means connecting to the cyberspace without limits or in no reasonable way. In other words, connecting to the cyberspace is not inherently misguided, but the line between normal use and addiction fibs where a positive or neutral use crosses into negative territory.

2) State of lack, where an unpleasant sensation felt when there is rules or reduction in the frequency of interaction with the cyberspace, such as sadness, anxiety, irritability, anger or boredom when access to technology is not possible.

3) Tolerance, in addition to the excessive interaction with the cyberspace, tolerance means the need to increase quantities or durations to achieve the same effects in short time, like purchasing new equipment and apps to increasing hours spent in front of terminals, which will lead to complete or partial ignorance of surrounding environment.

4) External consequences, such loss of interests of previous hobbies and or meaningful relationships, work or marriage problems, spending more time plugged-in the cyberspace rather than going out with friends or joining the family activities.

D. CYBER-SYNDROME FORMATION

There are many methods that can be applied for assessing technology usage measurements, including measuring usage time in minutes or hours per day or measuring the frequency of the number of uses in a particular time period [30]. Based on these measures, many norms related to technology usage have been proposed, such as limiting the usage time for each device or define a set of protocols and rules that one can be followed to avoid cyber addiction. Cyber-syndrome is developed through different stages, to recover from

Cyber-syndrome, it is important to know its stages and phases, in Figure 4 Cyber-syndrome's formation stages are presented.
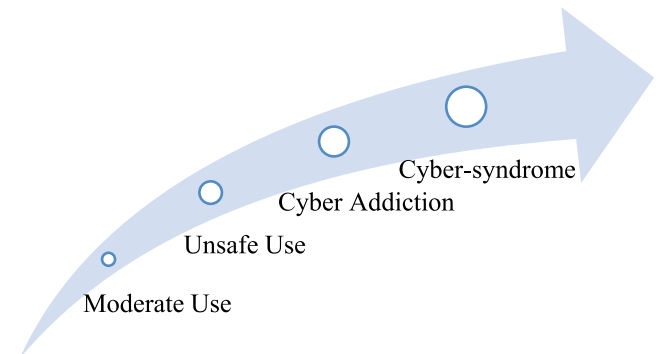

FIGURE 4. Formation Stages of Cyber-syndrome.

1) MODERATE USAGE STAGE

This stage is characterized by the interacting with the cyberspace through different devices. However, this stage is completely safe, as the total usage time is within the norms. Therefore, there is no risk on the subject's physical and mental health. Even though applying preventive measures and rules to maintain the current status is still required.

2) UNSAFE USAGE STAGE

It is a very fine line that separates between this stage and cyber addiction, However, at this stage, the subjects are not addicted nor dependent on cyberspace, but they tend to spend unhealthy amounts of time plugged into the cyberspace. Since the time spent is more than the recommended usage time by norm, the user might partially show some signs of addiction and abnormal activities but these signs cannot be classified as an addiction. Signs of this stage may include:

- Spending long time plugged into cyberspace (gaming, social networks, surfing the web).
- Decrease in sport activities time.
- Decrease in social activities time (friend gatherings, volunteer works, parties).
- Partial abandoning hobbies.

3) CYBER ADDICTION

At this stage, the subject suffers from cyber addiction, and disconnecting from the cyberspace gives the feeling that he is out of his comfort zone. However, recovering methods still effective at this stage, as the subject did not show any symptoms of Cyber-syndrome yet. Signs of this stage may include:

- A sense of euphoria while plugged in the cyberspace.
- Get frustrated when disconnected from the cyberspace.
- Hours of spare time completely disappear and is replaced by other cyber activates.
- Feeling anxious, ashamed, guilty or depressed as a result of being plugged into the cyberspace for long periods.
- Dishonesty about usage time.
- Irregular and discontinues sleep periods

4) CYBER-SYNDROME

At this stage, the user's physical health, mental health and social behaviors are damaged as a result of cyber addiction. in most cases recovering from this stage requires that subject perform long-term rehabilitation process. Symptoms at this stage may include:

- Abandoning of sport activities
- Abandoning hobbies that were once pleasurable
- Poor performance at school or work.
- Physical disorders (weight gain or weight loss, Neck or backaches, carpal tunnel syndrome, dry, red eyes, or other physical diseases).
- Social disorders (neglecting friends and family and avoiding social activities)
- Mental disorders.

IV. CLASSIFICATION

All the members of the World Health Organization (WHO) have agreed to use the International Classification of Diseases (ICD) [31] as a standard diagnostic tool for epidemiology, health management and clinical purposes. It provides a common language for reporting and monitoring diseases, and it has been translated into 43 languages. Despite the fact that ICD presents a holistic classification of the diseases and rich informative description of their related signs and symptoms. Nevertheless, it does not cover cyber-related diseases, such as their classification, symptoms and recommended remedies and recovering methods. Therefore, in this section, we present a classification of cyber-related diseases and disorders. Figure 5 presents a general classification of cyber related disorders. In this section, we explain each class and present a cyber related disorder as an example of each subclass.
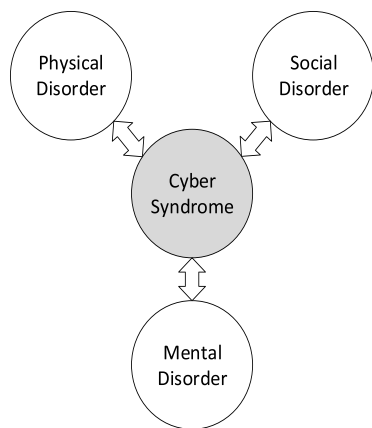

FIGURE 5. Cyber-syndrome disorders classification.

