CHILDREN, ADOLESCENTS, AND SCREEN TIME: A BIOCULTURAL ANALYSIS

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Despite the scientific data demonstrating the plethora of negative effects associated with screen time, use of screens is increasing exponentially across the globe due in part to the world-wide pandemic. Over the past decade, data from numerous fields has established a strong link between the use of screens and negative social, emotional, physical, neurological, and cognitive outcomes. As mounting scientific evidence continues to be published across continents confirming the negative effects associated with screen time, schools – from preschools to universities-are documenting significant increases in student screen time use. One key issue that has received very little attention in the empirical literature is how this proliferation of screen time is dramatically decreasing socialization and time spent in nature. The paper presented here will explore these changing demographics and will examine the physiological and psychological consequences of the meteoric rise of screen time use using a biocultural lens.

Introduction

According to Kahn and Kellert (2002), humans evolved in the natural world and this environment was the central feature of children's emotional, physical, neurological, cognitive, moral, and social development. Contrast this with the modern world where children (and adults) are continually exposed to artificial man-made environments and a plethora of electronic screens. The natural world, which was once an integral component of human existence, now competes alongside computers, smart phones, tablets, and various other electronic devices. Research indicates that 99% of school age youth use the internet, 85% routinely play video games, and approximately 97% of American youth have at least one electronic device in their bedroom (Hale & Guan, 2015).

Clearly, over the last 10-15 years there has been an unmitigated increase in the use of screens across much of the world (Kenney & Gortmaker, 2017). While it is certain that adult screen time has increased exponentially, data indicates that children and adolescents spend approximately 8 hours a day in front of a screen, which is more time that they spend on any other activity - including sleeping (Raphael, 2016; Rideout Foehr, & Roberts, 2010). This unprecedented use of screens has most certainly increased dramatically across the developed world due to the COVID pandemic. This dramatic increase in screen use is a relatively recent phenomenon, hence researchers are still trying diligently to decipher the multitude of effects associated with the ever increasing use of screens.

We do know that neuroimaging studies conducted over the last decade have confirmed that substantial changes occur in the brains of individuals who spend large amounts of time on screens and these changes include, but are not limited to, atrophy in the frontal, striatal, and Insula cortex regions of the brain with the most significant damage occurring in young children and adolescents (Hong, Zalesky, Cocchi, Fornito, Choi, Kim, Suh, Kim, & Yi, 2013). In addition, studies have confirmed that not only is the structural component of the brain compromised with high levels of screen time, emotional processing, executive functionality, attentional processes, and decision making capabilities are also negatively affected (Zhou, Lin, Du, Qin, Zhao, Xu, & Lei, 2011).

A review of the literature indicates that excessive screen time not only impairs brain structure and function, but also negatively impacts social, emotional, psychological, and physiological processes. This should come as no surprise as evolutionary biologists have hypothesized for decades that human beings have an innate and primordial need to be surrounded by the natural elements, and when this innate need is thwarted, distinct and quantifiable pathologies can result (Buss, 2004; Wilson,1984).

As data continue to provide empirical evidence documenting the multifarious negative effects associated with screen time, local, state, and federal governments across the globe continue their efforts to increase the amount of time students are exposed to screens. This meteoric increase in screen time is occurring at the same time that recess is being eliminated and physical education classes are being reduced or removed altogether from the curriculum (Stolzer, 2010). This increase in screen time coupled with a decrease in unstructured outdoor activity is occurring at daycares, preschools, elementary schools, middle schools, and high schools across the developed world. It is common knowledge that in many cultures, screen time is taking up more and more time not only at schools, but at home as well. Even the newer vehicles in many countries now come equipped with the latest and most technologically advanced screens so that communication among family members is severely limited.

Prior to the proliferation of screens, talking face to face with one another was the way the majority of human beings communicated. For 99.99% of our time on earth, human beings have been immersed in nature and social interaction were a critical component of the human experience. Evolutionary biologists postulate that due to millions of years of evolution and hominid adaptation, we are social beings at our core who require large amounts of contact with the natural world if optimal physiological and psychological development is to occur (Buss, 2004).

What will be the consequences of replacing face to face social interactions and nature immersion with inordinate amounts of screen time?

Certainly, there exists much speculation and conjecture, but there is also published scientific data documenting the deleterious physiological and psychological effects of moving away from our primordial bio evolutionary heritage. In the following section, the adverse effects associated with screen time will be discussed at length and the healing effects of nature in human populations will be examined.

