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Honor's Senior Thesis

Using Physical Activity in the Classroom to Combat Obesity in Children.
Introduction.

The Obesity Epidemic

Obesity, defined as having a Body Mass Index (BMI) of 30 kg/m^2 or greater, is now regarded as a worldwide pandemic with growing concern in the 21st century.[1] As of 2010, obesity is the fifth leading cause of death worldwide resulting in roughly 3.4 million deaths a year.[2] The increase in obese and overweight Americans seen nationwide is especially worrisome, and has led the American Medical Association to officially recognize obesity as a disease in 2013.[1,2] Currently, the number of obese or overweight Americans outnumber their healthy weight counterparts by 2 to 1.[1] This increased prevalence in obesity is particularly of concern in adolescents, where the incidence of obesity has quadrupled over the past 30 years with 1 in 3 adolescents currently considered either overweight or obese.[2] Over the past few decades, there has also been an increase in younger children's BMI, with a 6% increase in those falling in the morbidly obese range, defined as having a BMI of 40 kg/m^2 or greater.[1,2] This severe obesity is the fastest growing in children and has the most detrimental effects. Obesity in childhood is particularly concerning as obese children tend to live shorter lives than their healthy counterparts. Importantly, obesity is also the most prevalent disease that is considered to be preventable.[3]

The Consequences of Obesity.

Health Consequences

Obesity in childhood is associated with a number of adverse health effects with both immediate and long-term consequences, including insulin resistance, hyperinsulinemia, dyslipidemia, hypertension, type 2 diabetes, cancer, arterial stiffness and even mortality.[1,4,5,6]

Most concerning of these consequences are the cardiovascular conditions found to be increased in overweight children. These include problems maintaining healthy blood pressure, with obese children showing hypertension and diastolic dysfunction at higher rates than healthy peers. Hyperlipidemia, abnormal increases of lipids and lipoproteins in the blood, is also frequently seen in obese and overweight children who show abnormally high levels of low density lipoproteins, or so-called “bad cholesterol.” Perhaps most alarmingly, obese children show advanced cardiorespiratory deconditioning, suggesting an overall weakening of the cardiovascular system. The clustering of cardiovascular risk factors, known as metabolic syndrome, is seen to rise with increasing BMI. Studies have found that children who are severely obese are 3 times more likely to have metabolic syndrome than their overweight or obese counterparts.[4,5,6] These childhood conditions are of considerable concern as they are considered risk factors for cardiovascular disease in adulthood.

Disrupted insulin signalling, necessary for glucose homeostasis, is found to be a serious consequence of childhood obesity with obese children showing increased glucose intolerance and the development of insulin resistance. Visceral fat, which is stored in the abdomen region, increases with obesity and is associated with the accumulation of macrophages. These immune cells release cytokines that can impair insulin metabolism. Adipose tissue is also associated with obesity and is considered a factor to the causal relationship between excess weight and insulin resistance.[7] This is because an excess of adipose tissue can actually impair the homeostatic mechanism of leptin, a hormone meant to induce fullness and satiety. These childhood conditions are considered pre-diabetic and put obese children at a much higher risk for the development of type 2 diabetes in adulthood.[4]

Obese children also frequently experience respiratory difficulties, such as sleep apnea.[8,9] Obstructive sleep apnea may occur because of restricted airways due to excess weight. It can

additionally cause nocturnal hypertension, as well as impaired gas exchange resulting in hypoxemia and hypercapnia, the decreased concentration of oxygen and increased concentration of carbon dioxide in the blood, respectively. The decreased quality of sleep due to sleep apnea is also a contributing factor to decreased quality of life. Additionally, impaired sleep can cause abnormal levels of leptin production, indicating an issue with satiety signaling and further interfering with the appropriate regulation of hunger.[8,9]

In recent years, non-alcoholic fatty liver disease (NAFLD), the accumulation of fat in liver cells not due to alcohol, has become increasingly common and is attributed to an increase in obesity, especially severe obesity, in both adults and children.[7,10] Research has found NAFLD to be associated with visceral adiposity and insulin resistance, further exacerbating the issue of developing type 2 diabetes in adulthood.[7] It is also associated with cirrhosis, liver scarring that hinders proper blood flow to the liver, and steatosis, a fatty liver disease, further impairing health in obese children.[10]

Both bone and joint efficiency are also known to be negatively impacted by obesity with musculoskeletal discomfort increasing with the prevalence of obesity. Particularly, discomfort from carrying excess weight is a major problem because of the impact of on joints. Impairment of mobility also increases with increasing BMI, and an increased risk of fractures can be attributed to the musculoskeletal consequences of obesity. This discomfort and low mobility can also unfortunately advance the disease process of osteoarthritis because of the increased force and load on the joints.[11]

Sadly, the above listed conditions do not resolve themselves with age; rather, we see a continuation of ill health in obese children as they enter adulthood. Not surprisingly, long-term consequences of childhood obesity include cardiovascular diseases, such as stroke and heart failure, metabolic disease such as diabetes, and a continuation of the musculoskeletal issues

seen in childhood. Less obviously, long-term consequences faced by obese children also include an increased risk of malignancies such as colon, esophageal, thyroid, and bladder cancers.[1,2,7]

Social Consequences

Though less widely recognized than the effects on health, the social ramifications of obesity, and childhood obesity in particular, are no less critical for one's quality of life. Indeed, life satisfaction is seen to be negatively influenced by obesity due to these social consequences which can include discrimination, increased social stigma, and bullying.