A. PHYSICAL DISORDERS

All technologies and devices that may physically damage or affect the physical health of the user fell into this class. Figure 6 presents a classification of cyber-related physical disorders.
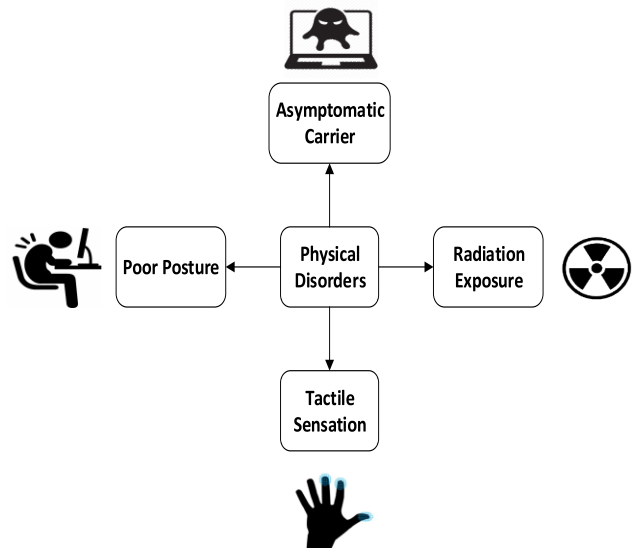

FIGURE 6. Cyber-syndrome's physical complications.

1) ASYMPTOMATIC CARRIER

Germs can spread through direct contact or through the inhalation of infected airborne sneeze droplets, such as shaking hands. However, around 80% of flu cases are contracted by touching an infected object. When we think about germs, the first place that our minds bring up are bathrooms and other dirty places, where usually these harmful bacteria live in. However, a series of recent studies and reports have proved that the average bacteria per square inch on a toilet seat varies between 50 and almost 300 for household seats and over 1,000 for the public varieties. Yet our daily used devices contain even more bacteria than that.

TABLE 2. Germs in electronic devices.

Device/Place	Germs per square inch
Phone	25,107
Desktop surface	20961
Keyboard	3295
Mouse	1676
Game controllers	1600
Toilet seat	50-300
Copy machine	69

What makes things worse is that most germs, including the influenza virus, can survive for only around five minutes on our hands, but they can live for up to two days on phones, keyboards, mouse and other devices. Table 2 presents a comparison between daily used devices and toilets in terms of germs per square inch based on recent reports [32]–[36], and it clearly shows that most of the daily used devices contain more germs than toilet seat, which put a huge risk to our health, as we spent most of the time using these devices.

2) RADIATION EXPOSURE

It has been proven that radiation from electronic devices can harm our physical health, radiofrequency radiation is one of the most widely used in our daily lives.

a: RADIOFREQUENCY RADIATION

Although that radiofrequency (RF) that can be found at natural sources such as outer space, the sun, the sky, and even the earth itself. However, RF radiation is one of the most dangers waves that pose a huge threat to our health, RF radiation is used for many different technology devices, such as phone singles, Wi-Fi, Bluetooth, ZigBee and many others. The WHO cancer classification includes all sources of RF radiation as a cancer cause. such exposure from mobile phone base stations, Wi-Fi access points, laptops, smartphones and tablets. Many studies have linked RF radiation with carcinogeneses such as on DNA repair, oxidative stress, down regulation of mRNA and DNA damage, and in most cases, the brain is the main target organ for RF emissions especially from the wireless phone [37]–[41].

3) POOR POSTURE

Poor posture while connected to the cyberspace for long periods may lead to a serious threat to the user's physical health. The risk could be as simple as slight neck pain, or as severe as musculoskeletal disorders. Many new physical disorders have appeared as a result of poor posture during interaction with the cyberspace, text neck syndrome is a typical example of poor posture.

a: TEXT NECK SYNDROME

The excessive use of the smartphone in the recent years, has led to the appearance of a new physical disorder known as the text neck syndrome [42], [43], recent studies show that smartphone users looking down at their device spend an average of 700 to 1400 hours each year, with their posture resulting in 27 kg of force on their neck [44]. Which may cause serious harms, including neck pain, upper back pain, upper back muscles spasm, shoulder pain and tightness. That is because our bodies are not designed to cope with long-term use of such compact smartphones and handheld devices.

