The Prevalence and Consequences of Poor Posture in Children and Adolescents

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Abstract

Correct posture is identified as a crucial aspect of healthy bodily functioning. The scientific community continues to discover evidence suggesting that improper sitting and standing posture results in musculoskeletal pain, degradation of ligaments, hindered respiratory functioning, and even increased feelings of negative emotions such as anxiety and depression. Whether due to limited physical capabilities, a lack of knowledge regarding the importance of physical posture, or other reasons, much of the general population consistently partakes in improper posture for increasing bouts of time despite the research. Technological advancements in particular seem to be exacerbating the situation, with the youngest and most tech-savvy generation being at the greatest risk for the negative consequences improper posture yields.

The Prevalence and Consequences of Poor Posture in Children and Adolescents

It is commonly acknowledged among the scientific population that correct posture is worthy of being maintained, taught, and exemplified (Hansraj, 2014; Kritz, 2008; Nair, Sagar, Sollers, Consedine, & Broadbent, 2015). However, the concept of "correct" posture may prove to be ambiguous when analyzing the various factors that encompass its meaning. The consequences of poor posture can prove detrimental to the individual, increasing in severity as long as the habits continue to go unresolved (Cuéllar & Lanman, 2017; Kado, Huang, Karlamangla, Barrett-Conner, & Greendale, 2004; Nair et al., 2015; Prieto, Myklebust, Hoffmann, Lovett, & Myklebust, 1996; Ting-Ting, Cinelli, Lyons & Lee, 2015). Poor postural habits can manifest at relatively young ages, even well before one's teenage years (Kratěnová, ŽEjglicová, Malý & Filipová, 2007; Murphy, Buckle & Stubbs, 2004). Despite the symptoms becoming apparent at strikingly early ages, these habits are often left untreated for the majority of one's lifetime which can lead to a variety of musculoskeletal issues in the later stages of one's life (Boyle, Milne & Singer, 2002; Milne & Williamson, 1983). It is probable that, had individuals suffering from the consequences of poor posture implemented proper postural habits at an earlier age, such consequences could have been lessened or perhaps altogether avoided.

This thesis will attempt to shed light on the common pitfalls of incorrect posture and the areas in which this problem can be most prevalent. Additionally, it will review in detail the specific anatomical intricacies of poor posture that are commonly seen in the general public and kids and elaborate on the most common areas in which such postural nuances are lacking in children in the modern age. Furthermore, it will review the

anatomical specifics of correct posture regarding angles of joints, lengths and activation of muscles, and ideal body positioning.

A Comprehensive Explanation of Proper Standing and Seated Posture

An understanding of proper posture is essential to comprehending and appreciating its importance in everyday life, as well as revealing the specificity that the term "posture" entails. Simply put, posture is the position in which the body is held and maintained during its everlasting defiance of gravity. Even when standing still and not in contact with visible external forces (excluding contact between feet and the ground), the body is, at all times, subject to the influences of external forces (most notably gravity, but also minute fluctuations in wind currents). Thankfully, the human body is capable of counteracting such forces usually without the need to devote conscious thought to its resistive actions. The nuances of proper posture are explored by Wright and Rothenburg (2011), who stated, "to maintain standing balance, the postural control system integrates information from the visual, vestibular, and proprioceptive systems" (p. 100). The body as a whole constantly receives signals from external visual cues and internal neuromuscular signals which are interpreted by the central nervous system to maintain tonic muscular activity that will assist in the body remaining in its desired position in relation to the center of gravity. Muscles, connective tissue, proprioceptors, etc. must work in conjunction and relation to each other to maintain a body’s posture (Wright & Rothenburg, 2011). The complexity of the mechanisms is difficult to comprehend, but the scientific community has procured a thorough understanding that continues to grow.

Correct posture is that which keeps the joints and bones in alignment with each other, resulting in evenly distributed body weight that is stacked upon itself such that the greater weight is borne by the anatomical structure located inferiorly. For example, while the cervical spine bears the weight of the head, the lumbar spine bears the weight of the head and the cervical spine, and so on until we have reached the feet (which bear the entirety of the body's weight). The mechanical structure of human anatomy is naturally inclined to specific positions that will properly distribute and direct the weight through the joints. Maintaining this position will significantly reduce abnormal wearing of joint surfaces that cause arthritis, improve the health of the ligaments, and eliminate unnecessary burdens on the muscles. It largely prevents strain and overuse issues as well as backaches and muscular pain. Correct posture will assure the maintenance of a neutral spine throughout the process of aging, avoiding altogether symptoms of scoliosis, kyphosis, etc. (Cleveland Clinic, 2015). It’s importance to the performance and basic operation of the human body cannot be understated.