In American culture, there is a cultural preference to be thin. This partiality is ubiquitous and children are often exposed to these preferences frequently and from a very young age. Often overweight children are the victims of discrimination due to this preference. This discrimination can additionally lead to obese and overweight children being regarded as lazy or sloppy. The consequences of these stereotypes often contribute to obese children having difficulty forming friendships with peers. This often contributes to the creation of a negative self-image that continues through adulthood and is further exacerbated by low self-esteem. Due to this, obese children have a greater prevalence of depression when compared to their normal weight counterparts.[12]

The preoccupation of American culture with thinness and weight control has also contributed to a preoccupation with diet and the prevalence of eating disorders in young children, with children being hyper-aware of their weight in comparison to their peers. In particular obese children have more eating disorders than their healthy counterparts. Disordered eating behaviors, such as binge eating and loss of control eating, are both common in obese

children. Often obese children will use disordered eating, such as binge eating followed by purging, as a self-prescribed treatment for their severe obesity.[13]

Economic Consequences

Obesity affects not only livelihood but also productivity. With 190 billion dollars spent annually to treat obesity and obesity related complications, obesity far exceeds smoking as the most expensive preventable disease. This cost amounts to 21% of the country's health care expenditure. A significant portion of this expenditure comes directly from the treatment of childhood obesity which costs 14.1 billion dollars a year. Including the direct costs of obesity and the indirect costs, over 275 billion dollars are annually spent on combating and treating obesity. Much of this cost is attributed to treating the high cost of comorbidities such as cardiovascular disease and type 2 diabetes, in which over 190 billion and 100 billion dollars respectively are spent.[14]

Because childhood obesity is the primary risk factor for obesity in adulthood, the consequences of failing to address obesity in childhood extend into adult life and into the workplace. Productivity in the workplace is also greatly affected by obesity. Employers pay 6.4 billion dollars a year for absenteeism and over 30 billion dollars annually due to reduced productivity attributed to obesity, such as disability and insurance claims. Since obesity affects mortality, work productivity decreases because the number of productive working years has significantly decreased with obesity. Obesity also leads to lost revenue because of indirect costs associated with obesity such as wider plane and bus seats, wheelchairs, and sturdier hospital beds.[14]

Economists suggest that "weight reduction could net cost-savings exceeding 610 billion dollars in 20 years" and predict that reducing obesity rates by even 1% could decrease cost by

9.5 billion dollars a year.[14] Since obesity could be greatly reduced with preventative measures, citizens should want to reverse the effects and implement proven techniques to reduce obesity. Elements to reducing obesity include screenings, nutritional therapy, behavioral modification, and physical activity. It is more economically favorable to treat obesity during childhood because the long term effects of obesity are costly, compared to treating the comorbidities at a younger age. Also, treating obesity and promoting healthier habits at a younger age are found to promote healthier lifestyles as adults.

The Causes of Obesity

Obesity is caused when calories consumed far exceed the calories expended in daily activities. This imbalance has been exacerbated by recent trends toward larger portion sizes and an increased intake of calorie-dense foods, coupled with unchanged or decreased physical activity. Many factors, including genetics, cultural values, and environment, are believed to play a role in the development of obesity. Understanding the etiology of obesity is critical to best determining policies for its prevention.

Genetic Factors

Evidence from twin studies suggests a genetic component associated with a susceptibility to obesity. Concordance rates between monozygotic twins were found to be more than twice that of dizygotic twins, with heritability rates ranging between 64-84%. Similarly, adoptee studies indicate the BMI of adopted children is most highly correlated to the BMI of their biological parents, and not that of their adopted parents. While obesity has been found to run in families, it doesn't appear to follow a simple Mendelian pattern of inheritance.[15,16]

Currently there are 11 single gene mutations and 50 loci known to be associated with obesity, and 127 candidate genes believed to be relevant to obesity. Studying the Pima Indian

community of Arizona, a group with one of the highest rates of obesity nationwide, researchers have identified loci influencing obesity-related phenotypes on chromosomes 1, 3, 6, 11, 18, and 20. Studies were further replicated to support these findings and when conducted in nuclear families, researchers found strong support for a genetic component related to obesity on chromosome 3 that also influenced BMI and waist circumference.[15,17,18,19]

Numerous studies have also found genetic variations at multiple loci that influence lipodystrophy, the abnormal distribution of fat.[17,18,19,20] This heritability of fat distribution has been shown to be due to DNA variants that have an effect on fat deposition.[15,20] Further research has found that there are sex specific differences in fat distribution that reflect certain specific genetic influences. For instance, in obese males fat is usually distributed around the abdominal region, whereas for obese women, fat is usually distributed around the hips.[20] In addition to fat distribution, it has been shown that waist circumference, waist to hip ratio, and BMI may also be heritable, with at least 40-70% of a person's BMI believed to be genetically based.[15]

The mutated genes found to be associated with obesity mainly impact the central nervous system (CNS) and adipose tissue.[20] Effects on CNS function occur at the level of the hypothalamus, a brain area responsible for controlling production of leptin and ghrelin, two hormones that maintain and regulate satiety and appetite. Leptin which is secreted by adipocytes, visceral fat cells, helps to induce a feeling of satiety and suppresses appetite. Ghrelin works to stimulate appetite and to increase food consumption as well as promote fat storage. Together, these hormones work together to maintain homeostasis, however, research has found that obesity can lead to leptin resistance, similar mechanistically to the insulin resistance caused by obesity. This is particularly troublesome because if leptin is not properly regulated, there will be a continuous feeling of hunger.[18,20]

Obesity has also been found to be related to some rare genetic syndromes. For example, genetic mutations for extremely severe obesity in the absence of developmental delays can be attributed to 20 autosomal mutations. These mutations affect the leptin and melanocortin pathway that is responsible for regulating appetite. Because of this, there is an increased appetite and diminished satiety which in turn contributes to an increase in calories consumed.[15,16,17,18,19,20]

While many studies have concluded obesity has a genetic component, an obesogenic environment that promotes a poor diet and lifestyle is necessary for the development of obesity. This indicates that genes and environment must interact to manifest BMIs that are classified as obese. Furthermore, examining the relationship between genetic, social, cultural, and environmental factors associated with obesity will provide insight into the development of childhood obesity.