4) TACTILE SENSATION

Different devices have different user interfaces, controlling these devices is not an easy task, as we perform thousands of keystrokes every day, without to mention touching and mouse clicks, which may subsequently harm our hands. Many tactile sensation disorders have emerged as a result of over usage of our body part to control electronic devices. Texting thumb is an example of tactile sensation physical disorders.

a: TEXTING THUMB

Texting thumb pain, or blackberry thumb, is the term being used to describe thumb injuries related to texting using a smartphone or other tactile touch devices. Text thumb comes as a result of excessive use of our fingers to control these devices. As our hands especially our fingers are the most used part of our bodies to interact with electronic devices, repetitive keystrokes, phone touching and mouse clicks may put us at risk for injury or aggravate existing conditions. In other words, we are giving our fingers excessive workout without even realizing it, and our thumb is not meant to engage in such repetitive motions.

B. MENTAL DISORDERS

1) DELUSIONAL DISORDERS

Cyber addiction can cause many delusional disorders, in here we present Phantom vibration syndrome as an example of this type of cyber related mental disorders

a: PHANTOM VIBRATION SYNDROME

Phantom vibration or phantom ringing syndrome is a new technology related mental disorder [45], people that suffer from this disorder always have the perception that their mobile phone is ringing or vibrating when it is actually not ringing. It is also known as ringxiety, fauxcellarm and phonetom. Phantom ringing usually is experienced during noisy activities, such as watching television, taking a shower or using a noisy device. Phantom ringing develops as a result of excessive use of mobile phone, a recent study shows that phantom ringing is common between mobile users, the rate of people suffering from phantom ringing could be as high as 90% among undergraduate students [46]. However, many people consider phantom ringing not really harmful or bothersome. While others think it's a warning sign that overuse of mobile phones might be a dangerous symptom that will subsequently lead to a more severe form of mental disorders.

2) HABITS DISORDERS

Cyber addiction can affect our daily activities, such as eating and sleeping.

a: SLEEP DISORDERS

Many kinds of sleep disorders can be linked to connecting with the cyberspace before bedtime. Several recent reports and studies proved that using smartphones before sleeping time has damaging effects on sleep quantity, quality and timing [47], [48]. The brightness of a smartphone, e-readers or computer screen may interfere with the natural release of melatonin (a hormone that is produced by the pineal gland to regulates sleep and wakefulness), that is because melatonin release happens only in dark conditions. The problem is not only with devices lights, but also with their sounds, as many of the people forget to silent their phones or other devices before sleeping. Which may lead to wake them up because of phone rings or other notifications and affect the quality of their sleep.
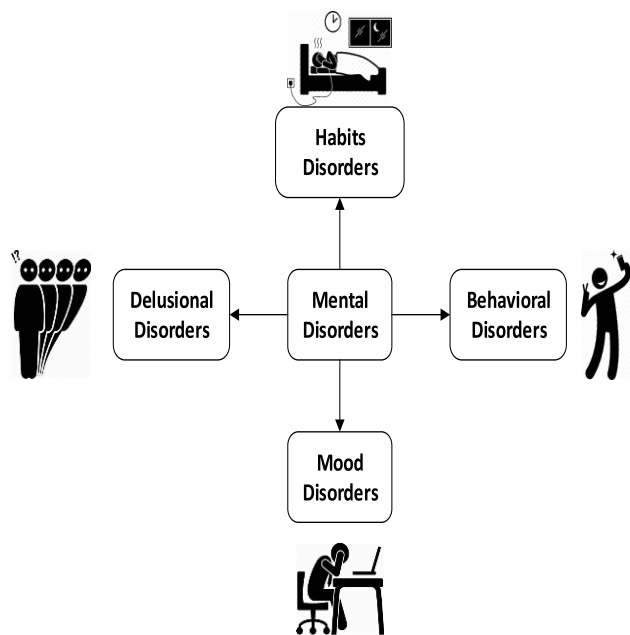
FIGURE 7. Cyber-syndrome's mental complications.

3) MOOD DISORDERS

Over usage of technology especially social media is associated with many mood disorders, such as Bipolar and Depression.

a: DEPRESSION

Although that depression itself is not a result of only interaction with the cyberspace. However, some studies have proved the relation between excessive interaction with the cyberspace and depression symptoms, especially smartphones [49], [50], that is because the overuse of smartphone helps people to avoid social activities and isolate themselves, which will make them more susceptible to stress. The above-mentioned studies have focused on the relation between phone usage and depression regardless of the consumed content, what makes things worse, is that some publically available harmful contents can be the main reason to escalate depression to a dangerous level and subsequently commit suicide. For example, recently a new game had led more than 130 teenagers to suicide [51].