It can be far too easy for one's standing posture to degrade after extended periods of time and over the course of one's lifetime. The American Chiropractic Association (2019) outlines clear standards for standing that incorporate injury-preventative maintenance. According to the ACA, the ideal standing position is one that encompasses several key physical cues. First, the neck demonstrates a 0-degree flexion, extension, and lateral flexion. The ears and the atlantoaxial joint are at rest directly above the glenohumeral joints. As the structural purpose of the neck is to uphold the relatively heavy head, maintaining this posture ensures the least amount of physical stress and

weight to be borne by the neck. In addition to proper neck positioning, the ACA recommends retracting the scapulae, activating the major and minor rhomboids and trapezius muscles and preventing a forward rounding of the shoulders in the process. The arms are to remain entirely relaxed, and there is no flexion, extension, or lateral flexion of the back. The pelvis is not to be tilted forward; doing so typically denotes a number of related issues and potential consequences. There is a slight bend in the patellofemoral joint to ensure adequate blood flow throughout the body, and the *q* angles are between 18 and 22 degrees. Finally, the feet are to be held directly below each shoulder, arched, and with the weight of the body held primarily on the balls of the feet. When standing for extended periods of time, the weight should be shifted between the feet or from the toes to the heels (American Chiropractic Association, 2019). Using these guidelines will enhance longevity and avoid the consequences of poor posture.

Although often overlooked, seated posture is equally as important as standing posture and perhaps more important for those who engage in lifestyles that require extended periods of being in a seated position (ex. students, truck drivers, and office-workers to name a few). Schmidt, Amereller, Franz, Kaiser, and Schwirtz (2014) performed a meta-analysis of optimal and preferred joint angles in automotive sitting posture and concluded, "there is still a lack of information in methodology and description of background . . . we suggest undertaking further research in the field of biomechanics and ergonomics to work out a scientific based and objectively determined ‘optimum’ joint angles" (p. 247). After analyzing 30 qualified articles, Schmidt has concluded that more research must be devoted to this topic. Rosário (2014) agreed, who

states in his photographic analysis of human posture that, "The study of posture is not an easy task, mainly because postural assessment is still scientifically inaccurate" (p. 56), as do Claus, Hides, Moseley, & Hodges (2009) who, in an article questioning the existence of an ideal sitting posture, explicitly states, "There is a lack of quantitative evidence for spinal postures that are advocated as 'ideal' in clinical ergonomics for sitting" (p. 404). According to O'Sullivan, O'Sullivan, O'Sullivan, and Dankaerts (2012), disagreement remains surrounding even basic inquiries such as what constitutes a neutral spine posture, and affirmed that physiotherapists cannot decide on the best sitting posture; however, O'Sullivan et al. asserts that, "qualitative comments indicated that sitting postures which matched the natural shape of the spine, and appeared comfortable and/or relaxed without excessive muscle tone were often deemed advantageous" (p. 432). There are identifiable guidelines to assist in developing the optimal posture capable of complementing the human anatomy's natural structural predisposition.

The work of O'Sullivan et al. (2012) provides additional guidance for seated posture. Guidelines relating to the neck are identical to those when standing; keeping one's chin parallel to the ground while keeping the earlobes above the shoulders remains essential, yet vastly unpracticed in the general population, especially when an individual is using a phone or desktop device. As such, it is recommended that individuals raise their electronic device to a level that allows for only a slight (<10 degrees) flexion of the neck. In accordance with the findings of previously reviewed articles, the ideal back position is one that is straight and vertical while following the natural curve of the spine. Back supports are recommended, especially to support the lower back. Shoulders are to

remain relaxed (in many cases requiring scapular retraction and back extension) and forearms are to be parallel to the ground. The positioning of the lower body is where things begin to differ so greatly from standing posture. The knees are to be positioned at or below the level of the hips with a small gap between the knees and the tip of the seat. It is recommended that legs are never crossed, likely to avoid prolong stress on the ligaments infusing the knee and hip joints. Feet should remain on the floor or, in scenarios in which the feet would not reach the floor (as may often be the case for children), upon a footrest, which would allow the body to balance out the force between the feet and the bottoms of the thighs which will allow for adequate blood flow through the lower extremities. Finally, one should avoid sitting in the same position for long periods of time (O'Sullivan et al., 2012; American Chiropractic Association, 2019). The human body is more suited for movement in which it must bear its weight against gravity.

The human body is neither meant nor is well-adapted for remaining in a single position for a substantial amount of time. Pope, Goh, and Magnusson (2002) asserted that remaining in the same anatomical position for a prolonged period will lead to static loading of the soft tissues which will cause discomfort (Pope et al., 2002). Additionally, the various popular seating positions can all prove to be detrimental to one's health and comfort in various ways. One study, conducted by Hough and Nel (2017), analyzed the postural risks of the three most preferred anatomical positions to assume when using a laptop without the assistance of a desk among 72 undergraduate students. The study sought to observe the postural risks and level of musculoskeletal discomfort experienced by the students. The following three positions were chosen: crossed legs with back

unsupported, back supported with feet on an ottoman, and in a horizontal, face-down prone position with the belly upon the floor or surface, and with the upper body propped upon its elbows.