Adverse Physiological Effects Associated with Screen Time

According to a major American study, the average 8-18 year-old spends 4-5 hours per day watching TV. 71% of children have a TV in their room, and by age 18, the average adolescent has witnessed 200, 000 acts of violence on television (Rideout, et al, 2010). From 2004 to 2008, researchers detected an increase of 50% in computer usage among 8- 18 year olds with the three most popular activities being social networking sites, computer games, and YouTube. Researchers have also documented that by age 21, this generation of screen users will have watched more than 20,000 hours of TV, spent 10,000 hours on phones, sent and received 250,000 emails and texts, and played more than 10,000 hours of video games (Rideout, et al, 2010).

A growing body of data concludes that this excessive use of screen time affects the physiological functioning of the human body in distinct and quantifiable ways. Researchers have documented that children and adolescents who spend substantial amounts of time on screens are more likely to 1. Suffer from insomnia as screens have been found to cause circadian malfunction brought on by a decrease in melatonin (Falbe, Davison, Franckle, Ganter, Gortmaker, Smith, & Taveras, 2015; 2. Increase the risk of obesity by decreasing the amount of physical activity, (Lissak, 2018); 3. Exhibit increased blood pressure and heart rate as a direct result of neurological arousal (Gopinath, Bauer, Hardy, Kifley, Rose, Wong, & Mitchell, 2012); 4. Increase the risk of type II diabetes because of dysfunction of metabolism leading to abnormal insulin levels (Henderson, Benedict, Barnett, Mathieu, Deladoey, & Gray-Donald, 2016); 5.

Suffer from blurry vision, eye strain, headaches, and an increase in myopia (Varma, Deneen, Cotter, Paz, Azen, Tarczy-Hornoch, & Zhao, 2006); and 6. Suffer from a reduction in bone density and an increase of musculoskeletal atrophy due to decreased physical activity, repetitive wrist movement, and unnatural inclination of head and neck (Lissak, 2018).

For over a decade researchers have been analyzing the effects of screen time on the human brain. Research indicates that when subjects spend as little as one hour a day online, detectable changes in the brain are dramatically visible (Small, Moody, Siddarth, & Bookheimer, 2009). Researchers have postulated that the human brain is malleable, and refashions itself based on recurrent environmental stimuli. When this specific type of neuroplasticity occurs, new neural connections are formed while the established connections are selectively pruned (Small, et al, 2009). This quantifiable data has led researchers to hypothesize that we may actually be in the process of altering the human brain (Evans, 2006; Small, et al, 2009). Throughout human evolution, flashing lights, tweets, emails, smartphones, and laptops were nonexistent. Instead, humans evolved in the natural environment which is complex, diverse, intricate, esoteric, and fraught with mystery (Wilson, 1992).

Further neuroimaging studies have reported significant alterations in brain function in individuals who spend 2-4 hours a day on screens (Paulus, Squeglia, Bagot, Jacobus, Kuplicki, Breslin, Bodurka, Morris, Thompson, Bartsch, & Tapert, 2019). These changes include cognitive dysfunction, decreased large motor function, insomnia, decrease in grey matter, and a significant increase in white matter (Ducharme, Albaugh, Nguyen, Hudziak, Mateos-Perez, Labbe, Evans, & Karama, 2016).

State of the art neuroimaging studies have provided evidence that concludes that children and adolescents who spend more than 4 hours a day on screens display a significant reduction in the thickness of the orbitofrontal cortex (Hong, Kim, Choi, Kim, Suh, Kim, Klauser, Whittle, Yucel, Pantelis, & Yi, 2013). These findings implicating the orbitofrontal cortex are significant because the reduction of the thickness of the orbitofrontal cortex is also apparent in individuals with other types of addictions (Hong, et al, 2013). Researchers have postulated that there may be a neurological mechanism at play in the development of specific addictions, including screen addiction. Thinning of the orbitofrontal cortex has also been shown to significantly impact memory and can increase the incidence of obsessive- compulsive disorder (Chamberlain, Menzies, Hampshire, Suckling, Fineberg Del Campo, Aitken, Craig, Owen, & Bullmore 2008).