4) BEHAVIORAL DISORDERS

Cyber addiction could cause serious behavioral disorders, in here we present Selfitis as an example of cyber related behavioral disorders

a: SELFITIS

Selfitis, or selfie addiction is a behavioral disorder that makes people feel compelled to constantly take selfies and share them online [52]. People who suffer from selfitis may argue that their behavior is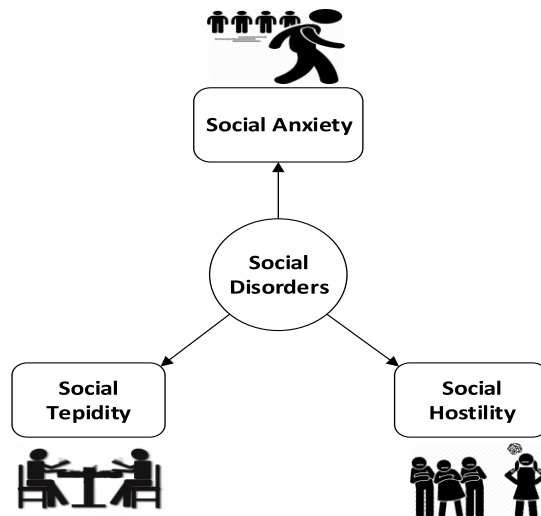 normal and that they take selfies only to make good memories and share it with their friends. For this reason, some researchers have developed scales to assist the diagnosis of selfitis, such as the one presented in [53]. The psychological explanation behind selfie addiction is that people generally want to seek attention from their social circle and boost their confidence.

FIGURE 8. Cyber-syndrome's social complications.

C. SOCIAL DISORDERS

1) SOCIAL ANXIETY

Social anxiety disorder, also known as social phobia, is the fear of engaging in social activities. The relation between social anxiety and interaction with cyberspace is a hard question to answer, just like the chicken-and-egg problem: is it due to the social anxiety people tend to overuse technology or because of overuse of technology people develop social anxiety? However, a growing evidences show that excessive use of the internet, and social media in particular, help developing social anxiety, the study in [54] had proved the positive relationship between social anxiety and social media usage.

2) SOCIAL TEPIDITY

The excessive interaction with the cyberspace not only help developing social anxiety and fear to make new social relations, but also damage the existing social relations, such as families and friendship relations. Excessive usage of smartphones during a social gathering could negatively affect the social relationships. As the social eye contact and visual interaction are main elements in social relationship development, the social media could turn our relationships with families and friends to a textual relationship. Reference [55] shows that people tend to less meeting with their partners (23%), children (33%), parents (31%), and friends (35%) because they can communicate with them using social media.

3) SOCIAL HOSTILITY

Excessive use of social media can help to develop anti-social feelings such as being jealous, angry or feeling unpopular and isolated. The consequences of such feelings can vary from a simple action such as unfollowing or deleting some friends, to more serious aggressive behaviors such as cyber-bullying or even physical harm. A recent online survey in [56] has shown that 61% of the participants felt bad when finding out that someone "unfriended" them, and 59% were angry after someone posted a critical or negative comment on their profile.

V. PREVENTION AND RECOVERY

Different formation stages have different prevention and recovering strategies. Although that in the moderate usage and unsafe use stages no recovery is required, but several prevention rules and methods must be applied to maintain a safe interaction with the cyberspace. As presented in Figure 9, the first two stages required prevention rules, with the last two need recovery process.
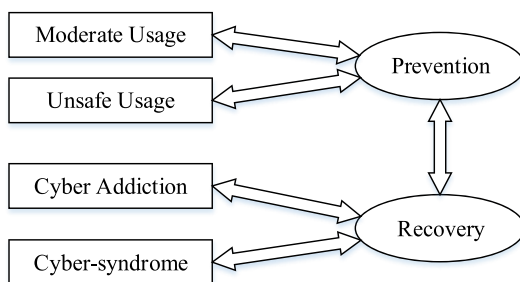

FIGURE 9. Cyber-syndrome prevention and recovery.

A. CYBER-SYNDROME PREVENTION
1) PHYSICAL DISORDER PREVENTION

Many prevention methods and rules can be applied at the physical level, such as correct posture, clean environment and radiation protection.

a: POSTURE CORRECTNESS

As people spent long periods plugged into the cyberspace, applying a correct posture is crucial physical prevention measure. There are three approaches for posture correctness as follows; i) office equipment upgrade: such as using height adjustable chair and screen, footstool, large screen, and other upgrades that may help improving posture; ii) recommendation adaptation: during typing, the wrist should be in straight way and with the forearms in parallel to the floor; thus, using a slight touch on the keyboard rather than pounding on it. Moreover, keyboard and mouse should be placed close to each other and on the same height for best usage; iii) software adaptation: many apps and smart sensors could be used to track posture correctness, some of them can be connected with a sensor that keeps track of the subject's back position, such as Microsoft Kinect sensor [57].

b: CLEAN ENVIRONMENT

As mentioned in section IV, cyber enabled devices are perfect germs carrier, therefore, maintaining a clean environment can prevent infections, germs transfer and proliferation. Recommendations include: (1) regular cleaning daily used electronic devices, such as mouse, keyboard and smartphone. (2) smartphones should never be used inside the bathroom and other dirty places [58].

c: RADIATION PROTECTION

With the emergence of fog computing and edge comparing [59], more and more cyber enabled devices are situated near the user. Our bodies are exposed to many types of radiation from these devices, we cannot stop these radiations, however, we can take many preventive steps to reduce the effect of these radiations. Radiation protection recommendation include: (1) applying 20-20-20 rule [60] to prevent eye strain problem, the rule is simple and is advised by many doctors, basically, every 20 minutes spent looking at the screen, you should try to look away at something that is 20 feet away from you for a total of 20 seconds. (2) another important recommendation is keeping phones away from the brain during sleep time, to reduce the impact of phone radiation on the brain cells.