Cultural Factors

American culture has been suggested to be obesogenic, leading both to unhealthy diets and lifestyle choices.[21,22,23] Since 1980 the Department of Health and Human Services and United States Department of Agriculture have published the Dietary Guidelines for Americans in an attempt to encourage healthy eating. Every five years these guidelines are updated to reflect new scientific findings. These guidelines employ a “food pyramid” design in order to convey the number of servings recommended from each of the major food groups. Originally, these guidelines recommended 8 to 11 servings of carbohydrates from bread, cereal, rice, and pasta as the base of the food pyramid. The second level of the food pyramid included 3 to 5 servings of vegetables and 2 to 4 servings of fruit. Following that, the third level included 2 to 3 servings of dairy along with 2 to 3 servings of non-dairy protein such as meat, poultry, eggs, beans, and

nuts. Lastly, the apex of the pyramid indicated that Americans should use fats and oils "sparingly."[24]

This drastically increased caloric consumption associated with nationally recommended servings of carbohydrates, along with the lack of physical activity in the average American lifestyle, has greatly contributed to the increase in obesity seen in recent decades. Current research into the long-term consequences of a diet high in carbohydrates have prompted a modified visual in the 2015-2020 Guidelines, called MyPlate. This recommendation uses a plate as a chart to divide up the recommended servings for fruits, vegetables, protein, and grains. Instead of the old recommended number of servings provided by the food pyramid, the new MyPlate recommendation eliminates serving sizes and instead uses proportions in comparison with other food groups. Based on the MyPlate recommendations, Americans are recommended to include fruits and vegetables in half of their plate, and the other half for proteins and grains, though not equally divided (**Figure 1**).[24]

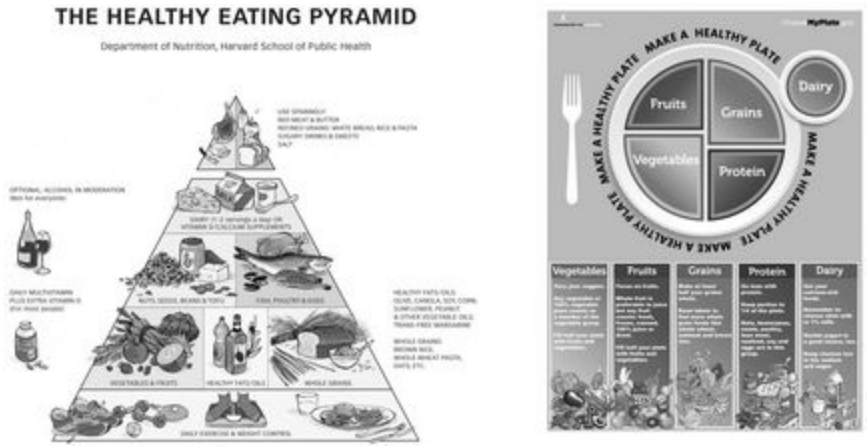

Figure 1. Original Healthy Eating Pyramid from 1980 and current MyPlate graphic showing recommendations for the American diet

Another major facet of American culture that has contributed to the growing obesity epidemic is the dietary practices of our nation. Portion sizes, particularly at fast food restaurants,

have significantly increased in recent decades, encouraging overeating. The contribution of larger portion sizes to the obesity epidemic, both when eating out and at home, has been termed the "portion size effect."[23] This effect can be exacerbated by packaging, where it has been found that people tend to eat more when the packaging size is larger.[21,23] Overall, these larger portion sizes stimulate overconsumption which can often translate to obesity. Additionally the calories from fat in menu options offered in the United States often exceed daily recommendations. For instance, the McDonald's Big Mac has 540 calories in the United States, compared to only 508 in Ireland.[25,26] This is further evidence of the obesogenic culture in America.

Further contributing to poor dietary choices, is the increased consumption of processed foods. Processed food has become more readily available and more abundant, therefore contributing to lower costs. Manufactured commodities are high in sugar, fats, and salt and are appealing for mass production and consumption because there is a low production cost, a long shelf life, and a high profitability. Because of the economic appeal of processed foods, there is increased consumption. Technological innovations have also contributed to mass food production. With the invention of vacuum sealing, preservatives, and artificial flavoring, processed food has become more abundant. Because of the availability of these inexpensive and calorie-dense foods, many American consume excessive amounts of calories a day.[2]

Alongside poor diet, a sedentary lifestyle is a major contributing risk factor to obesity. With advancements in technology as well as more efficient modes of transportation, the modern lifestyle has significantly decreased the typical American's daily physical activity. In many buildings and workplaces, elevators are centrally located and made appealing for people to use, whereas stairs are noted as "emergency exits" and used less frequently.[27,28,29] Also, people in today's society are making use of cars more often, driving to destinations even if they are only a

short distance away. Even when people resort to public transportation, walking is frequently minimized as bus stops are often typically located near to one another. Because of this ease of transportation, fewer people are walking or cycling to work, school, or shopping centers.[22,27,28,29]

Video game and electronic game usage is seen to be related to BMI, with those who exhibit a higher weight spending more time playing video and electronic games.[30,31,32,33] There is also a strong evidence that excessive screen time through television viewing is related to obesity. Children who watch 5 or more hours of television a day are nearly 5 times more likely to be obese than those who watch television for 0-2 hours a day.[31] Children who spend the most time during childhood watching TV had the greatest increase in body fat, which translated to an increase in obesity.[33]

Over the past few decades the typical American environment has become increasingly obesogenic with abundance of unhealthy food options and the decreased opportunities for physical activity. Despite this grim predicament, research has found that lifestyle modifications such as improved diet and increased physical activity contribute to decreasing obesity. Modifications should be targeted to change the environmental influences that are associated with and significantly contributing to obesity.