Interestingly enough, only 5 out of the 72 participants scored at "medium risk" or above when assessing their postural risk after having assumed all three positions, meaning that only these few suffered a significant amount of functional loss (Hough & Nel, 2017). However, half of all participants reported pain in the lower back, shoulders, and neck. It is also worth noting that the study does not specify how long each position was held before questionnaires were answered. Even though with current research there seems to be only one, somewhat loosely defined, ideal for optimum sitting posture, alternating positions to other popularly assumed positions may not be the ideal solution. This notion is further supported by Benatti and Ried-Larsen (2015), whose meta-analysis of the effects of intermittent movement to split up prolonged sitting periods revealed its benefits. Benatti and Ried-Larsen assert that the currently available experimental studies provide ample evidence to intermittent bouts lasting as low as 2 minutes with light intensity are effective in inducing favorable changes in metabolic parameters, mean respiratory exchange ratio, and positive aspects of muscle development, growth, and proliferation. The evidence makes clear that proper body position alone is not the quintessential element to prolonged periods of sedentary activity.

The Rise of Sedentarism in the Modern Era

The modern age is home to the greatest era of luxury that the world has yet seen. To varying extents throughout the world, technological advancements have enabled the

use of devices that are just shy of miraculous in the capabilities, information, and entertainment they have to offer. Unfortunately, the incredible benefits of smart-devices and other such technological advancements have served as a reminder that too much of a good thing can be a bad thing. The instant gratification that certain technology can provide can serve as a temptation to indulge in excess amounts of leisure and/or entertainment that our society is becoming increasingly dependent upon in its day-to-day functioning, as supported by statistics from Pew Research Center (2018), Nielsen Holdings Inc. (2018), and eMarketer (2016).

The use of smartphones has skyrocketed in recent history. According to the Pew Research Center (2018), 95% of adult Americans owned a cellphone of some kind in January of 2018, with 77% of those being smartphones. It is extremely likely that American society will see smartphones under the ownership of every one of its citizens within a few generations or less, because out of youngest age group that participated in the poll (ages 18-29), 100% of people owned a cellphone with an astounding 94% of those being smartphones. If the trend continues, then it will not be long before the smartphone transforms from a luxury into a necessity for living in modern civilization.

The smartphone is not the only factor contributing to the era of entertainment we have achieved. The Nielsen Holdings Incorporated (2018) speculates that about 119.9 million homes in the U.S. have ownership of a television. Considering that there are only about 127.6 million households in the United States according to the U.S. Census Bureau, this means about 94% of households contain a television. Additionally, the video game industry continues to grow exponentially, as over 150 million Americans play video

games and over 64% of American households are home to at least one person who plays video games at least three hours per week, according to research conducted by the Entertainment Software Association (2018). These astounding numbers exhibit the popularity of handheld or screen-induced mediums of leisure and are a highly likely culprit for the growing trends of sedentarism observed in the past several years.

Statistical data continues to demonstrate that the vast majority of modern households have not just made these accessories into common utilities, but they spend unprecedented amounts of time using said accessories in ways that societies would likely have never predicted during the birth and popularization of these technological devices just decades ago. There is some conflicting evidence regarding the amount of average time spent on mobile devices, with the conservative ends asserting that the Americans spend about three hours per day on their mobile phones while more extreme ends state that Americans spend over five hours a day on their smartphones. According to a statistic from eMarketer (2016), the average American adult spent 173 minutes (2 hours and 53 minutes) per day on their smartphone. This trend this was expected to increase to about 203 minutes (3 hours, 23 minutes) per day on their smartphone – excluding time spent talking over the phone – in 2018. According to the Nielsen Holdings Incorporated (2018), the average U.S. citizen spends about 38 hours and 46 minutes per week using the television, with the numbers decreasing slightly for younger generations and increasing in the older age categories. Finally, according to market research conducted by Limelight (2018), those who play video games (namely the younger generations) do so for

approximately 6.44 hours per week in America, which is higher than the 5.96 global average.

With such astounding statistics, three major points should be noted before continuing on. First, there is undoubtedly some overlap among these entertaining media, namely between smartphone usage and video gaming and between television use and video gaming. Such an overlap is difficult to quantify in census reports and market surveys with such large target populations. Next, while smartphone usage data do report staggeringly high numbers, smartphone uses stretch beyond entertainment-centered applications such as Facebook, YouTube, Instagram, etc. into tools used for more practical purposes such as calling, emailing, texting, setting one's alarm, listening to music/podcasts, and more. Finally, the data does not account for multitasking, such as using one's smartphone while watching television. In the spirit of fairness, these unquantified variables must be acknowledged. But even with such caveats sustained, the trends are clear: Americans, along with the rest of the world, cannot seem to get enough screen time.

