

The Impact of Obesity and Inactivity in Adolescent students on Academic Achievement as
Demonstrated by Grade Point Average (GPA)

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Demonstrated by Grade Point Average (GPA)

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Accepted by the Department of Kinesiology, Sport Studies, and Physical Education, SUNY Brockport, in partial fulfillment of the requirements for the degree Master of Science in Education (Physical Education).

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Table of Contents

Title Page.....	1
Signature Page.....	2
Acknowledgements.....	3
Table of Contents.....	4
Chapter 1.....	5
Chapter 2.....	11
Chapter 3.....	13
Chapter 4.....	23
Reference Page.....	31
Appendix A:.....	34

Chapter 1: Introduction

Obesity not only impacts adults, but it is also continuing to impact adolescents in many ways. The health consequences of obesity may be more well known, but obesity may also pose a potential risk to adolescents' academic achievements. Today, across the globe, adolescents are being negatively impacted more and more by obesity affecting their academic performance and achievements as displayed by several studies.

The Centers for Disease Control and Prevention (CDC) states that "Childhood obesity is a serious problem in the United States, putting children and adolescents at risk for poor health. Obesity prevalence among children and adolescents is still too high" (2017, p. 2). The CDC estimated that obesity occurs in 19.3% of children aged 2-19 and affected about 14.4 million children and adolescents across the United States. Furthermore, the CDC states that "less than one-quarter (24%) of children 6 to 17 years of age participated in 60 minutes of physical activity every day. In 2017, only 26.1% of high school students participate in at least 60 minutes per day of physical activity on all 7 days of the previous week. In 2017, 51.7% of high school students attended physical education classes at least 1 day in an average week, and only 29.9% of high school students attended physical education classes daily" (2017, p. 2). This clearly displayed that Americans are not getting enough exercise, particularly adolescents and children.

Kahan and McKenzie stated that "2008 United States Physical Activity Guidelines, published by the US Department of Health and Human Services (USDHHS), recommends that youths engage in at least 60 minutes of mostly moderate-to-vigorous PA (MVPA) daily" (2015). The CDC recommends adolescence to engage in 60 minutes of moderate to vigorous physical activity daily. In addition to 60 minutes of aerobic physical activity, it is recommended that adolescence participate in strength and bone building activities three times per week (CDC

2021). Physical education is a great and vital tool to get the youth to participate in physical activity. Not only does physical education help increase bone strength, muscle growth, and positively impact the cardiovascular system, but it may also provide stimulation to cognition and brain activity that may lead to higher levels of academic achievement. Along with improved physical fitness and health and improved academic performance, physical education allows students to develop and strengthen interpersonal skills and peer relationships. Although the importance of physical education is well known to fitness professionals, our school systems are lagging behind in their education on this subject and its benefits. “A mandated curriculum area in 43 states for elementary grades, 41 for middle schools, and 44 for high schools mandate substantial amounts of PA during class time and is considered a public health resource for combating and preventing overweight and obesity” (Kahan and McKenzie, 2015).

Fitness is often viewed as an avenue to achieve a healthier and more fit body, but it may also play an integral part in academic achievement of adolescents. Fitness, therefore, could be valued not only as a health-enhancing activity, but as a cognitive enhancing activity. A growing amount of evidence suggests that physical fitness and obesity may play a significant role in academic performance of adolescence. The more well-known positive associations with physical activity and maintaining a healthy body weight include “decreased body fat content and more favorable cardiometabolic risk factor levels and better bone health in children and adolescent” (Haapala et al., 2020). In addition to the more obvious benefits that higher levels of fitness provide, research also suggests that obesity is associated with decreased grade point average (GPA) among adolescents. Haapala et al., found that “lower levels of moderate to vigorous physical activity were associated with lower grade point average (GPA) in boys and girls” (2020, p. 3). In a society where college admission and future professional work success depends

partially upon academic achievement and GPA, it is paramount that we understand how to best set up our youth for success. With increased academic achievement, comes an opportunity for higher paying jobs and a chance at a better quality of life.

“Academic performance refers to a child's success and performance in school and can be measured by grade point averages (GPA), as a cluster of achievement tests or, using specific tests for reading or arithmetic skills, such as reading speed, fluency and comprehension, and the ability to solve logical/arithmetic problems.” (Santana et al., 2020). Santana et al., suggests that there is increasing evidence of an association between physical fitness and academic performance” (2020). Santana et al., further reduces that this could be the result of physical fitness's positive effects on cognition and performance in attention tasks, or by its effects on depression, stress, and sleep quality.