Environmental Factors

Environmental factors, such as one's socioeconomic status, have also been shown to affect obesity. Individuals living in lower income communities often must contend with environments that are without healthy food options and restrict their physical activity due to safety concerns and lack of green spaces, all which directly contribute to obesity.

The environment where one lives is a major contributing factor to both adult and childhood obesity, with residents of low socioeconomic neighborhoods being much more likely

to be obese than those of high socioeconomic areas.[34] This finding is most likely due to factors such as the poverty of healthy food options that exist and the neighborhood environment itself.

Low socioeconomic neighborhoods are often considered “food deserts” where healthy food options such grocery stores are not present. Rather, common food options are typically convenience stores and fast food restaurants. The prevalence of these less healthy food options serve as risk factors for childhood obesity since healthy food options are not readily available. Also, as mentioned previously, the majority of options available at these establishments are highly processed foods that are dense in calories. However, since they are available at a low cost, residents of low socioeconomic status may lack the incentive or mobility to pursue healthier alternatives.[34]

Low socioeconomic neighborhoods are also often associated with increased crime rates. Because of this, participation in outdoor physical activity is less frequent, as residents do not feel safe or comfortable outside. Also, residents tend not to walk around their neighborhood as a leisure activity. Compounding this problem, many such neighborhoods may lack the sidewalks or bike lanes that allow for safe travel. By not providing people with a safe passage to walk or cycle, physical activity and exercise are compromised. When walkability is compromised in a neighborhood, either due to safety concerns or a lack of infrastructure, sedentary lifestyles are further established.[34]

Historically, students would walk or bike to school, especially if they attended their local neighborhood school. Increasingly, however, parents are hesitant to allow their children to walk to school unattended, instead choosing to drive them for fear of their safety. There are some neighborhoods where the crime levels are so high that it is not safe for students to walk to school because they fear becoming a victim of gun violence. Some cities have attempted to establish “Safe Passages” which involve crossing guards and supervision at intersections, but

this still has not led to the same walkability as historically seen. Also, with the recent increase in school bus programs, students are more likely to choose this alternative to walking.[34]

The Role of Physical Inactivity in Obesity

Obesity can be principally attributed to poor diet and a lack of physical activity. While some efforts have been made to address improved dietary habits in American children, such as legislation requiring at least 1.5 cup servings of fruits or vegetables in school lunches, legislation that requires physical activity has not been federally mandated. Though the U.S. Department of Health (USDH) recommends 60 minutes of moderate to vigorous physical activity a day for children, most states have not implemented this recommendation and The Center for Disease Control and Prevention (CDC) reports that only 1/3 of children under age 19 are actually meeting this recommendation. The introduction of improved physical education and physical activity standards is not only necessary to fully address the problem of childhood obesity, but would also lead to additional benefits such as improved physical health and mental well being.[5,35]

Health Benefits of Physical Activity

Physical activity has been shown to improve many of the health consequences associated with obesity. Directly, physical activity can promote weight maintenance thereby reducing one's risk for obesity. Indirectly, physical activity can help attenuate the many health consequences associated with obesity. Specifically, physical activity is seen to improve cholesterol levels, reducing low density lipoproteins and increasing high density lipoproteins, reducing the risk for cardiovascular disease seen in obese children. Additionally, physical activity improves glucose metabolism and insulin sensitivity, reducing the risk of type 2 diabetes. Physical activity is also seen to reduce the negative impact of obesity on musculoskeletal

system. Both osteoporosis and osteoarthritis are reduced with physical activity due to increased bone mineral density and less weight and force on the joints. Overall, increasing physical activity can reduce the risk of premature death due to comorbidities such as diabetes or cardiovascular disease.[36,37,38,39]

Social Benefits of Physical Activity

Appropriate levels of physical activity in children have also been shown to impact psychosocial health. Again the maintenance of a healthy weight itself can ameliorate much of the stigma associated with obesity. This can in turn promote self-esteem and positive body image while decreasing levels of aggression.[40,41,42] Additionally, physical activity can impact mental well being as it is considered a stress releasing behavior due to the release of endorphins seen with vigorous exercise. Increased physical activity is also associated with emotional stability, resulting from the increased release of serotonin.[42,43] Indeed, high levels of physical activity in children are associated with lower levels of depression and anxiety. Overall, children who actively participate in exercise and physical activity daily report being happier than their inactive counterparts.[43,44,45,46,47,48,49]

Educational Benefits

Physical activity can also prove beneficial in the classroom. Studies have found that learning and memory are increased with physical activity, meaning that children will be more productive while in class. Children who actively participate in regular exercise have overall stronger cognitive control abilities and perform better in more challenging situations. Physical activity is also associated with increased attention, which allows classroom teaching to be more effective. Teachers can spend more time teaching rather than trying to engage their students.

Finally, since physical activity is seen to increase self-esteem and self-confidence, children are motivated to try harder and challenge themselves.[50]

Long-term Benefits

Some long-term benefits of physical activity include the development of health conscious adults who are more active. Studies have found that children who learn about nutrition and exercise early in their academic years are more likely to continue implementing their knowledge in later years. This means that children who are more physically active during their childhood will have a lower risk of obesity, better health and reduced incidence of chronic illness, and other preventative diseases. Though physical activity declines with age, children who learn about healthy lifestyles early, carry these healthy habits throughout their adult life.[35,40]

Barriers to Implementing Physical Activity Recommendations

Limited funding and resources

There are multiple reasons why physical activity recommendations for children are not currently being met. As school-aged children spend the majority of their days in their classrooms, many of these barriers reside in the school environment.[51] First, a lack of funding and resources are a major barrier to addressing physical inactivity in schools. With state and federal budget cuts, funds are not being allocated to physical education and the resources necessary to increase physical activity in the classroom.