2) SOCIAL DISORDER PREVENTION

The cyber related social disorders could be stopped by applying prevention strategies that address the risk factors before cyber addiction evolves into cyber-syndrome. Many researchers have agreed that the prevention methods should focus on children and teenagers. Since they have the highest prevalence rates of cyber addiction of many kinds including internet addiction and gaming addiction [61]. Preventing such social disorders can be achieved by applying strict rules at the individual, social system of the community, education, family and workplace. Experts mainly recommend two prevention strategies, (1) Improving relationships, for example improving parent-child communication and understanding the children's needs. (2) monitoring of cyber activities, this can be done by creating rules that regulate the content of online activities and/or by criticizing excessive cyber activates but without setting strict time limits for usage time. At the community level, setting up a list of strict rules that alleviate the effect of technology on the social relationships like forbid phone usage during family or friend gathering.

3) MENTAL DISORDER PREVENTION

Prevention of cyber related mental disorders is mainly a task of the surrounding community of the subject, as mental disorder subject in most cases does not have the ability to recognize their current conditions. the most effective prevention strategy at the mental level is raising awareness about the effect of cyber activities on mental health.

TABLE 3. Limitations, requirements and challenges during recovery and prevention.

Limitations	Requirements	Challenges
Pornography material widespread availability without age limits	Stricter content filtering for pornography content, for example, pornography materials must require authentication, and registering that require ID card that clearly shows the age of the user.	International collaboration on such issues faces many difficulties, as different countries have different laws regarding pornography content, in some countries is it illegal for all ages, while in other countries it is age restricted.
Terrorist content and hate speech filters methods too easy to overcome	• More collaboration between social networking companies and security authorities. • Developing more sophisticated automatic content filtering algorithms.	Social networks content sharing by companies to authorities take a long time and go through complicated procedures, that require a court order in some cases, which slow the investigation process.
Screen sizes and quality of manufacturing is not strictly monitored up to a satisfactory level.	Screens should be eye friendly to reduce bad effects of radiations	• Standardization of screen qualities • Develop the tools to check fitness and lifetime of screen at the user's site • Measure its impact on eyesight
Time duration based statistics are missing to guide about healthy usage limits	• A tabular and graphical information should be presented to show the bad effects of increasing the duration of connecting to the cyberspace	• Differentiate between good and bad use • How to adjust cyber involvement for education, research, and business.
Lack of fitness certificates for the devices mostly used to connect to the cyberspace	• Each device under use should be tested for its harmful effects after a certain period of time • Regulatory authorities and organizations should also focus to consider customer health as per technology boost up.	• Accept and highlight deficiencies in mostly used products • Accessibility to customers • Should be included in customer relationship management (CRM)
Limited awareness campaigns for Cyber-syndrome prevention at academia and industry	Regular training is needed along with counseling sessions.	Convince the individuals to abstain from unhealthy interaction with the cyberspace

B. CYBER-SYNDROME RECOVERY

1) PHYSICAL DISORDER RECOVERY

Recovering from Cyber-syndrome at the physical level is done through different rehabilitation programs, such as chiropractic rehabilitation, postural restoration and other spinal adjustment programs. In addition to rehabilitation programs and physical exercises, regular technology breaks, where the subject stay away from any devices or any other source of radiations for regular periods of time might help to recover from Cyber-syndrome effects.

2) SOCIAL DISORDER RECOVERY

At the social level, recovery from Cyber-syndrome may involve separate and collective treatment, Some psychotherapeutic and pharmacological recovery methods have been proposed and recommended for cyber addiction both separately and collective levels [62], one of the suggested methods is that the subject's family or close friends involve collectively with him in social recovery and rehabilitation programs.

3) MENTAL DISORDER RECOVERY

Cognitive behavioral therapy (CBT) has been proven to be effective in treating some addictions related to

Cyber-syndrome and has been recommended by many studies [62], [63]. CBT focuses on the relationship between behaviors, thoughts and emotions, CBT psychotherapists train coping methods, and acceptance of treatment, enhancing behaviors and preventing relapses.

C. LIMITATIONS, REQUIREMENTS AND CHALLENGES

Despite the prevention and recovery methods mentioned above, there are many limitation and challenges that need to be addressed. A few of open challenges and required policies to overcome these limitations are presented in Table 3.