Statement of Problem

It is imperative to understand the impact of obesity on not only quality of life but also academic achievement. Obesity in United States' is continuing to trend upwards, and the rate of adolescents with obesity is on the rise (CDC 2021). “The No Child Left Behind (NCLB), Act of 2002, which reauthorized the Elementary and Secondary Education Act of 1965, put pressure on school administrators to improve their standardized test scores each year. The Center on Education Policy found that in response to NCLB schools shifted large chunks of classroom time to English and math and cut recess/PE” (Whitehouse and Shafer, 2017).

The result of marginalizing physical education as an important course has led to schools focusing more on core classes such as math, science, and language, while physical education is often an after-thought. The third standard from SHAPE America (National Physical Education Standards) states that “The physically literate individual demonstrates the knowledge and skills

to achieve and maintain a health-enhancing level of physical activity and fitness” however, many P.E. programs are failing to do so. SHAPE states that, “In many states across the country, schools allow exemptions and waivers from physical education classes, and funding for PE averages a mere \$764 per school, per year” (2016, p. 1). With such low budgets, and less classroom time allotted to PE, obesity continues to rise. The problem right now is the lack of support for physical education as a vital course, its impact on obesity, and the marginalization of how physical education helps raise academic achievement and GPA of the country’s youth. PE allows students to learn the tools and science of how to keep their body healthy for a lifetime.

Purpose of Synthesis

The purpose of this synthesis is to review literature of the impact obesity and physical inactivity on academic achievement on adolescents.

Operational Definitions

1. Obesity – “Body weight that is higher than what is considered healthy for a given height is described as overweight or obesity.” (CDC, 2021). A body mass index of 30 or greater is categorized as “obese”. A body mass index of 25-29.9 is categorized as “overweight” (CDC, 2021).
2. Body Mass Index (BMI) - “Body mass index (BMI) is a person’s weight in kilograms divided by the square of height in meters. A high BMI can indicate high body fatness.” (CDC, 2021).
3. Academic Achievement – “The extent to which a student or institution has achieved either short or long term educational goals. Academic Achievement may be measured through students’ grade point average (GPA), whereas for institutions, achievement may be measured through graduation rates” (Tophat, 2021).

4. Adolescence- “Adolescence is a transitional stage of physical and psychological development that generally occurs during the period from puberty to legal adulthood. (Merriam-Webster, 2012).

Research Questions

The following research questions will be the primary focus explored for this literature review:

1. Does obesity impact academic achievement as measured through GPA in adolescence?
2. What role can physical educators play in helping adolescents become physically literate and increase their levels of physical activity?

Delimitations

1. The articles used in the literature review of the synthesis were both peer reviewed and full text.
2. The review included articles between 2011-2021.
3. Peer reviewed scholarly articles focused on the impact of obesity on academic achievement in adolescent-aged children.

Chapter 2: Methods

The purpose of this chapter is to review the methods and procedures used to determine the impact of obesity on academic achievement in adolescents as displayed by grade point average (GPA). An extensive search for previous research was conducted to obtain the information pertinent to complete this synthesis. This chapter specifically details the methods and procedures used in obtaining the appropriate information and statistics for this synthesis.

The studies collected for this synthesis were located using the EBSCO database from The SUNY Brockport's Drake Library and Google Scholar. Research guides within the library website and Google Scholar are broken down by subject. For this synthesis the research guide subject selected first was Kinesiology and Sport Studies & Physical Education. Google Scholar was an additional database utilized to guide parts of the research completed for this synthesis. A combined search of the two databases resulted in thousands of articles returned depending on the number of keywords used that was further evaluated for appropriate research studies with increased detail filters.

Keywords for the research study search was determined to form a clear focus for the research topic previously mentioned. Keywords included *obesity, academic achievement and performance, GPA/ grade point average, and adolescents*. These keywords were selected based on their relevance to the research questions. *Obesity and academic achievement* were identified as the most important keywords to return results that would serve as a starting point for the research study. These keywords resulted in numerous, more broad articles that then required more refining. The search was then refined with the *GPA and adolescents*. *Adolescents* was used as a keyword because that is the age of students this synthesis would be evaluating. The keyword *grade point average (GPA)* was chosen to refine the search even further after numerous articles

were reviewed with the key word *academic achievement*. *Grade point average (GPA)* was chosen because GPA is an evaluation tool used widely in the United States used to assess academic achievement in adolescent-aged students.