Along with decreased funding, a lack of qualified staff further exacerbates the inadequate provision of physical inactivity in schools. For instance, many schools require strict technical standards for physical education instructors making it more difficult for qualified teachers to become certified to teach physical education. There are also not enough staff and teachers who can supervise children during recess, one of the few times in the school day

allocated for physical activity and play time. This problem has actually led to a reduction in recess time or its elimination in some schools all together. Additionally, some schools are not willing to implement physical education or recess in fear that their school will be held liable for any injuries that happen during those times. Because of that, they are not making any efforts to increase physical activity because they are wary of any liabilities and associated costs of injury.[51]

Limited Time

As mentioned previously, schools are increasingly being assessed based on the performance of their students on standardized tests. As these assessments are frequently the basis for funding and other necessary resources, many schools are reluctant to take time away from the core curriculum to implement physical education and other means of increasing physical activity during the school day. Sadly, one reaction has been to entirely eliminate physical education from the curriculum and focus class time exclusively on subjects such as math, science, reading, and writing.[51]

One potential solution that has been suggested is a longer school day, which could allow recess and physical education to be added into the school day without impeding on class time devoted to academics. However, schools are often reluctant to implement this increase due to the increased costs associated with a longer day.

Limited Space

Many schools have a designated outdoor space such as a playground for recess and other forms of unstructured physical activity. However, when the weather is cold or unfavorable for outdoor activity, teachers must find an alternative. Often times, if a school does not have an indoor space, then there is no chance that students can have recess time when weather

conditions are not optimal. For those schools without a designated outdoor area the difficulties of meeting physical activity recommendations are further increased.[51,52]

Research has found that a reduction in school sports programs has led to an increase in childhood obesity. To address that issue, some schools have now offered intramural sports leagues for their students as a way to increase physical activity. Sometimes, schools have to conduct intramural sports at an off-campus location to accommodate the number of students and the limited spaces available. However, the school bus leaves at the end of the school day and won't accommodate for students who are participating in after-school activities. What this means is that children who do not already have a prearranged means of transportation won't be able to participate in afterschool activities. This creates an unfair advantage to students who have other modes of transportation.[53]

Current Policies and Programs

Studies have found that childhood obesity prevention programs can have significant impacts. Specifically, school based interventions focusing on physical activity are highly effective since children spend most of their waking hours at school. Specific recommendations to combat obesity include requiring elementary schools to offer healthier food options as well as mandating dedicated time for physical activity during the school day. Since federally legislated policy has mandated schools to provide healthier and nutritious lunch foods, the issue of calorie dense foods is currently being addressed. Now, the remaining issue is to address the physical inactivity of many young Americans.

Currently, only Oregon and Washington, D.C. meet the national recommendations for time spent on physical education in elementary and middle schools. Though a significant percentage of states do require students to take physical education, there is no required amount

of instructional time and therefore, many states allow exemptions or substitutions.[51] This loophole renders such policies ineffective and reduces the amount of time students are able to participate in physical activity during the school day.

There are several factors associated with implementing physical activity at school that current and future policy must address. For instance, the optimal intensity and duration of physical activity must be chosen. Research states that in order for the health benefits of physical activity to be realized, participants should achieve target heart rates, which is calculated based on a range of ideal percentages (60-85%) of 220 - age.[35,37] For example, a 10 year old child would be hitting their target heart rates when their heart rate is between 126 to 179. Though many schools implement short activity breaks, these typically do not allow participants to reach these target heart rates, and therefore do not have the same effects on health and fitness as longer bouts of activity would. Another issue relates to how to fund structured physical activity in the classroom. As mentioned above, funding is frequently lacking in many schools across the country and sadly resources devoted to physical activity are not typically prioritized. Additionally, teachers struggle over how to allocate time for physical activity and how physical activity instruction will affect classroom structure and learning.[54,55,56,57,58]

Current policy solutions vary widely in their effectiveness.[55] Some programs aim to incorporate short activity breaks in the classroom instruction to avoid having to find time to fit a full 60 minutes of physical activity into an already busy school day. Other initiatives at the state level aim to mandate that all grades through high school have dedicated physical education time in the school day. However, it is up to each individual school district to fund and implement state mandated programs.[59,60]

In School Activity Breaks[61]

"In School Activity Breaks" are a current program implemented by the American Heart Association (AHA) that includes 3 5-minute breaks incorporated throughout the school day. The AHA provides a workbook of over 100 different possible exercises to use in the classroom with instructions and examples of ways to involve all students. This program also incorporates class lecture material into the short bouts of exercise and can be led by the homeroom teacher, rather than a physical education teacher. The exercises included require few to no materials and can happen with students staying near the desks, making this program more feasible for use in the classroom. However, because the exercises themselves are only 5 minutes long, the target heart rate of students is not reached or maintained. Also, there is no mandated legislation for this program so it is optional for schools to follow. Schools need to prioritize classroom instruction so that students can succeed. However the tangible results of this are test scores. For this reason, schools who are low performing would maximize classroom instruction time over physical activity instruction.[61]

Traditional Recess[62]

Traditional recess is typically, unstructured, outdoor free time. This can be difficult to implement in schools where space and time are limited. Additionally there are often no alternatives if there is unfavorable weather. This form of physical activity can also be quite expensive, as there is a need for personnel to supervise traditional recess in order to ensure that the risk of injury remains low, and increased costs associated with litigation should injuries occur.[62]

Sometimes, recess is cancelled when classroom behavior is not optimal. In some states, this form of punishment for bad behavior i is forbidden or merely discouraged against .