Evidence from a review of the literature indicates that neurological functioning- including crystallized intelligence and fluid intelligence - is negatively impacted by the use of screens (Paulus, et al, 2019). Neurological functioning is also impacted by hormonal charges during puberty, environmental stimuli, generic traits, and distinct maturational processes. It has been hypothesized that screens may affect individuals in different ways as structural brain changes are a consequence of multivariational processes including but not limited to, how much time is spent engaging in screen time, screen content, after dark use of screens, type of screens utilized, and the number of devices used (Kenney & Gortmaker, 2017; Lissak, 2018; Paulus, et al, 2019).

While it is certain that more research is needed in order to fully understand how screen time impacts distinct neurological functioning, cross cultural research indicates that significant brain alterations are detectable in those individuals who spend substantial amounts of time on their screens (Hong, et al, 2013; Chamberlain, et al, 2008).

Adverse Psychological Effects Associated with Screen Time

A review of the literature demonstrates that there is strong scientific evidence linking screen time with a multitude of psychological dysfunction. Liu and Colleagues (2015) found a significant correlation between clinical depression and overall screen time in children and adolescents 5-18 years of age who were using screens for over 2 hours per day. However, other researchers have hypothesized that it may be that the lack of sleep caused by screen time is the variable that is actually responsible for the onset of depressive symptoms in child and adolescent populations (Oshima, Mishida, Shimodera, Todhigi, Ando, & Yamaski, 2012).

Screen time use has been associated across various continents with a significant increase in psychological dysfunction including reduced familial interactions, poor school performance, and overall interpersonal maladaptation (He, Chen, Bao, & Lei, 2012). These findings have led researchers to conclude that with regard to the development of psychological dysfunction, regular and prolonged use of screens plays a critical role (Yang, Zhou, Liu, & Fan, 2019).

It has been hypothesized that the association between depression and screen use may be more pronounced in adolescents given that they have 1. Been using screens longer than younger populations; 2. an increase in hormonal production which may increase the development of depressive symptoms; and 3. they are exposed to an increase in heightened stress due to educational, societal, and familial expectations (Frison & Eggermont, 2015).

Conversely, other researchers have argued that younger children are actually more vulnerable to the negative effects of screen time due to 1. Greater vulnerability to negative socio-cognitive outcomes from screen use; 2. a greater vulnerability to physiological responses from the arousal of the central nervous system; 3. a negative synergistic effect occurring in the brain, and 4. heightened negative effects on the sleep-wake cycle (Kremer, Elshaug, Leslie, Toumbourou, Patton, & Williams, 2014).

Cao, et al (2011) found a strong correlation between urban Chinese adolescent screen time and depression and general life satisfaction. Cao, et al, also found that for Chinese adolescents, those that used screen time frequently were significantly more likely to report academic underachievement, substance abuse, social isolation, and suicidal ideation.

British researchers conducted a longitudinal cohort study and discovered a significant correlation between screen time use at age 16 and the development of depression at age 18 with the strongest increase in depression detected in those individuals who used screens to gain access to social media sites (Khouja, Munafo, Tilling, Wiles, Joinson, Etchells, John, Hayes, Gage, & Cornish, 2019). Yang, et al, (2019) conducted multiple regression analyses and found results similar to the British cohort study when they concluded that even after controlling for gender and age, screen time addiction was significantly associated with the development of both anxiety and depression in high school students.

Twenge and Campbell (2018) examined a large national random sample (N= 40,337) of 2- 17 year old children and adolescents in America and found that after one hour of use of daily screen time, children and adolescents were significantly more likely to suffer from a decrease in curiosity and self-control, were more distractible, had more difficulty making friends, were less emotionally stable, were less attentive, and displayed an inability to finish tasks. The 14-17 year old participants in this study who used screens 7 or more hours per day (less than the national average) were more than twice as likely to be diagnosed with depression when compared to their cohorts who used screens less than one hour per day. The 14-17 year olds in this study who used screens more than 7 hours a day were also twice as likely to be diagnosed with anxiety, to be treated by a mental health practitioner, and to be prescribed daily doses of psychiatric drugs in the last year (Twenge & Campbell, 2018).

A cross-sectional survey conducted in 30 communities across three states in Australia (N= 8,256) found that for children and adolescents ages 10-16, leisurely screen time was significantly correlated with depression, with rates higher among female participants. Logistic regression analyses found that subjects who regularly participated in outdoor physical activity were significantly less likely to report depression even if they used screen time for an hour a day on average. These findings were detectable even after controlling for age, gender, socio- economics, and geographical location (Kremer, et al, 2014).