While methods of entertainment continue to steadily increase, sedentary behavior has increased in kind. In light of history, the emergence of lifestyles filled with leisure is a relatively new phenomenon. As Owen, Sparling, Healy, Dunstan, and Matthews (2010) state, "The recent shift from a physically demanding life to one with few physical challenges has been sudden, occurring during a tiny fraction of human existence" (p.1138). Lifestyles are incorporating substantially more sedentary behavior than ever before with lack of exercise and excessive sitting being the main culprits. According to

Centers for Disease Control and Prevention (2001), the percentage of the population meeting recommended physical activity levels (≥30 minutes per day, ≥5 days per week) increased slightly from 24.3% to 25.4% in 1990 to 1998, respectively. This takes a turn, however, when viewing more recent years. For example, Ogden, Carroll, and Lawman (2016) found that obesity has nearly doubled in children (aged 6-11) from 11.3% in 1988-1994 to 19.6% in 2011-2014. The trend was almost identical in adolescents (aged 12-19), whose obesity rates jumped from 10.5% in 1988-1994 to 20.6% in 2011-2014. Research provided by Boddy, Fairclough, Atkinson, and Stratton (2012) states that from 1998 to 2010 there has been an annual decrease in cardiorespiratory fitness of 1.39% and 2.29% in boys and girls, respectively. To summarize the apparent trend Kohl and Cook (2013) state, "During the a past 30-40 years, probably even longer, the volume and intensity of physical activity among youth have gradually declined" (p. 36). This unfortunate decrease in physical activity in youth is of great concern to the physical health of all future generations.

The correlation between the steady decline in physical activity and the meteoric rise in electronics usage is no coincidence. The growth of technological advances has both directly and indirectly influenced sedentary lifestyles by creating more efficient methods of survival to allow for less time to be devoted to the same job, and by birthing extraordinarily complex media for inactive entertainment. As it becomes increasingly commonplace for individuals to find themselves with hours of leisure time at their disposal and as methods of entertainment grow increasingly attractive, it is no wonder that societies are seeing a decline in physical activity in their youth and adults alike.

While such technological advancements are not to be repressed and have benefitted society in countless ways, the trends previously outlined will only grow more severe in their consequences in ways that will have a lasting impact on the posture – and by extension the quality of life – of today's youth.

The Effect of Technological Advancements Upon Posture in Children and Adolescents

The modern generation, more than any other generation in recorded history, has seen an excess of sedentary behavior. The detriments of sedentarism have themselves been heavily researched, including its multifaceted effects on the posture of children and adolescents. This specific target population has proven unique to any other generation as they are the first to have ever grown up in a world in which the apparatuses that would have been considered the pinnacle of technological progress only a few decades ago are now considered pedestrian. As such, it will be all the more crucial to implement habits of proper posture in this newest generation; failure to do so will only yield physical, mental, and emotional pain in greater masses of people.

Perhaps the most obvious and even stereotypical affect technology has had on posture in children and teens (as well as adults, in fairness) is in the craning of the neck while using a mobile device. Researched presented by Hansraj (2014), examined the scope of the damage that a simple neck flexion can sustain. Hansraj concluded that bending the neck forward a matter of 15 degrees beyond one's center of gravity can more than double the weight and stress thrust upon the neck muscles, tendons, and ligaments, increasing the average weight of the head as a whole from about 10 to 12 pounds up to 27

pounds. A 30-degree bend will create a 40-pound burden, a 45-degree bend causes a 49-pound burden, and a 60-degree bend means a 60-pound burden placed upon the neck. Although anyone could guess that multiplying the amount of stress to be placed on the neck by a factor of six for hours at a time and on a daily basis will yield detrimental results, actions of this sort are engaged in without second thought, especially among the youth.

This epidemic has led to a notable rise in patients complaining of neck and upper back pain, specifically among the younger age groups, according to spinal surgeons Cuéllar and Lanman (2017). Discussing their observations of the average individual using his mobile device, Cuéllar and Lanman ask their readers to look carefully at the individual's sagittal spinal alignment, claiming that almost every time you will notice their cervical spine in a position of 15°–60° of flexion. Such ranges fall within the exact ranges outlined by Hansraj (2014) previously, solidifying the suspicions of irresponsible positioning. Cuéllar and Lanman (2017) continue to describe the uncertainty surrounding the extent of the damage, postulating the possibility of intervertebral disc degeneration and consequent cervical spondylosis. It seems that this epidemic, dubbed the "text neck" epidemic, is likely to be contributing to a clandestine upswing in neck and upper back aches associated with the trapezius, splenius capiti and splenius cervici.

Although the television boom has seemed to plateau and perhaps even decline among the youth, it remains a formidable threat to the youngest generation's posture. The astounding quantity of hours per week spent watching television even among younger age groups is not to be ignored. Research conducted by O'Sullivan, Smith, Beales, and

Straker (2011) confirms that adolescents who participate in greater amounts of television watching and video gaming portray a significantly greater degree of slump in their posture and are at greater risk for back pain. A similar study from Filho, Coutinho, and Silva (2015) goes further in depth, asking subjects to identify their preferred position in which to watch television out of five common positions. One of the five positions incorporated the components of proper posture; each of the other four common positions had varying degrees of neck, thoracic, and lumbar flexion. Of the 1,102 subjects, 78 identified their preferred television watching position to be the position with ideal posture. Research is insufficient regarding the introduction of video games into the equation; however, one can be reasonably certain that including hand-held controllers and the necessity for intense focus is more likely than not to further incentivize individuals to allow their posture to degrade to the most comfortable position – which is not necessarily the most mechanically efficient position – leading to poor posture.