The first combined search from The SUNY Brockport's Drake Library database used the keywords *obesity* and *academic achievement*. This search resulted in 35,211 Results. A limiter was then applied to produce only search results with full text and available online was defined to return only results from scholarly (peer reviewed) journals. A published date limiter was also applied to reveal results between the years of 2011-2021. These limiters dwindled the results down to 25,391 results. Then the keywords *grade point average (GPA)* and *adolescents* were used to refine the search to 370 articles. Of the 370 articles returned, five articles fit the criteria for use in the synthesis because they directly looked at how obesity impacts academic achievement. While other articles contained the keywords, they did not directly look into the impact obesity has on academic achievement.

. The second search process began with a broad approach similar to what was utilized in the first search; however, the Google Scholar Database would be used. Two key words *obesity* and *academic achievement* resulted in 125,000 search results. The same limits in the first search were then applied and filtered, (full text, scholarly peer reviewed journals, and a published date between the years of 2011-2021). The key words *grade point average (GPA)* and *adolescents* were then added to the search to supply 223 articles. Of the 223 articles, five fit the criteria of the purpose of this synthesis and were used for the literature review because they directly dealt with the impact of obesity on academic achievement. The other articles included the keywords, but the focus of their study was not to evaluate the impact of obesity on academic achievement.

Ten total articles were selected through the refined search process. These Ten articles were researched further to determine if they were appropriate for inclusion in the literature review.

For the articles to be included in the research process, it was vital that the article met certain relevance indicators. The article must have studied the impact of obesity on academic achievement as seen through grade point average (GPA), or it must have included the impact of physical activity or inactivity on academic achievement in adolescent aged students. Some of the articles selected also offered ideas for improvement in regard to obesity rates in adolescents, therefore improving their academic achievement (GPA) as well.

Articles were produced from the following journals: *Journal of Sport and Health Science*, *Journal of the National Academy of Sciences*, *Journal of Applied Sciences*, *International Journal of Obesity*, *International Journal of Sport and Exercise Psychology*, *Annals of Human Biology*, *Journal of Nutrients*, *International Journal of Environmental Research and Public Health*, and three articles *Scandinavian Journal of Medicine & Science in Sports*.

The critical mass for this synthesis was comprised of 52,045 individuals, all participants were adolescent aged students. Survey respondents who made up a much smaller portion of the sample size included adolescent aged students. Data was derived from a critical mass of ten articles globally. The average age of students used in this survey population were 14 years old.

The articles selected for research included both qualitative and quantitative research approaches. The literature review included nine articles that were quantitative and one qualitative. These studies gathered information using a variety of methods including data collection from resources obtained from institutions, article reviews, surveys, and questionnaires.

The data that were collected informs the readers that there was a multitude of methods utilized to gather information regarding the impact of obesity on academic achievement (GPA). Various articles selected had included the critical mass assist in information collection with respects to what can be done to decrease obesity rate and improve academic achievement in the adolescent population.

Chapter 3 – Review of Literature

The purpose of this chapter is to present a review of literature regarding the impact that obesity has on academic achievement in adolescents and ways to enhance learning and health in schools. The following topics will be explored: the impact of obesity on academic achievement, how students may benefit from a healthy and active lifestyle. An analysis of literature found that these themes emerged as being essential to understanding the overall impact of obesity on adolescent's academic achievement.

When you think about physical activity and physical education, you often think about the health benefits associated with exercise, however, we often forget to think about how physical activity may positively impact our lives in other aspects. First discussed will be the association between low levels of fitness and increasing levels of obesity on students' academic achievement.