However in the majority of states, there is no recommendation against this penalty. Therefore, teachers are taking away recess and physical activity time from students when they misbehave. This can have serious repercussions as children frequently become increasingly jittery and more ill behaved when they do not have an outlet to release their energy, rather than less.[51,62]

Instant Recess[63,64]

"Instant Recess," developed by Toni Yancey, was originally intended to spark "a movement to energize America" 10 minutes at a time. This program was created for the workplace and therefore was intended to include stretches at the desk and low intensity exercises that are inclusive for everyone, including people with disability. Instant recess includes brief activity breaks that occur in the middle of the day accompanied by culturally salient music. Workplaces and schools that use Instant Recess often use instructional videos that can be found online or by ordering a kit from the website. Because of this video instruction, there is no need for a teacher to lead the activity breaks. These activity breaks sometimes even involve teamwork activities that can help build leadership roles. However, since the program was originally developed for the workplace, there is no instructional material incorporated in the activity breaks. Also, due to attempts to make the activity breaks inclusive, the exercises are very low intensity that does not allow for the maximum heart rate to be reached or maintained.[63,64]

NBA Fit Fast Break[65]

The NBA Fit Fast Break activity program was created as a campaign to incorporate physical activity into a busy school day, though the exercises are targeted primarily towards children in the classroom. The program includes 7 exercise cards that are found on the NBA Fit Fast Break website. These exercises include things such as jumping jacks and star jumps

(**Figure 2**). Although this program was designed for students to use before exams, there is no instructional material incorporated into the actual physical activity breaks. The instructions in the kit state that students should vote on their favorite 5 exercises and do each for 24 seconds (resembling a 24 second shot clock) for the "final 2 minutes" before the exam. These exercises can be led by a teacher or any student. While the high-intensity exercises are able to help students reach their maximal heart rate, the bouts of exercise are too short to keep the heart rate up and to make a significant difference in total physical activity.[65]

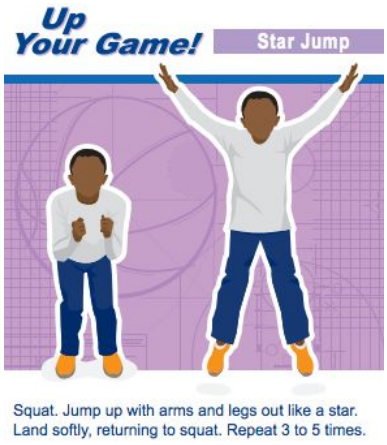

Figure 2. An Example of an Exercise Card from the NBA Fit Fast Break.[65]

Kids Health Classroom Exercise Break[66]

Developed by the Kids Health by Nemours Initiative, this exercise program is intended simply as a list of suggestions for how teachers and parents might incorporate exercise into their children's daily activities. This program incorporates light, moderate, and vigorous activities such as arm circles and jumping jacks. However, the program does not include any instructions regarding the recommended sequence or duration of exercises during an exercise break. Also, there are no suggestions as to how to incorporate classroom material into the exercise breaks.[66]

Brain Breaks[67]

The Brain Breaks program includes a variety of light, moderate, and vigorous exercises that are paired together to provide 1 to 2 minutes of exercise. These short bouts of exercise are meant to be incorporated into daily instruction once for every 30 minutes of class time. Because of their short duration, they can be an advantageous strategy to use when switching between topics. The breaks themselves are specially designed to include a mix of high and low intensity exercises that maximally elevate heart rate. By the regular incorporation of these breaks into the school day, students can total 10 to 20 minutes of physical activity a day, which far exceeds what students currently receive in many states. However, because of the short duration of each break, they don't have as much impact as fewer, longer bouts of physical activity would during the day. Also, this resource is not free of charge but rather cost anywhere from $15-50 a kit. Additionally, no instructional material is incorporated into the Brain Breaks.[67]

Energizers[68]

The Energizers Initiative is part of North Carolina's, Eat Smart Move More program. This campaign is intended to increase the number of minutes spent physically active and to create more health conscious citizens. Specifically, the Energizers campaign is a 10 minute physical activity break that combines physical activity with academic concepts taught from the core curriculum of North Carolina. The exercises are structured so that they don't disturb any scheduled learning. Each kit costs $22 and includes private videos and lesson plans that are meant to integrate physical activity and instructional material. There is also a workbook of texts that is provided to help with planning the lessons and incorporating exercise into a variety of subjects. The exercises are designed to be performed by students at their desks and aim to be inclusive so that all students can participate. They do not require any additional materials, and

any classroom teacher can lead these exercises and include them in lesson plans as he/she sees fit. Despite these benefits, the exercises provided are low intensity only, so target heart rates are not always achieved.[68]

Just A Minute[69]

The Just A Minute (JAM) campaign is a free wellness tool that includes resources and videos meant to increase the amount of time spent on physical activity. The campaign provides a weekly email that includes 5 exercises appropriate for the classroom. These exercises are meant to be low intensity and feasible for all participants. The weekly emails can incorporate classes all the way through 12th grade. However, JAM requires a director or appointed leader in each school to print the email and distribute it to all teachers. There are no additional resources or materials needed for JAM and it can be done in the classroom with a teacher or any student willing to lead the exercise session for the day. However, it is important to note that there is no implementation of classroom curriculum. Also, since the exercises are all low intensity, target heart rates are not achieved.[69]

Take 10[70,71]

The Take 10 program is an initiative that integrates movement with current instructional materials. These include competencies from the core curriculum as well as nutritional and physical education. They are built in to the daily schedule as a ten minute break that can include a combination of over 40 exercises per grade. The breaks require very minimal resources and are designed and developed by teachers, and they can also be implemented by teachers. The breaks integrate the core components such as math, reading, language arts, science, social science, health, and nutrition. These are built into a teacher's manual that highlight exercise in

the curriculum. However, this program includes low intensity exercises so therefore, it is unlikely that maximal heart rates will be achieved.[70,71]