Canadian researchers conducted a cross-sectional design assessing 2,482 English speaking grade 7-12 students. These researchers found that Canadian youth spend on average 7-8 hours per day engaged in screen time which is strikingly similar to the screen time habits of American youth (Maras, Flament, Murray, Buchholz, Henderson, Obeid, & Goldfield, 2015; Rideout, et al, 2010).

Canadian researchers (Maras, et al 2010) controlled for socio-economic standing, gender, age, school attended, mother and father educational attainment, ethnicity, and language spoken at home. Results of this study indicated that duration of screen time was significantly correlated with severity of depression and anxiety. Video games and computer use were associated with the most severe depression while video games were most strongly associated with the severity of anxiety (Maras, et al, 2015). This research is unique in that it looked specifically at the relationship between types of screens and the incidence of depression and anxiety in children and adolescents. These findings indicate that while video games and computers are significantly associated with depression and anxiety, television viewing is not (Maras, et al, 2015).

According to the published literature, various other psychological problems are detectable in children and adolescents who use screen time for more than one hour per day. Carson, et al, (2016) reported that there is a strong association between behavior problems and screen time in school age children while Suchert and colleagues (2015) found a positive association between screen time and Attention Deficit Hyperactivity Disorder (ADHD) and various other forms of inattention in both children and adolescents.

Kim, et al, (2015) found 1. children and adolescents report high levels of anxiety when screens are not available; 2. blatant refusal to discontinue screen use even when told to do so; and 3. that children no longer enjoy activities that they once considered fun and desirable as screens now occupy the majority of their time.

At the present time there exists clear and incontrovertible evidence linking screen time to various mental health problems, yet screen use continues to rise across much of the world (Lissak, 2018; Paulus, et al, 2019). These mental health problems are pervasive and have been detected in numerous familial, educational, social, behavioral, and affective settings across five continents (Yang, et al 2019).

Although there is considerable data from various continents linking screen time use with various physiological and psychological dysfunction (Kouhja, et al, 2019; Liu et al, 2015; Twenge & Campbell, 2018), there exists very little data on those factors that may decrease the deleterious effects associated with screen time. In the following section, the mitigating effects of various biological processes will be examined in depth.

The Healing Effects of Nature

Decades of research has established an association between contact with the natural world and enhanced physiological and psychological functioning (Greenleaf, Bryant, and Pollock, 2014; Gullone, 2000). For 99.9% of our time on earth, our very existence was intrinsically intertwined with the natural world (Stolzer, 2010). According to Kahn & Kellert, (2002), the whole of the primate species (including humans) evolved in the natural world and this natural world continues to be the place where optimal physical, emotional, psychological, cognitive, and moral development occurs. As a direct result of the proliferation of screens, children and adolescent's exposure to the natural world is now, in the 21st century, either severely limited, indirect, contrived, managed, or vicarious (Kahn & Kellert, 2002). What is glaringly absent in the 21st century in many western cultures is direct and sustained contact with nature (i.e., direct physical contact with various forms of nature and nonhuman species that is consistent, frequent, and enduring) (Kahn & Kellert, 2002; Stolzer, 2010).

E. O. Wilson (1993) hypothesized that as a consequence of evolution, the natural world is the single most important environment that children will ever encounter. Wilson postulated that human beings have an innate predilection to focus on nature and distinct natural processes. A review of the literature confirms that human's connection with nature is an ancient biological need - indeed a "biophilial urge" according to Wilson (1984). Data confirms Wilson's hypothesis by demonstrating unequivocally that humans exposed to nature frequently and for long durations enjoy significantly better psychological and physiological health outcomes throughout the various life stages (Greenleaf, et al, 2014; Twohig-Bennet & Jones, 2018).

"Biophilia" is defined by Wilson as an innate, biologically driven need to immerse ourselves in nature- including plants, animals, water, sun, and weather (1984).Research confirms that exposure to nature significantly reduces stress (Kaplan, 1995), improves attentional predilection and learning capacity (Berto, 2005), significantly improves the symptoms associated with ADHD (Kud & Taylor, 2004), significantly reduces pain and aids in the healing process (Ulrich, 1984), and decreases the incidence of many illnesses and diseases (Greenleaf, et al, 2014; Mass, Verheij, deVries, Spreeuwenberg, Schellevis, & Groenewegen, 2009).