VI. CONCLUSION

In this paper, the Cyber-syndrome was discussed, which is the physical, mental and social disorders that affect a person as a result of immoderate interaction and regular connectivity with the cyberspace. The formation stages, as well as a classification of cyber related disorders was proposed along with example cases in each category, Moreover, a number of preventive measures are enumerated to timely abstain from side effects of Cyber-syndrome and interaction with the cyberspace in a safe manner. Our work elucidates a comprehensive set of identifying issues and related guidelines that

could be beneficial for a huge number of internet users to abstain from Cyber-syndrome.

REFERENCES

[1] C. Cheng and A. Y. Li, "Internet addiction prevalence and quality of (real) life: A meta-analysis of 31 nations across seven world regions," *Cyberpsychol. Behav. Soc. Netw.*, vol. 17, no. 12, pp. 755–760, 2014.

[2] J. Miranda *et al.*, "From the Internet of Things to the Internet of people," *IEEE Internet Comput.*, vol. 19, no. 2, pp. 40–47, Mar./Apr. 2015.

[3] F. Delmastro, V. Arnaboldi, and M. Conti, "People-centric computing and communications in smart cities," *IEEE Commun. Mag.*, vol. 54, no. 7, pp. 122–128, Jul. 2016.

[4] S. Feng, P. Setoodeh, and S. Haykin, "Smart home: Cognitive interactive people-centric Internet of Things," *IEEE Commun. Mag.*, vol. 55, no. 2, pp. 34–39, Feb. 2017.

[5] B. Guo *et al.*, "Mobile crowd sensing and computing: The review of an emerging human-powered sensing paradigm," *ACM Comput. Surv.*, vol. 48, no. 1, 2015, Art. no. 7.

[6] A. A. Youssef, B. Abdelhamid, S. H. El-Ramly, H. M. Elattar, and H. H. Ali, "LDPC decoding algorithms for implant to implant wireless body area network," *IEEE Access*, vol. 6, pp. 13200–13212, 2018.

[7] K. R. Foster, R. Koprowski, and J. D. Skufca, "Machine learning, medical diagnosis, and biomedical engineering research—Commentary," *Biomed. Eng. Online*, vol. 13, no. 1, p. 94, 2014.

[8] G. Litjens *et al.*, "A survey on deep learning in medical image analysis," *Med. Image Anal.*, vol. 42, pp. 60–88, Dec. 2017.

[9] Y. Zheng, D. Wei, J. Li, T. Zhu, and H. Ning, "Internet use and its impact on individual physical health," *IEEE Access*, vol. 4, pp. 5135–5142, 2016.

[10] K. Young, "The evolution of Internet addiction disorder," in *Internet Addiction: Neuroscientific Approaches Therapeutical Interventions*, C. Montag and M. Reuter, Eds. Cham, Switzerland: Springer, 2015, pp. 3–17.

[11] C. S. Andreassen, "Online social network site addiction: A comprehensive review," *Current Addiction Rep.*, vol. 2, no. 2, pp. 175–184, Jun. 2015.

[12] S. Siddiqi and Z. A. Memon, "Internet addiction impacts on time management that results in poor academic performance," in *Proc. Int. Conf. Frontiers Inf. Technol. (FIT)*, 2016, pp. 63–68.

[13] C.-H. Ko, "Internet gaming disorder," *Current Addiction Rep.*, vol. 1, no. 3, pp. 177–185, Sep. 2014.

[14] D. Kaptsis, D. L. King, P. H. Delfabbro, and M. Gradisar, "Withdrawal symptoms in Internet gaming disorder: A systematic review," *Clin. Psychol. Rev.*, vol. 43, pp. 58–66, Feb. 2016.

[15] K. S. Young, "Internet sex addiction: Risk factors, stages of development, and treatment," *Amer. Behav. Sci.*, vol. 52, no. 1, pp. 21–37, 2008.

[16] S. M. Gainsbury, "Online gambling addiction: The relationship between Internet gambling and disordered gambling," *Current Addiction Rep.*, vol. 2, no. 2, pp. 185–193, Jun. 2015.

[17] S. Hinduja and J. W. Patchin, "Bullying, cyberbullying, and suicide," *Arch. Suicide Res.*, vol. 14, no. 3, pp. 206–221, 2010.

[18] T. Coe. OxfordWords Blog. (2015). *Where is the Origin of 'Cyber'?* Accessed: Apr. 19, 2018. [Online]. Available: https://blog.oxforddictionaries.com/2015/03/05/cyborgs-cyberspace-csi-cyber/

[19] N. Wiener, "Cybernetics," *Sci. Amer.*, vol. 179, no. 5, pp. 14–19, 1948.

[20] A. Newitz, (2013). *The Bizarre Evolution of the Word 'Cyber'*. Accessed: May 6, 2018. [Online]. Available: https://io9.gizmodo.com/today-cyber-means-war-but-back-in-the-1990s-it-mean-1325671487

[21] N. Elhefnawy, *Cyberpunk, Steampunk and Wizardry: Science Fiction Since 1980*. Charleston, SC, USA: CreateSpace Independent Publishing Platform, 2015.