FAB 5[72]

The FAB 5 initiative is a program designed to improve cognition, fitness, and concentration. The exercises in FAB 5 require no equipment and can happen in the classroom with no need to move tables, desks, and chairs around. The exercise breaks include material covered in the curriculum and last anywhere from 4-7 minutes, depending on which DVD is used. There is no need for an instructor because all of the exercises are directed in the video. However, the videos cost $15-20 each and are specific to each grade level because they are curriculum oriented, therefore it becomes a costly alternative. Also, since the exercises are all low intensity, it is unlikely that maximal heart rates will be achieved.[72]

Active Academics[73]

Active Academics is a fitness program with little instruction, meant to increase physical activity in grades Pre K to fifth grade. The physical education aspect of this program is meant to enhance learning, mood, and memory. The activities are all standardized in order to include instructional material from the Common Core, and they utilize classroom content. However, extensive materials and advance preparation are required, making this less feasible than other activity break programs.[73]

Take a Break - Colorado Initiative[74]

The Take a Break initiative is comprised of activity cards and other online resources that include breathing techniques, stretches, yoga movements, brain teasers, and other activities intended to enhance health and wellness. The resources are entirely free and available online

for schools to use. Also available are worksheets, lesson plans, and templates to help incorporate these breaks into the daily curriculum. Although the exercises are intended to be used alongside classroom content, there is no direct integration of instructional material in the exercise breaks. The exercises included are all low risk and low intensity, with modifications for all students, regardless of any disability or handicap. Since the exercises are all low intensity, it is unlikely that maximal heart rates will be achieved.[74]

Effects of Current Interventions

These interventions have helped alleviate the problem of inactivity in schools, but they have not entirely eliminated it. Each individual program has its own unique helpful techniques and practices, that if thoughtfully combined could be used to craft an ideal standard policy.[74,75,76] It is likely to take many such efforts and revisions of these types of policies and programs to entirely solve the problem, because it is so multifaceted.

Action Plan

To solve the problem of physical inactivity in the classroom, the proposed policy is intended to increase time spent on physical activity and physical education in the classroom while incorporating relevant academic content.

Morning Motivator and Afternoon Activator

To begin, this policy recommends combining classroom material with bouts of physical activity. Research has found that incorporating breaks during learning can help increase retention.[59] Studies have also indicated that participation in physical activity while learning can help enhance memory.[50] With these findings in mind, the proposed policy aims to incorporate academic content into two 15 minute bouts of physical activity each day. The extended duration

of time will allow for target heart rates to be reached, allowing for maximal effectiveness. Teachers can choose material from the previous days' lessons to include in the first bout, or *Morning Motivator,* which serves as a review session. Similarly, the second bout, or *Afternoon Activator,* will serve as a recap of all of the material covered on that day and serve to promote enhanced retention.

Since teachers already allocate time in their daily curriculum to review material, this should not take away from their classroom instructional time. Instead, teachers will be able to use time that they have already devoted to review and incorporate physical activities into the learning experience.

Feasibility and Effectiveness

This proposed policy should solve the problems left unaddressed by current ineffective physical activity approaches in the school system because it addresses all of the major issues involved with physical inactivity. One reason school districts advocated against extended bouts of physical activity during class was because of the associated costs with increasing the school day to accommodate for the additional time. The expenses, from overhead costs to operate the school and costs to pay teacher salaries, could accumulate quickly. However, with this proposed policy, costs can remain as they are since physical activity is integrated into existing class time.

Another concern with current and previous policies is that there is a lack of staff to supervise physical activity. With this proposed policy, the classroom teachers will be trained to integrate functional yet effective exercises with little to no associated risk. This way, there will be no difficulty with the strict requirements to find a staff member to supervise physical activity or

recess because the classroom teacher will supervise the activities during his/her or classroom instructional time.[1]

Similarly, since this activity break can happen inside and outside, the classroom space can always serve as an alternative space if the weather is not appropriate for outdoor activity. This is also time efficient because teachers do not have to worry about filing students in and out of the classroom and taking a headcount each time.

By incorporating instructional material into the physical activity breaks, such as vocabulary words, spelling, or historical dates and figures, students will be using collaborative learning methods and actively learning. This not only enhances recall and retention, but facilitates long term memory and application. Students also benefit from these exercise bouts because physical activity is found to improve attention. Because of the fact that these physical activity breaks will happen in the classroom, with the homeroom instructional teacher, and will incorporate and include instructional material from the current curriculum, this policy is extremely feasible and effective. Time to review material is already allocated, so by incorporating physical activity into this same time and instructional methodology, students benefit greatly from the combination of physical activity and learning. Teachers can include physical activity in their daily curriculum without the expense of missing out on instructional time.

[1] I would like to stress that this doesn't mean physical education teachers are not needed. Physical education and physical activity are two different things. This policy and thesis focuses on physical activity, which is attempting to hit 60 minutes a day of active movement, with a goal of hitting a specific heart rate that would indicate maximum efficiency. However, physical education is multifaceted. Physical education includes learning about health, nutrition, mental wellness, and the rules and regulations of sports. Teachers who teach physical education must be certified and renew their certification often. This requirements make it hard to find staff who fit the qualifications. This policy is intending to solve the problem of physical inactivity in children and is doing so by addressing classroom time. This is not intended to reform physical education and instructional time in physical education classes.