For decades, scientists have been warning of the plethora of physiological and psychological problems that would result from depriving children and adolescents of the natural world (Sebba, 1991; Wilson, 1984). Sebba (1991) postulated that nature is such a potent force that it innately attracts and stimulates children's curiosity and attention to such a degree that it positively affects numerous biological and emotional maturational processes.

Despite our intrinsic need to connect with the natural world, our exposure to nature has been dramatically reduced as a direct result of the high-tech world that dominates most every culture (Greenleaf et al, 2014). Published data indicates that Americans spend approximately 90% of their time in man-made structures, while American children average 30 minutes a day engaged in unstructured outdoor play (Greenleaf, et al, 2014). Compare this with the 8 hours a day on average that American children spend on their screens, and it quickly becomes apparent that children in America are immersed in a nature deprivation crisis that is causing severe and quantifiable pathology (Raphael, 2016; Rideout, et al, 2010).

Empirical data indicates that mental illness rates are reaching epidemic proportions in the United States of America (Stolzer, 2016). While ADHD is the most commonly diagnosed mental illness in American children and adolescents, diagnoses for depression, anxiety, oppositional defiant disorder, autism spectrum disorder, and a myriad of other psychiatric disorders continue to increase exponentially (Stolzer, 2016). This unprecedented increase in mental illness has led researchers to coin the term "acquired psychiatric disorder" as researchers have documented evidence linking screen time with the development of ADHD and various other mental disorders (Khouja, et al, 2019; Small, et al, 2009; Twenge & Campbell, 2018).

Perhaps our children are not "disordered" as claimed by many experts, but are in fact exhibiting behaviors that are both normative and appropriate given the disordered environments they are continually exposed to (i.e., high tech environments). It is worth noting that human beings are classified as mammals belonging to the primate subspecies. Primates are biologically programmed to interact socially with other primates and require extremely large amounts of unstructured contact with the natural world if optimal psychological, physiological, cognitive, neurological, and social development is to ensue (Wilson, 1984; 1993).

Numerous studies have determined that frequent and prolonged contact with the natural world significantly reduces a variety of diseases, illnesses, and syndromes (Gullone, 2000; Ulrich, 1981; Yuen & Jenkins, 2019). Researchers have concluded that it is not simply "exercising" that reduces illness as data documents significantly more positive restorative benefits associated with physical activity when surrounded by trees, grass, and sunlight.

These benefits include a decrease in; 1. particular cancer rates and type II diabetes, 2. insomnia and high blood pressure, 3. salivary cortisol levels, and HDL cholesterol and 3. an increase in overall mental health functioning (Bowler, Buyung- Ali, Knight & Pullins, 2010; Hartig, Mang, & Evans, 1991; Twohig - Bennett & Jones, 2018).

Research has also indicated that substantial contact with nature significantly increases school performance, overall cognitive capacity, emotional-well-being, and moral development in children and adolescents. Nature contact has also been shown to significantly reduce stress and attentional difficulties, and aggression and violent behavior (Kud & Sullivan, 2001; Picavet, Milder, Kruized, deVries, Hermans, & Wendel - Vos, 2016).

From an evolutionary perspective, the new high-tech world characterized by extensive screen use is a foreign environment to the human species (Lee, Park, Tsunetsugu, Ohira, Kagawa & Miyazaki, 2011). The literature clearly documents that substantial exposure to man-made environments (including technology) negatively impacts human health (Stilgoe, 2001), yet collectively, we continue to increase our use of technology while simultaneously severely limiting our contact with the natural world (Greenleaf, et al, 2014).

After decades of confirmatory evidence documenting the myriad of health benefits associated with nature immersion, numerous international research organizations are now engaged in projects promoting the use of nature in human healing (Lee, et al, 2011). "Forest bathing" (i.e., nature immersion) is used extensively across Asian cultures including, but not limited to, China, Korea, Japan, and Taiwan, as forest bathing has been linked to decreased blood pressure, heart disease, and lung cancer. Forest bathing has also been found to decrease pain and cortisol levels, and to significantly reduce symptoms associated with depression, anxiety, and ADHD (Lee, et al, 2011; Li, Kobayashi, Inagaki, Katsumata & Hirata, 2008).