Impact of Obesity on Academic Achievement

Does a sedentary lifestyle and obesity negatively impact a student's academic achievement? Finn, et al., (2018), completed an analysis that researched 196 high school students to observe possible correlations between BMI and academic achievement in the students. The purpose of the study was to examine the associations between BMI levels and academic achievement. The research collected included Body mass index and student grades which were obtained through the school records from the 196 high school student participants. These 196 students were from a large suburban school in the northeastern United States and completed surveys during three separate periods. 95% of the participants were in the ninth grade, among those participants 47% were males and 53% were females. Approximately 70% of the respondents reported race as white, 15% as African American, 6% Hispanic, and 9% other. The three forms of school engagement that were examined during this research included behavioral,

presenteeism, and affective. These three forms represent engagement ranging from external classroom behaviors and actions, to internal attitudes and views about school and their education. The results revealed that gender was not significantly correlated with any of the other variables, however, race was significantly correlated with both BMI and GPA, displaying that lower BMI and higher GPA were more typically associated with white students (Finn, et al., 2020). More classroom participation and less presenteeism were found among white students. The findings overall, confirmed that BMI is related to GPA and that student engagement was a significant factor of this particular relationship. The purpose of this study was to examine whether engagement in school can be used to explain the link between obesity and achievement among adolescents (Finn, et al., 2018). This study concluded that being overweight or obese is negatively impacting educational outcomes as seen through GPA.

Similarly, Rajagopal, et al., (2017) completed a study with the purpose of determining the relationship between GPA and BMI, exercise habits, and weight perception. Data for this study were obtained from the school-based health promotion centers (SBHC). Sixth, seventh, and eighth grades were screened at the SBHC for a variety of behaviors and lifestyle characteristics using the Perkins Adolescent Risk Screen (PARS). Data were collected from a total of 579 students: 281 males, 298 females, 278 sixth graders, 151 seventh graders, and 150 eighth graders (Rajagopal, et al., 2017). Of these students, 145 were underweight, with a BMI less than 18.5; 241 were considered a healthy weight and had a BMI between 18.5 and 24.9; 100 were overweight, with a BMI between 25 and 29.9; and 93 were obese, with a BMI over 30. GPA and BMI were related ($r = -0.446$, $p < 0.01$). T-tests were conducted to assess if BMI and GPA differed depending on weight perception and exercise and to further assess if GPA differed depending on BMI category. There were significant ($p < 0.05$) differences in GPA between the

following groups: BMI under 25 vs BMI 25+, normal BMI vs abnormal BMI (Rajagopal, et al., 2017). Rajagopal, et al., concluded that a higher BMI, lack of exercise, and poor weight perception were related to a lower GPA. The significance that this study displayed is that students who are overweight or obese tend to perform more poorly in school compared to their peers of a healthier BMI.

In addition, Garcia-Hermoso, et al., (2020), evaluated longitudinal associations of physical fitness and body mass index with academic performance. The purpose of the study was to examine longitudinal associations of changes in physical fitness components and body mass index with academic performance among adolescents (Garcia-Hermoso, et al., 2020). This study included 1802 adolescent participants. Physical fitness components were assessed following the ALPHA health-related fitness test battery, and academic achievement was assessed from school records. The study occurred over a two-year span and was created to assess the relationship of physical activity and sedentary behaviors on health indicators (physical fitness, metabolic and cardiovascular disease risk factors, inflammation-immunity biomarkers, and mental health) over time (Garcia-Hermoso, et al., 2020). This study included 1802 adolescents (46.8% girls, and 53.2% boys) with baseline data, and two year follow-up data on physical fitness, BMI, education level, and academic performance (Garcia-Hermoso, et al., 2020). Academic performance was assessed via school records at the end of the academic year. GPA was determined in this study through student records. The findings from this study showed that maintaining high levels of cardiorespiratory fitness and motor ability was correlated with higher academic achievement over a two-year span. The participants that were considered overweight/obese at baseline, had lower academic achievement scores at follow-up when compared to those with normal weight (Garcia-Hermoso, et al., 2020).

Similarly Haapala, et al., (2020) also studied how physical activity affects academic achievement in boys and girls aged 11-13. The purpose of this study was to determine the associations of moderate-to-vigorous physical activity (MVPA) with academic achievement in adolescents. This was a longitudinal study, and included a total of 635 adolescents (283 boys, 352 girls). The participants were followed over a two-year time span. Moderate-to-vigorous physical activity was assessed by the Health Behavior in School-Aged Children study questionnaire and grade point average (GPA) was acquired from school records (Haapala, et al., 2020). This study discovered that adolescents who were inactive at baseline or at both baseline and follow-up had lower GPA during follow-up than their continuously highly active peers (Haapala, et al., 2020). This study found that in boys, MVPA was positively associated with GPA at baseline and found that girls who were continuously inactive had lower GPA over the follow-up period than those who were continuously active (Haapala et al., 2020). This study therefore concluded that physical activity is an important factor in academic achievement.