Administration, School Districts, and Coalitions

In order for this policy to be implemented, the respective school districts would have to implement this in their master curriculum, a template for teachers to use when designing their own curriculum.[78,79,80] By creating a master curriculum that standardizes physical activity in the school day, all schools, regardless of their current physical activity and physical education requirements, will then be required to incorporate at least thirty minutes of physical activity into their instructional time. School districts, such as the Chicago Public School District, are directed by a superintendent that is typically elected by the mayor. In this case, gaining support from the mayor and the superintendent would allow for a smoother transition into mandating physical activity in the curriculum. To win the support of individual School Districts, local school councils and other nonprofit organizations would need to lobby to push for the increase in physical activity time. The American Heart Association, American Cancer Society, and the Let's Move Campaign would likely help support the mandate for physical activity in the classroom based on their current programs and policies intended to improve the wellbeing of the American public. Garnering the support of these organizations would help promote the acceptance of this proposal by other school districts to achieve a national standard.

To gain the support of these organizations, and other organizations that encourage physical activity, I would personally lobby, along with other supporters of my policy, to campaign for the publicity of this proposal. I would suspect that parents and teachers on the local school councils would greatly support and encourage this proposed plan. I would first campaign for and announce this proposal to the local school councils. In gaining their support, we could raise this issue to the teachers' union to encourage teachers to participate in this campaign as well. It will be much more feasible to approach the school districts and superintendents with this proposal after the teachers support the campaign and understand the importance of increased physical

activity. Based on previous campaigns and the support from within the teachers' union, I suspect that they would greatly support the proposal because it supports the well-being of their students. Also, the local school council, which consists of parents and teachers, would serve as advocates for this proposal because this would benefit the students and serve as an opportunity to increase physical activity within the school community.

The teachers, parents, and other advocates of increased physical activity such as personal trainers, could form a coalition to support and further lobby for this campaign. To gain increased support from the general public, I would create a social media campaign using Facebook, Twitter, Instagram, Tumblr, Pinterest, and other outlets to gather public support and interest in the proposed policy.

Obstacles and Opposition

In implementing the policy proposal, I believe that the most critical obstacle I anticipate is a political obstacle. Little to no financial resources are needed to implement this policy, since there are no additional materials, equipment, or other associated costs, there should be no financial obstacles. One practical obstacle to keep in mind is that students have to be appropriately dressed in order to participate in physical activities of moderate to vigorous activity levels. To address this issue, while putting forth this policy in schools, we'd encourage students to wear activity appropriate clothing and to keep a pair of athletic shoes in a locker or cubby near the classroom. Similarly, students might have issues with excessive perspiration during the school day especially with an increase in physical activity so to combat this, students would be asked to keep deodorant or antiperspirant and teachers would be asked to keep the classrooms as well ventilated as possible.

I do not anticipate any legal or ethical obstacles since recess and physical education are already popularly approved in the typical elementary school day. However, I do believe that there are potential political obstacles based on implementing a master curriculum. Since this is standardized curriculum, it will take a lot of time and plenty of influence from people who are in positions of power such as school principals, executive school directors, and school superintendents for this change to gain broad acceptance.

I anticipate that some district officials would be opposed to this proposal, primarily because they would be afraid that the physical activity component of the exercises would affect the most tangible measure of learning effectiveness, the standardized test score. To counteract the influences of the opposition, I would ensure that evidence is collected to evaluate the proposal that the suggested policy changes would not in fact negatively impact test scores. I would provide assessment information as often as it is available to justify my argument that the *Morning Motivator* and *Afternoon Activator* will actually prove beneficial and have a positive influence on academic achievement and behavior in the classroom.

Implementation

To implement this policy, I would first gather support from schools, specifically by targeting teachers and school administrators such as principals and vice principals. I would also gather support from parents and the local school council. With their support, I would then approach the Teachers Union. The union would assist in lobbying school district officials to implement this policy in classrooms. With the support from teachers, parents, and the union, I would anticipate that the policy would be well received within the school districts and would not face many obstacles when it comes to implementing the policy in the master template.

Expected Results and Benefits

If this proposal is adopted as soon as possible, it would take one full school year before we could expect schools to implement this new curriculum. Teachers would have to adjust their lesson plans accordingly to include these new physical activity components of the curriculum. Once implemented in teacher lesson plans, we would expect to see significant results within the first year. I expect that by increasing their physical activity by an additional thirty minutes each school day, students will show improvements in physical health within the first year of implementation and may also have adopted healthier lifestyles outside the classroom. I anticipate levels of obesity to slowly decrease and overall BMI to decrease as well.[46,49,50] I'd expect an increase in aerobic fitness because physical activity is regularly implemented in the school day. In addition, I anticipate that students will display increased attention in the classroom. Finally, schools may observe an increase in student test scores, since they are implementing active learning methods that have been proven to be highly effective.

Within five years, I expect that students would continue to include regular physical activity in their lives both inside and outside the classroom. This would further increase their adoption of healthy habits, which would be expected to continue through adulthood. The long term effects of this proposed policy should include a decrease in the number of children with obesity and a resulting decrease in comorbidities, including cardiovascular disease, diabetes, and depression.

Conclusion

As the prevalence of obesity increases in America at the present time, efforts to combat this increase must be addressed. Not only does obesity affect physiological health but also mental health and wellbeing. Children are showing the greatest increase in obesity and the disease has been labeled an epidemic. Being obese in America can sometimes bring upon

hateful discrimination and in today's obesogenic environment, it is much harder to combat obesity when physical activity recommendations are not met.

While physical activity and a healthy diet are two of the greatest solutions to obesity, it seems as though physical activity policies that are already in place are not doing a great job in addressing the issue. To remediate this, a policy that incorporates physical activity in the school day makes it more feasible for children to participate because they spend most of their waking hours in school. The Morning Motivator and Afternoon Activator is structured to include curriculum specific instruction alongside moderate to vigorous physical activity, which encourages teachers and students to participate in physical activity and develop healthy habits for the future.

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