Television and mobile phone usage are not the only culprits to blame for postural issues prevalent in the upper back and neck in children and adolescents. Computers and tablet use have both become substantially more popular among younger and younger age groups, perhaps in part due to their increased popularity as an educational tool in classrooms. The use of computers in grade school classrooms translates to an earlier introduction of this technology within the ideal learning environment, leading to a swifter and more efficient indoctrination. According to Domingo and Garganté (2016), the use of screens is seen by most teachers as a means to facilitate student-access to information while promoting engagement to the subjects at hand. Hatakka, Andersson, and Grönlund

(2013) claim that increasing numbers of teachers in grades K-12 are opting to use computers, laptops, tablets, etc. on a one-to-one ratio, meaning one device per child. Such education strategies may certainly have their merits and are worth the exploration. Evidence from Straker et al. (2008) has demonstrated that these methods of education are likely to be a beneficial alternative to notebook paper in the classroom setting. When comparing the use of a desktop computer without a keyboard, a tablet device, and ordinary textbook paper and pencil, Straker et al. (2008) observed a significantly smaller neck flexion maintained in the subjects, with the desktop computer creating a mean neck orientation of 61.5 degrees while the paper and tablet devices caused an orientation of 70.3 degrees and 76.3 degrees, respectively. These findings indicate that desktop computer usage in the classroom setting is likely to be more preferable to notebook paper. With this said, tablet usage has only served to exacerbate the issues at hand; Straker et al. suggest that it may be yielding the worst results among head and neck flexion, trunk flexion, abdominal lateral bending, and more. Unfortunately, due to factors such as transportability, convenience, cost (both in initial price and maintenance), etc. it seems that tablet usage is the more popular choice and will continue to be so in the years to come.

While usage of a desktop computer and laptop in a classroom setting is an arguably positive alternative to pencil and paper with regard to posture, it remains a detrimental option as a source of entertainment outside of the classroom without proper postural instruction. In a separate study focused on muscular activity in children using a tablet versus playing with toys, Straker, Campbell, Coenen, Ranelli, and Howie (2015)

conclude, “Tablet computer use by young children is typified by less movement, muscle activity and poor spinal posture than toy play . . . all of which may increase the risk of musculoskeletal symptom development” (p. 3). As previously discussed, usage of computers and tablets is too often characterized by extreme flexion of the neck and trunk; indulging in seated positions with such flexion for extended lengths of time will exacerbate the issues associated with poor posture.

In fact, even the simple act of sitting, if prolonged, has been shown to have negative effects on posture. A study conducted by Waongenngarm, Rajaratnam, and Janwantanakul (2015) examined the effects of three prolonged sitting postures, implementing the Borg scale to measure perceived pain. The study found that sitting with a forward leaning posture for one hour is significantly associated with iliocostalis lumborum pars thoracis (ICL) and superficial lumbar multifidus (MF) muscle activity, which resulted in a significantly higher prevalence of low back discomfort. By contrast, sitting in an upright posture for one hour gave relatively moderate ICL and MF activation, with increased transversus abdominus and internal oblique activation. But despite the positive difference upright sitting made, notable increases in discomfort were recorded in the neck, upper and lower back, and both hips and thighs. It seems that prolonged sitting, which has been known to contribute to a large amount of health issues and risks, is evidently a concerning risk for one’s well-being even when proper posture is enforced. Certainly, it is uncommon for one to sit for the sake of sitting for over an hour at a time in a singular position, so the contents of the aforementioned studies may seem irrelevant if taken out of context. But when one’s attention is held by any sort of activity

requiring cognition/focus, it is substantially easier to allow one's body position and physical discomfort to slip into the unconscious as the cerebral cortex is preoccupied, such as with television, video games, and smart phone usage. It is possible that this would allow individuals to assume less-energy demanding positions with poor posture despite the body's indications of discomfort/pain until the body no longer finds such positions painful but has adapted to make them the standard.

Although it is a relatively broad cause compared to previously discussed topics, the sedentarism that we have seen rise in correlation with the boom of the electronic industry is another significant cause of poor posture in the youth. Physical activity is an absolute necessity for the proper health of the human body, and so much more so in those that are still growing. One study from Bogdanović and Marković (2010) examined 299 kids who did not engage in sports and tested for lordotic poor posture to discover that the plurality of the subjects did not select a specific reason for not participating in any sport, opting for the "other" option in the questionnaire. Of those 115 subjects, the highest prevalence of poor lordotic posture was identified. Bogdanović and Marković articulate their educated speculations for the phenomenon of poor posture in children who do not participate in sports, stating, "It's important to avoid weakening of the muscle region of the spinal column, which leads to some disruption in the region in terms of poor posture, certain postural disorders and finally physical deformity appearance" (p. 63). A cross-sectional study conducted by Kratěnová, et al. (2007) supports the notion that the muscular strength and endurance that participation in sports could provide may explain

why children who do not participate in sports tend to have a higher prevalence of poor posture. The evidence for the effect of sedentary behavior on posture is clear.