Hermassi, et al., (2020) wanted to look at the academic achievement of handball players, and if obesity affected the GPA of these players. This study aimed to examine the differences in physical fitness and academic achievement in obese and non-obese adolescent handball players. This study included 31 males, with the average age of 15 years old. Academic achievement was determined through GPA and academic achievement was determined from school records. The results of this study showed that non-obese participants had superior performances in mathematics and science when compared to those who were considered obese. The largest differences occurred in the subject of mathematics.

Correa-Burrows, 2018, studied how high adiposity affects academic achievement in Chilean adolescents. This study included 632 participants that were 16–17-year-old adolescents

(51% male, 49% female) living in Santiago, Chile, from low-to-middle socioeconomic status (Correa-Burrows, 2018). GPA was determined using school records for the participants who were all in 9-12th grade. Obesity was measured by finding fat percentage through skinfold measurements. This study found that in both males and females, the greatest losses in school achievement was related to increased obesity (Correa-Burrows, 2018). This study concluded that Obesity was associated with lower school grades across high school grades 9th to 12th and is an important factor in academic achievement.

In addition, Torrijos-Nino, et al., (2018) performed a study to examine the relationship between obesity, fitness levels, and academic achievement. This study used BMI as its measure to determine whether students were obese or not. The study included 893 participants, aged 9-11 years, that lived in Cuenca, Spain and data were collected from September to November 2010 (Torrijos-Nino, et al., 2018). Torrijos-Nino, et al., measured academic achievement by averaging the grades of each student to find their GPA. This study found that academic achievement was positively related to fitness levels and obese boys and girls had lower grades when compared to boys and girls who were classified as overweight or normal weight. This study also found that optimal cardiorespiratory and speed/agility levels were associated with high academic achievement (Torrijos-Nino, et al., 2018). Overall, this study concluded that academic success is associated with overall higher fitness levels, and that schools should consider additional strategies to improve fitness as part of their overall strategy for improving academic achievement. Kahan and McKenzie (2015) found that one benefit of physical activity during PE is that it requires student energy expenditure, and this in turn helps to control overweight and obesity.

Kahan and McKenzie, (2015) further recommend that the health implications of Physical education be given high research priority. Kahan and McKenzie, (2015) also state that in addition to promoting physical activity, physical skills, and fitness, PE traditionally has had many other objectives (e.g., cognitive, social, and emotional development). In this study, they Kahan and McKenzie, (2015) found that health-optimizing Physical education, which prioritizes student physical activity during lessons, has been promoted as a vehicle for actualizing PE's potential to improve public health. These studies by Kahan and McKenzie mentioned above show the impact that physical education has on limiting obesity, increasing physical activity, and improving health.

Additionally, Hammadi, et al., (2020) wanted to look at the relationship between obesity and academic achievement in people that live in Kuwait. More than 40% of adults are classified as obese in Kuwait. Along with high levels of obesity found in adults, prevalence of obesity is also extremely high among Kuwaiti children and adolescents. In Kuwait, obesity rates are rising among adults and children, costing the country a minimum of 2.8 billion dollars annually in both direct and indirect costs (Hammadi, et al., 2020). The purpose of this study was to test whether academic achievement differed between female undergraduates with obesity, as measured through BMI, and those who were non-obese within Kuwait (Hammadi, et al., 2020). This study found that the GPA among students who were classified as obese was significantly lower than students classified as non-obese. This study suggests that there is an issue with obesity that exists and universities should look at ways to help students with their BMI. Lastly, this study concluded that undergraduates with BMI-defined obesity had poorer overall academic achievement than those who did not have obesity, and this difference could not be explained by socio-economic status.