The healing effects of forest bathing are hypothesized to be directly related to the release of phytoncides from various tree species (i.e., antimicrobial allelochemic volatile organic compounds found in essential tree oils). Studies conducted over the last decade report that phytoncides have a significant effect on GABA receptors which enhance immune and endocrine systems thus leading to better overall physiological and psychological health outcomes (Li, 2010).

Researchers have conducted quantitative field experiments to ascertain the effects of forest bathing on central nervous activity, autonomic nervous activity, biological markers that regulate stress hormones, and immunological functioning. Results of this field experiment indicate that exposure to nature increases relaxation, and significantly decreases anxiety, tension, anger, fatigue, and blood glucose levels (Tsunetsugu, Park & Miyazaki, 2010). Interestingly, blood glucose levels were measured before and after forest bathing, and during all nine field experiments, glucose levels, on average decreased from 179 to 108 mg/dL and this effect was recorded regardless of the distance walked in the forest bathing sessions (Ohtsuka, Yabunaka, & Takayama, 1998). Based on the findings reported in this study, "Shinrin-Yoku" (i.e. forest bathing) is now recognized by many in the scientific community as a valid treatment for diabetes mellitus (Ohtsuka, 1998; Tsunetsugu, et al, 2010). In light of the fact that type II diabetes is projected to increase exponentially in child and adolescent populations across many continents over the coming decade, perhaps it is time to seriously question the ethics involved in the ever increasing use of screen time that has been documented across diverse cultures.

The unprecedented proliferation of screen time should concern the scientific community, parents, teachers, and others interested in child welfare as the deleterious effects of screen time are well documented in the literature (Lissak, 2018; Paulus, et al, 2019). One of the most documented detrimental effects of screen time is the decrease in outdoor play that is a direct result of screen use. Researchers have reported increasingly low rates of outdoor play over the last decade in many parts of the world, and this decline has serious consequences for our youth including: 1. a doubling of obesity rates over the last decade (Kemple, Oh, Kenney, & Smith-Bonahue, 2016); 2. a significant decrease in large motor skills, lung capacity, and heart functioning (Bell, Wilson, and Liu, 2008); 3. a decrease in joint, bone, and muscle health (Bell, et al, 2008); 4. a decrease in flow of oxygen to the brain resulting in lowered brain function (Shaw, 2005); 5. an increase in myopia and asthma (Lovasi, Quinn, Neckerman, Perzanowski, & Rundle, 2008); 6. an increase in heart disease and type II diabetes (Misra, Pacaud, Petryk, Collett-Solberg, & Kappy, 2008); 7. an increase in problematic classroom behaviors - including inattention and other ADHD symptoms (Kuo & Faber Taylor, 2004); 8. a marked decrease in scholastic achievement, (Kemple, et al, 2016); 9. a significant decrease in social interactions, creativity, and imagination (Herrington & Studtmann, 1998); and 10. a measurable increase in stress and anxiety (Kuo & Faber Taylor, 2004).

Kaplan (1995) hypothesized that natural environments promote optimal psychological and physical health primarily through restorative mechanisms. Nature, according to Kaplan, relieves us of the hectic, non-stop pressures that we encounter in the modern high-tech world. Mitchell (1983) expands

Kaplan's hypothesis by adding that we as human beings that have evolved over millions of years require the sense of unity, connectedness, and spiritual and emotional belonging that can only be satisfied by habitual, persistent, and ubiquitous contact with the natural world.

Adding credence to the nature based theories put forth by Wilson (1983), Mitchell, (1983), and Kaplan (1995) have provided empirical data demonstrating that daily exposure to sunlight is required if optimal health is to be achieved, yet the literature indicates that significant numbers of children and adolescents do not get adequate sunlight as a direct result of our collective obsession with screen time (Kemple, et al, 2016; Paulus, et al, 2019). Although many people believe that direct sun exposure is dangerous and therefore limit sun exposure for their children, published research indicates that all humans - including children and adolescents- "must accumulate sufficient non-burning sun exposure daily to maintain vitamin D levels at 30 ng/mL or more year-round" (Hoel, Berwick, de Gruijl, & Holick, 2016, p.12).

Researchers state that to maintain sufficient vitamin D levels, fair skin individuals require 15-25 minutes of direct sunlight a day, while individuals with darker skin require 20-30 minutes when the sun is at its highest point in the sky with at least 40% of the skin exposed (Mead, 2008). The amount of direct sunlight required to maintain optimal health depends on many factors including age, skin color, latitude, time of day exposed, and the time of year when exposure occurs (Hoel, et al, 2016). Hoel and colleagues (2016) assert that while many parents may be trying to protect their children by reducing exposure to sunlight because of numerous public health warnings, avoiding direct sunlight and the increased use of chemically based sunscreens may actually increase the incidence of melanoma - the most deadly form of skin cancer.