Finally, although it is not necessarily related to technological advancements, it would be careless not to mention the heavily researched and documented effect that backpacking has on children's posture. Research from Kim, Yi, Kwon, Cho, and Yoo (2008) found that carrying backpacks has resulted in significantly higher activation of the upper trapezius, sternocleidomastoid, and cervical paraspinals as well as a significantly greater forward head angle and forward head distance. Considering the amount of time children typically spend with backpacks on their backs walking to and from school, the bus stop, and in between classes, this could have concerning indications. Studies from both Rai, Agarwal, and Bharti (2013) and from Hong and Cheung (2003) agreed that when backpacks that weighed 0%, 10%, and 15% of the subjects' bodyweight were carried, there was no significant impact on posture in students, but when 20% bodyweight load was reached it usually resulted in the significant anterior shifts and flexions previously noted. Additionally, Pascoe, Pascoe, Wang, Shim, and Kim (2010) found that carrying book bags was found to decrease stride length and increase stride frequency, thereby reducing the gaits support phase. Ironically, technological advancements have been given a considerable amount of blame for poor posture in children yet may be the best hope of reducing the strenuous effect of backpacking in the future. As information and education continues its shift away from paper and into the digital realm, it may be that children will be expected to carry less weight in the future.

Physical Consequences of Poor Posture in Children and Adolescents

Thus far the specifications and pervasiveness of poor posture among the youth has been discussed in detail. In order for such a topic to even be relevant it requires the magnitude of the potential consequences to serve as its context. Allowing the body to position itself in positions that do not complement the natural curvature of the spine is sure to have disastrous effects.

Posture is primarily centered around the spine and its position within the body. Positions that fail to complement the natural curvature of the spine act as the source of the adverse effects that are derived from poor posture. This holds true for every part of the body; the neck is a prime example. Hansraj (2014) states, “Loss of the natural curve of the cervical spine leads to incrementally increased stresses about the cervical spine. These stresses may lead to early wear, tear, degeneration, and possibly surgeries” (p. 2). According to research from Siriluck, Janwantanakul, Pensri, and Jiamjararangsi (2012), it was discovered that a greater occurrence of cervical pain is typically identified in students who use a laptop for greater than 3 hours a day, as well as a greater risk of thoracic and lumbar pain. Those with the forward-head posture produced by regular laptop and television activity have also been shown to have a greater prevalence of chronic tension-type headaches according to Fernández-de-la-Peñas, Nielsen-Arendt, and Gerwin (2010), which is no surprise given the microtraumas of poor posture and the increased load that is placed on the posterior cervical and occipital muscles that must be created to support the weight of the cranium. Such findings were further investigated by Mingels, Dankaerts, Etten, Thijs, and Granitzer (2016), who conducted a study in which individuals with postural induced headaches were compared to healthy controls. Those

with postural induced headaches were shown to have a greater head-protraction of 22.3% when compared to the control group. The described posture coincides infamously with laptop and computer usage as well as many forms of television watching and mobile cell usage.

Another issue that has been identified is that of thoracic hyperkyphosis (THK). In essence, thoracic hyperkyphosis refers to the slumping of the upper back that has been identified and documented in countless adolescents in peer-reviewed studies. A study conducted by Kado et al. (2004) provides evidence for the effect THK has upon mortality, concluding that elderly community-dwelling men and women with THK had a 1.44 greater risk of mortality. Increased mortality can seem to be simultaneously a greatly intimidating factor and a factor that is quite a bit less relevant when referring to the youngest members of society; by contrast, pain is certainly relevant to any age. An alarming study from Petcharaporn, Pawelek, Bastrom, Lonner, and Newton (2007) shed light upon the correlation between pain and thoracic kyphosis (TK). One-hundred patients were involved in the study, aged 8-18. Fifty patients with either TK or THK (11 to 95 degrees of flexion) were compared to 50 control subjects. Those with TK were shown to be significantly more symptomatic than normal individuals and had increased pain, function, and activity levels. Those with THK were significantly more symptomatic even than those with TK (Petcharaporn et al., 2007). This could imply a dose-response relationship between the forward-flexion posture commonly seen in the general population and the physical disadvantages that accompany it.