[22] Cambridge Dictionary. (2018). *Meaning of 'Syndrome' in the English Dictionary*, Accessed: May 6, 2018. [Online]. Available: https://dictionary.cambridge.org/dictionary/english/syndrome

[23] D. Menon. Health Writer Hub. (2015). *Disease, Disorder, Condition, Syndrome—What's the Difference?*. Accessed: Apr. 19 2018. [Online]. Available: https://www.healthwriterhub.com/disease-disorder-condition-syndrome-whats-the-difference/

[24] Q.-L. Xue, "The frailty syndrome: Definition and natural history," *Clin. Geriatric Med.*, vol. 27, no. 1, pp. 1–15, 2011.

[25] D. Cicchetti and M. Beeghly, *Children with Down Syndrome: A Developmental Perspective*. Cambridge, U.K.: Cambridge Univ. Press, 1990.

[26] K. S. Young, "Internet addiction: A new clinical phenomenon and its consequences," *Amer. Behav. Sci.*, vol. 48, no. 4, pp. 402–415, 2004.

[27] The World Bank. *Individuals using the Internet (% of population)*. Accessed: Jun. 12 2018. [Online]. Available: https://data.worldbank.org/indicator/IT.NET.USER.ZS?end=2016&name_desc=false&start=1960

[28] K. W. Beard and E. M. Wolf, "Modification in the proposed diagnostic criteria for Internet addiction," *Cyberpsychol. Behav.*, vol. 4, no. 3, pp. 377–383, 2001.

[29] Statista. (2016). *Number of Mobile Phone Users Worldwide from 2013 to 2019 (in Billions)*. Accessed: Jun. 12. 2018. [Online]. Available: https://www.statista.com/statistics/274774/forecast-of-mobile-phone-users-worldwide/

[30] L. D. Rosen, K. Whaling, L. M. Carrier, N. A. Cheever, and J. Rokkum, "The media and technology usage and attitudes scale: An empirical investigation," *Comput. Hum. Behav.*, vol. 29, no. 6, pp. 2501–2511, 2013.

[31] *International Statistical Classification of Diseases and Related Health Problems*, vol. 1, World Health Organization, Geneva, Switzerland, 2004.

[32] S. E. Matthews. *Why Your Cellphone Has More Germs Than a Toilet*. Accessed: Jun. 14, 2018. [Online]. Available: https://todayhealth.today.com/_news/2012/08/30/13569391-why-your-cellphone-has-more-germs-than-a-toilet

[33] R. Hines. (Aug. 2015). 5 Gadgets With More Germs Than Your Toilet Seat. Forbes, New York, NY, USA. [Online]. Available: https://www.forbes.com/sites/reehines/2015/08/11/5-gadgets-with-more-germs-than-your-toilet-seat/#1450534312fe

[34] S. Kõljalg, R. Mändar, T. Sõber, T. Rööp, and R. Mändar, "High level bacterial contamination of secondary school students' mobile phones" *Germs*, vol. 7, no. 2, pp. 73–77, 2017.

[35] A. K. Al-Ghamdi, S. M. Abdelmalek, A. M. Ashshi, H. Faidah, H. Shukri, and A. A. Jiman-Fatani, "Bacterial contamination of computer keyboards and mice, elevator buttons and shopping carts," *Afr. J. Microbiol. Res.*, vol. 5, no. 23, pp. 3998–4003, 2011.

[36] M. Elgan. Why Phones, Keyboards and Mice Make me Sick. Computer World. Accessed: Jun. 12 2018. [Online]. Available: https://www.computerworld.com/article/2547438/mobile-wireless/why-phones–keyboards-and-mice-make-me-sick.html

[37] O. P. Gandhi, L. L. Morgan, A. A. de Salles, Y.-Y. Han, R. B. Herberman, and D. L. Davis, "Exposure limits: The underestimation of absorbed cell phone radiation, especially in children," *Electromagn. Biol. Med.*, vol. 31, no. 1, pp. 34–51, 2011.

[38] L. Hardell, M. Carlberg, and K. H. Mild, "Use of mobile phones and cordless phones is associated with increased risk for glioma and acoustic neuroma," *Pathophysiology*, vol. 20, no. 2, pp. 85–110, 2013.

[39] E. Cardis *et al.*, "Distribution of RF energy emitted by mobile phones in anatomical structures of the brain," *Phys. Med. Biol.*, vol. 53, no. 11, p. 2771, 2008.

[40] N. D. Volkow *et al.*, "Effects of cell phone radiofrequency signal exposure on brain glucose metabolism," *J. Amer. Med. Assoc.*, vol. 305, no. 8, pp. 808–813, 2011.

[41] M. Z. Akdag, S. Dasdag, F. Canturk, D. Karabulut, Y. Caner, and N. Adalier, "Does prolonged radiofrequency radiation emitted from Wi-Fi devices induce DNA damage in various tissues of rats?" *J. Chem. Neuroanat.*, vol. 75, pp. 116–122, Sep. 2016.

[42] S. Neupane, U. T. I. Ali, and A. Mathew, "Text neck syndrome—Systematic review," *Imperial J. Interdiscipl. Res.*, vol. 3, no. 7, pp. 141–148, 2017.