At the present time, there is no valid scientific evidence documenting that chemically based sunscreens reduce the risk of melanoma, however, sunscreens do significantly reduce the natural production of vitamin D in the skin (Hoel, et al, 2016). This is highly problematic as numerous studies conducted over the last 100 years have documented the plethora of health benefits associated with vitamin D production that occurs only when human skin is exposed to direct sunlight. Although vitamin D supplement sales have increased dramatically over the last 5-10 years, the data indicates that it is direct sunlight that has been associated with the most positive health outcomes over the life course (Hess & Unger, 1921; Hoel, et al, 2016).

Numerous researchers have found that avoiding direct sun exposure is especially dangerous as it has been correlated with an increase in overall mortality rates. Lindqvist concluded that avoidance of sun exposure was a risk factor for all-cause death of the same magnitude as smoking (Lindqvist, Epstein, Nielsen, Landin-Olsson, Ingvar, & Olsson, 2014), while Afzar and colleagues randomized analysis found that decreased levels of sunlight contributed to an increase in all-cause mortality - except cardiovascular mortality (2014).

Decades of data has demonstrated that sufficient amounts of direct sunlight over the life course can decrease a myriad of diseases and chronic health conditions. Published scientific data documents the benefits associated with daily sun exposure. These benefits include: 1. A reduction in colon cancer (Rebel, der Speck, Salvatori, van Leeuwen, Robanus-Maanday, & de Gruijl, 2014), breast cancer (Mohr, Gorham, Kim, Hofflich, and Garland, 2014), Non-hodgkin's lymphoma, prostate cancer, bladder cancer (Hoel, et al, 2016), lung cancer, pancreatic cancer and ovarian cancer (Holick, 2014); 2. A significant decrease in autoimmune disorders, infectious diseases, and bone fractures (Holick, 2011); 3. A marked reduction in cardiovascular disease and high blood pressure (Hoel, et al, 2016): 4. A decrease in Alzheimer's disease and dementia (Littlejohns, Henley Lang, Annweiler, Beauchet, Chaves, Fried, Kestenbaum, & Kuller, (2014); 5. A reduction in multiple sclerosis and rheumatoid arthritis (Hoel, et al, 2016); 6. Significantly lower rates of type I and type II diabetes (Sawah, Compher, Hanlon, & Lipman, 2016); 7. A reduction in non-alcoholic fatty liver disease (Gorman, Black, Feelisch, Hart, & Weller, 2015); 8. A significant decrease in macular degeneration (Millen, Meyers, Liu, Engelman, Wallace, LeBlanc, Tinker, Lyengar, Robinson, & Sarto, 2015); 9. A decrease in obesity and metabolic syndrome (Geldenhuys, Hart, Endersby, Jacoby, Feelisch, Weller, Matthews, & Gorman, 2014); A measurable decrease in myopia even if both parents were myopic (French, Ashby, Morgan, & Rose, 2013); 11. A marked reduction in psoriasis (Hoel, et al, 2016); 12. Significantly lower incidence of seasonal affective disorder, depression, schizophrenia, and migraine headaches (Abi- Dargham, Laruelle, Aghajanian, Charney & Krystal, 1997; Hoel, et al, 2016); 13. A measurable decrease in insomnia (Mead, 2008); and a significant decrease in the likelihood of developing Parkinson's disease (Nair & Maseeh, 2012).

For decades, public service announcements and the medical community have focused on the hazards associated with too much sun exposure hence, the fear of the sun has taken hold in many cultures. However, it is worth noting that "excessive sun exposure accounts for only 0.1% of the total global burden of disease in disability-adjusted life years. In contrast, the disease burden of 3.3 billion disease in disability-adjusted life years results from very low levels of sunlight exposure" (Mead, 2008, p.30). Mead (2008) clearly and definitively makes the point that lack of sunlight is a major health concern, while getting too much sunlight results in relatively few diseases and chronic conditions worldwide.