The forward-flexed posture that TK produces has an effect on everyday tasks such as walking, as identified in a gait-analysis test conducted by Lewis and Sahrmann (2015). Lewis and Sahrmann observed the gait of 15 healthy subjects with the average age of 29.5. The adults were instructed to engage in their normal gait, followed by a "swayback" gait and a forward-flexed gait. While the swayback posture had its own slew of problems, the forward-flexed posture is of the greatest significance to the topic at hand. The forward-flexed posture reduced the force required of anterior structures, implying that a lower maximum anterior hip force was produced. While this may seem like a positive phenomenon, the study of posture has made clear that the least energy-demanding position is rarely the most ideal. Lowered maximum anterior hip force results in a reduced strength of the hip flexors, which leads to an imbalance of muscular strength that, if it should progress, would likely need clinical correction.

The detriments of poor posture continue beyond muscular and joint pain and degeneration to include several other miscellaneous and sinister consequences. A study from Kang, Jung, Lee, Kim and Lee (2016) evaluated respiratory function in individuals after using a smartphone for one hour. The study found that forced vital capacity and peak expiratory flow were both reduced significantly when compared to the control group. The slumped sitting posture utilized by the majority of the subjects was connected by the authors to a plethora of factors including reduced global and local muscular performance, segmental instability of the cervical and possibly the thoracic spine and increased intra-abdominal pressure among other things. In addition to these, speculations have been made by Wang (2016) regarding the connection between poor posture and

hypertension, diabetes, and injury susceptibility. Much has yet to be fully researched, but the more that is uncovered, the uglier poor posture appears.

The effect of poor posture has been well-documented across all ages, but they are especially of concern when witnessed in the youthful population. Things like headaches, back pain, and respiratory function are worth preventing upon initial manifestation, but they become a more pressing factor when considering the fact that they will continue to only grow more severe as time wears on and as posture degrades with it. As it is, kyphosis and lordosis have both been seen to have increased a significant amount during puberty, according to a 10-year longitudinal study conducted by Widhe (2001). Unsurprisingly, studies from Prieto et al. (1996) have demonstrated that aging is associated with a worsening of postural steadiness as well. Sensorimotor control also declines with age (Ting-Ting et al., 2015). The unfortunate truth is, every aspect of bodily functioning tends to decline with age. Kim, Cho, Park, and Yang (2015) provides insight on the connection between this degradation and its early onset in children, stating

> If incorrect postures become a habit at an early age, individuals maintaining those postures may adapt and consider them comfortable . . . which can lead to fatigue and deformation. Thus, incorrect habits, such as excessive use of computers, use of desks and chairs without proper height, lack of health care education, lack of exercise, carrying heavy school bags, and inappropriate postures when studying or watching television, affect the shape of muscles, deform the skeleton, and cause abnormal development, which prohibit the maintenance of correct posture (p. 1791).

Indulging in improper posture and the negative consequences that will manifest will only speed up the process of aging and its destructive effects on joint mobility, muscle elasticity, the sturdiness of ligaments, and more.

Additional Adverse Effects of Poor Posture in Children and Adolescents

The mind and the body have an inseparable connection that is bridged by physiology. The study of biology and anatomy have revealed time and again that to alter an individual's physiological functioning will inevitably have measurable consequences on their affect and mental health. It is clear that physical activity is essential to the proper functioning of the person as a whole, not just their physical well-being. According to Guszkowska (2004), simple continuous exercise has been shown to have a beneficial effect on anxiety, depression, and general mood both acutely and chronically, likely due to the release of endorphins and monoamines that regulate such aspects of mental health. In addition to these, Sharma, Madaan, and Petty (2006) state that general exercise has been shown to assist in sleep, stress relief, energy levels, and more. In light of this evidence, few would argue that the well-being of the body does not affect the health of the mind and spirit. The question remaining is whether posture constitutes a significant enough factor to have such an influence over mental health. Given the established connection between physical function and proprioceptive postural control (Wright & Rothenburg, 2011), it is plausible that even energy expenditure levels as low as those required to maintain proper posture are likely to have a significant affect upon mental health.

In fact, posture has a substantial influence over several key aspects of health that encompass more than the physical alone. In the Petcharaporn et al. study conducted in 2007, the same questionnaire that provided evidence that thoracic kyphosis (TK) increased pain also discovered that those with TK scored significantly lower in the self-imaging portion of the questionnaire. Furthermore, the evidence suggests that sitting in specific body positions can affect emotional processes. In a fascinating study from Michalak, Mischnat, and Teismann (2014), 30 depressed subjects were split into two groups, one that was to perform the experiment with an upright seated posture and another with a slumped posture. The subjects then viewed a screen which displayed words with both positive and negative connotations. The subjects were asked to imagine a visual scenario involving themselves in connection to the word given, which they would be asked to recall later on in the experiment. Those with upright seated position recalled an approximately equal amount of positive and negative terms, while those who sat in the slumped position recalled significantly more negative terms.

Sitting in the slumped position has been shown to impair a plethora of other cognitive processes as well, according to a study from Nair et al. (2015). In the study of 74 subjects, 35 subjects were randomly assigned to sit in the slumped position while performing a variety of tasks involving reading, speaking, and mood assessments. These subjects were compared with the control group of 39 subjects who were instructed to perform all of the same tasks while sitting upright. Those who sat in the slumped position scored significantly worse in nearly each of the factors analyzed during the test. The slumping group saw a diminishment in overall affect and positive state arousal after the

postural intervention. A higher quantity of words with negative emotion and sadness-association and a lower quantity of positive emotional words were used by the slumped group in the speaking test when compared to the control group. Greater fear in social threat situations was perceived, tasks were pursued for shorter durations of time, and self-esteem was significantly reduced within the slumped group.