[43] B. N. Green, "A literature review of neck pain associated with computer use: Public health implications," *J. Can. Chiropractic Assoc.*, vol. 52, no. 3, pp. 161–167, 2008.

[44] S. Thiyagarajan and S. V. Telegbal, "Text Neck: Is it a new term for physiotherapist?" *Indian J. Med. Heal. Sci.*, vol. 2, no. 2, p. 119, 2015.

[45] A. Deb, "Phantom vibration and phantom ringing among mobile phone users: A systematic review of literature," *Asia–Pacific Psychiatry*, vol. 7, no. 3, pp. 231–239, 2015.

[46] M. Drouin, D. H. Kaiser, and D. A. Miller, "Phantom vibrations among undergraduates: Prevalence and associated psychological characteristics," *Comput. Hum. Behav.*, vol. 28, no. 4, pp. 1490–1496, 2012.

[47] C. J. Calamaro, T. B. A. Mason, and S. J. Ratcliffe, "Adolescents living the 24/7 lifestyle: Effects of caffeine and technology on sleep duration and daytime functioning," *Pediatrics*, vol. 123, no. 6, pp. e1005–e1010, 2009.

[48] J. den Bulck, "Television viewing, computer game playing, and Internet use and self-reported time to bed and time out of bed in secondary-school children," *Sleep*, vol. 27, no. 1, pp. 101–104, 2004.

[49] S. Thomée, A. Härenstam, and M. Hagberg, "Mobile phone use and stress, sleep disturbances, and symptoms of depression among young adults - a prospective cohort study," *BMC Public Health*, vol. 11, no. 1, p. 66, Jan. 2011.

[50] C.-F. Yen *et al.*, "Symptoms of problematic cellular phone use, functional impairment and its association with depression among adolescents in Southern Taiwan," *J. Adolescence*, vol. 32, no. 4, pp. 863–873, 2009.

[51] A. Rossow. (2018). Cyberbullying Taken to a Whole New Level: Enter the 'Blue Whale Challenge,' Forbes, New York, NY, USA. [Online]. Available: https://www.forbes.com/sites/andrewrossow/2018/02/28/cyberbullying-taken-to-a-whole-new-level-enter-the-blue-whale-challenge/2/#79bee3114a38

[52] S. Kaur and D. Vig, "Selfie and mental health issues: An overview," *Indian J. Health Wellbeing*, vol. 7, no. 12, pp. 1149–1152, 2016.

[53] J. Balakrishnan and M. D. Griffiths, "An exploratory study of 'Selfitis' and the development of the selfitis behavior scale," *Int. J. Mental Health Addiction*, vol. 16, no. 3, pp. 722–736, 2017.

[54] T. Pierce, "Social anxiety and technology: Face-to-face communication versus technological communication among teens," *Comput. Hum. Behav.*, vol. 25, no. 6, pp. 1367–1372, 2009.

[55] M. Woburn, (2017). *Kaspersky Lab Study Shows How Social Media Threatens Real-life Communication*. Accessed: Apr. 13 2018. [Online]. Available: https://usa.kaspersky.com/about/press-releases/2017_kaspersky-lab-study-shows-how-social-media-threatens-real-life-communication.

[56] J. Noble. (2018). *Study: Social Media Making People Anti-Social, Jealous*. Accessed: Apr. 13 2018. [Online]. Available: https://www.studyfinds.org/study-finds-social-media-jealousy-facebook/

[57] Z. Zhang, "Microsoft Kinect sensor and its effect," *IEEE MultiMedia*, vol. 19, no. 2, pp. 4–10, Feb. 2012.

[58] C. Porter, "Calling all germs," *Wall Street J.*, Oct. 2012. [Online]. Available: https://www.wsj.com/articles/SB10000872396390444868204578064960544587522

[59] P. Hu, S. Dhelim, H. Ning, and T. Qiu, "Survey on fog computing: Architecture, key technologies, applications and open issues," *J. Netw. Comput. Appl.*, vol. 98, pp. 27–42, Nov. 2017.

[60] L. Mowatt, C. Gordon, A. B. R. Santosh, and T. Jones, "Computer vision syndrome and ergonomic practices among undergraduate university students," *Int. J. Clin. Pract.*, vol. 72, no. 1, p. e13035, 2018.

[61] P. Vondráčková and R. Gabrhelík, "Prevention of Internet addiction: A systematic review," *J. Behav. Addiction*, vol. 5, no. 4, pp. 568–579, 2016.

[62] V. A. Santos *et al.*, "Treatment of Internet addiction with anxiety disorders: Treatment protocol and preliminary before-after results involving pharmacotherapy and modified cognitive behavioral therapy," *JMIR Res. Protocol*, vol. 5, no. 1, p. e46 2016.

[63] K. S. Young, "CBT-IA: The first treatment model for Internet addiction," *J. Cogn. Psychother.*, vol. 25, no. 4, pp. 304–312, 2011.

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