Vitamin D is one of the oldest hormones on the planet as it had existed for at least 750 million years (Holick, 2008). According to published research, vitamin D produced by direct sunlight can be stored in the liver and fatty tissue to be utilized during the winter months when sun exposure is infrequent (Razzaque, 2018). Data continues to confirm that humans have the primordial ability to manufacture increased levels of vitamin D when skin is exposed to direct sunlight. Researchers from more than 100 countries have documented that exposure to direct sunlight significantly decreases 15 different types of cancer, and significantly reduces a myriad of diseases and chronic conditions (Holick, 2014). Furthermore, there is research documenting that sensible and frequent sun exposure during childhood and adolescence is associated with more favorable health outcomes throughout the life course (Holick, 2014). In light of these findings, scientists from divergent fields have recommended that in order to achieve optimal health status, the primary source of vitamin D should be direct sunlight - not exogenous supplements (Hoel, et al, 2016; Razzaque, 2018).

Conclusion

If we are serious in our collective endeavor to positively affect human health outcomes exponentially across diverse populations, the time has come to thoroughly explore the ethical implications surrounding the meteoric rise of screen time use in child and adolescent populations that is occurring across the majority of cultures on planet earth. Data has clearly documented that the average youth is spending unprecedented amounts of time on various screens and this excessive use of screen time has led to impairment in brain structure and function, to a myriad of psychological disturbances, and to a dramatic increase in physical disorders (Kenney & Gortmaker, 2017; Lissak, 2018; & Paulus, et al, 2019).

If our goal is to significantly reduce the myriad of psychological disorders, learning disabilities, and physical diseases and maladies that are now rampant in our youth, one of the first steps in alleviating these pervasive disorders is to simultaneously decrease screen usage and significantly increase access to the outdoors (i.e., recess and outdoor physical education classes) in all types of childcare facilities and educational settings across the globe.

Although a significant number of children spend the majority of their formative years enrolled in daycare centers, Head Start facilities, and other formal educational settings, parents too must be vigilant about dramatically decreasing screen time use at home. It is worth noting that in order to change a child's behavior, the adults entrusted to teach the child must first and foremost change their own behavior. We as adults can no longer pay lip service to the harmful effects associated with screen time while continuing our own obsessive use of screens. If long term change is to occur, we as the adults must not only model appropriate and healthy behavior patterns, we must also dramatically limit the amount of time our children are focused on various types of screens.

Over the last 5-10 years there has been a growing concern about the impact of screens on our children's health, yet Americans continue to purchase screens in record numbers despite the considerable evidence documenting the deleterious effects associated with screen time. The ever increasing use of screen time has many unintended negative consequences including the dramatic decrease in the time children and adolescents spend out of doors immersed in the natural world. Not only are our children not receiving the required amount of sunlight per day, they are also not getting the direct social interaction needed by all primates, nor are they using their imaginations or creative play to ensure proper neurological responsivity (Kemple, et al, 2016, Paulus, et al, 2019).

Researchers have documented unprecedented numbers of children and adolescents suffering from ADHD, obesity, overweight, metabolic syndrome, and type II diabetes, and all of these conditions are directly linked to the dramatic increase in screen time usage that has occurred over a relatively short time in many high-tech cultures (Small, et al, 2009).

There exists incontrovertible scientific evidence documenting that behaviors in childhood and adolescence are directly correlated with health outcomes in adulthood (Ducharme, et al, 2016). In light of the science published on five continents, perhaps the time has come to embark on a massive world-wide public service campaign modeled after the anti-smoking campaigns of the past. This call to action would require governmental, educational, medical, and familial involvement in order to effect change at both the micro and macro levels. It is a distinct possibility that many are unaware of the serious negative effects associated with excessive and prolonged screen time. A world- wide campaign would help to ensure that the public was educated, and that informed consent would occur.

For decades, the public was unaware of the dangers associated with cigarette smoking, hence governments embarked on a massive anti - smoking campaign in order to reduce health care costs and save lives. This campaign was successful and led to a dramatic decline in the number of smokers across the globe. Conceivably, the same type of compendious campaign could reduce the use of screens, and ultimately reduce morbidity and mortality rates exponentially across diverse populations.

In summary, the unprecedented rise in screen time use in child and adolescent populations has led to the manifestation of a myriad of physiological and psychological disorders that were virtually unheard of in prior generations. In light of the vast scientific data that exists documenting the wide range of pathology caused by prolonged screen use, the time has come to actively challenge those systemic processes that initiate, encourage, and promote the use of screens. Our children deserve no less.

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