The results of these studies are nothing short of alarming, and the extent that things as simple and routine as sedentary behavior (i.e. sitting) and poor postural habits (i.e. slumped sitting) can have on cognitive and emotional functions is becoming prodigiously clear. As society continues to make strides in the identification and treatment of mental health issues, studies like those mentioned above are both a call to action and a stark reminder that many of the battles modern civilization faces in the fight against suicide, depression, anxiety, and other aspects of psychological well-being can clearly be aided by things in plain sight, such as simple postural adjustments.

The Benefits of Proper Posture

While explaining the many detriments of poor posture is certainly a worthy pursuit, proper and comprehensive motivation requires more than intimidation alone. In order to have the greatest desire to change, individuals must have both a fear of what could become should they remain the same and a solidified, rationalized belief that the results of changing will be worth the effort it requires. To that end, it is important to acknowledge the many benefits of proper posture to supplement the knowledge of the detriments of poor posture.

First, every study that has been analyzed thus far can be seen from an alternative perspective: observing the many positive consequences that good posture can bring. For example, while those who were instructed to sit with a slumped posture tended to display cognitive processes that had higher association with stress, anxiety, and negative thinking in the previously mentioned study conducted by Nair et al. (2015), the opposite was observed in those with upright posture. Nair et al. stated, "Upright participants reported higher self-esteem, more arousal, better mood, and lower fear. . . the upright participants reported feeling more enthusiastic, excited, and strong" (p. 632). These things alone are clearly worth striving for, but the benefits continue. In addition to feeling good internally, proper posture has its external merits as well. According to Swann (2009), people who stand with proper posture tend to be viewed as confident and outgoing. Mehrabian and Blum (1997) found that proper and erect posture has even been shown to increase an individual's overall attractiveness. Looking better and feeling better can both be achieved through simple body adjustments.

The improvements in attitude and mood in those with good posture were expounded upon further by Hansraj (2014) who writes, "High-power posture posers experienced elevations in testosterone, increases in serotonin, decreases in cortisol, and increased feelings of power and tolerance for risk taking. Low-power posture posers exhibited the opposite pattern" (p. 2). As increased serotonin and decreased cortisol levels are associated with improved mood, Hansraj's insight would provide the biological foundation for the improved affect witnessed in studies thus far. Furthermore, exercise programs that are targeted specifically on postural correction in students have been

shown not only to significantly alleviate pain in the neck, back, shoulders, and other areas commonly afflicted with pain from poor posture, but also to improve bodily balance, improve relaxation, and improve overall quality of life (Kim et al., 2015). Exercise in general is more than likely to improve quality of life given its well-researched connection to muscular control and, by extension, proper posture and its consequential benefits. Tailoring exercise to meet postural needs seems a particularly effective strategy for this goal and more.

Conclusion

Making a habit of maintaining proper posture is essential to the health and functioning of the human body (Hansraj, 2014; Kim et al., 2015; Nair et al., 2015; Swann, 2009). Correct vertical alignment of the vertebrae that follows the natural alignment of the spine and neutral positioning of the joints combined with shifting one's weight intermittently is the ideal posture to be upheld (American Chiropractic Association, 2019). An abundant amount of research related to posture – especially posture in children – has been conducted with largely concurrent results. The studies have shown that failure to maintain proper posture will result in a multitude of issues, including degeneration of joints, improper muscle functioning, pain in various parts of the body, irregular development and deformities, worsened cognitive functioning, and greater feelings of numerous negative emotions (Fernández-de-la-Peñas et al., 2010; Hansraj, 2014; Kado et al., 2004; Michalak et al., 2014; Nair et al., 2015; Siriluck et al., 2012). Successfully maintaining proper posture has been shown to have the opposite

results (Hansraj, 2014; Kim et al., 2015; Nair et al., 2015). The research points unflinchingly toward the necessity of proper posture.

Despite the implications of this widely researched topic, many continue to choose (whether unconsciously or not) to uphold a form of posture that is detrimental to their health, as shown by the prevalence of improper posture (Quka, Stratoberdha & Selenica, 2015). Physical activity levels have declined in the last several decades as modern technology becomes increasingly advanced, allowing people a surplus of opportunity to engage in destructive posture (Kohl & Cook, 2013). The issue in need of resolution is not the prevalence of screens and technology, but the lack of education and acknowledgement of the severity surrounding incorrect posture. Modern civilization must choose to make a greater effort to implement and educate the newest generations of both how and, more importantly, why proper posture is such an integral part of their physical and mental health; the body research has made clear that there is every reason to do so in the interest of a brighter, healthier future.

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