Furthermore, Weston, et al., (2020) looked into how obesity specifically affected black Americans. Physical activity is recognized as an important factor in attaining a healthy lifestyle. Despite the contribution of physical activities to adolescent health status, opportunities for adolescents to engage in physical activity are still limited in the United States, particularly true for black adolescents. This study examined how physical activity affects the GPAs of black school-aged adolescents. This study included a baseline survey that was administered to 9th grade students in 2011, and the sample size included 944 schools with over 23,000 students along with their parents, school counselors, administrators, and teachers (Weston, et al., 2020). The survey sampled public, private, and Catholic schools and randomly selected 9th grade students from within each school. Follow-ups began in 2013 when the majority of the students were now in the 11th grade followed by high school transcripts collected in 2013 (Weston et al., 2020). Another follow-up occurred in 2016, when most students were three years into their post-secondary education phase. The results of the study showed that physical activity had influenced GPA among the participants. This study found that girls had enrolled in physical education less than boys, and that GPA is correlated with physical activity. This study also looked into other factors that affect GPA, such as the participants' environment. According to the National Physical Activity Plan Alliance, (2018), 64% of children and adolescents with ages ranging from 6–17 years live in a safe environment, however, among black children and adolescents only 53% live in safe communities, compared to their white counterparts. This perceived lack of safety reduces participation in physical activity, which in turn decreases academic achievement. This study suggests that physical activity, school attitudes, socioeconomic status, demographic factors, safety, and gender play a critical role in academic achievement (Weston, et al., 2020).

Along with the above-mentioned studies, Aime, et al., also completed a study in which they were seeking to better understand the relationship between BMI and GPA (2014). Participants consisted of 298 college women who volunteered to complete online questionnaires between the months of October to December of 2014 (Aime, et al., 2014). Data for this study were collected from 298 French-speaking college students of a suburban university in the province of Quebec, Canada. These students, aged 18 to 29, were enrolled mainly in undergraduate programs. Most participants were Caucasian (93.0%). The study broke participants into three groups: 67.8% had a normal weight, 22.1% were overweight, and 10.1% were considered obese (Aime, et al., 2014). This study was conducted because studies that examine the link between BMI and GPA using university samples are scarce. The results from this study determined a correlation between BMI and GPA when sociodemographic variables were controlled. In conclusion, data from this study showed that overweight and obese students demonstrated a lower GPA, higher levels of depressive symptoms, and a lower sense of academic self-efficacy than normal-weight students.

Summary

Research has found a few variables that can impact GPA, including physical activity, dietary habits, participation in physical education classes, socio-economic status, perception of safety, and body fat percentage. Does a healthy weight student always produce a better GPA than a student that is obese? Of course not, but overall, research shows that in general, obese and overweight students have lower levels of academic achievement than healthy weight students.

Research showed that there is a strong relationship between academic achievement and obesity. Research gathered from this synthesis showed that this relationship does not

discriminate based on the region of the world or population. From Canada, Japan, United States, to the Middle East obesity was shown to impact the academic achievement of adolescents.

One study particularly suggests that physical education plays an important role in student's weight and opportunity for physical activity. Physical activity is an important variable in attaining a healthy body weight and it is suggested that students engage in physical activity to maintain a healthy body weight. The above studies suggest that in order to optimize academic achievement, adolescents should aim to achieve a healthy body weight, whether it be from dietary habits, physical activity, or a combination of both.

Chapter 4

Results, Discussion and Recommendations for Future Research

The purpose of this chapter is to present the results of the review of literature in regards to the impact of obesity on academic achievement in adolescents. The results presented show an alignment with the research questions that guided this synthesis project. This chapter will also provide recommendations for future research as it relates to obesity and academic achievement.

The results of this review of literature displayed a clear result as to the impact of obesity on academic achievement. The results support that obesity has an influence on adolescents' academic achievement. The research indicates that maintaining a healthy body weight can help maximize students' abilities to perform academically. It is also suggested that moderate to vigorous exercise, cardiovascular activity, and 60 minutes of exercise a day play a factor in helping maintain a healthy body. In addition, the evidence suggests that cardio-vascular exercise and moderate-to-vigorous physical activity is beneficial to a person's heath and academic performance. Research is supportive of physical education programs, school athletics/intramurals, and community activity centers to help mitigate this issue and ensure that students are not having their academics negatively affected. These multiple modalities allow adolescents the ability to participate in a level of health-enhancing physical activity.

Discussion

Interpretations

Research questions were posed prior to the literature review; the first research question synthesized read as, "what impact does obesity have on academic achievement as measured by

Grade Point Average (GPA) of adolescents?” The results of the previous literature review show the negative influences that obesity can have on adolescent’s academic achievement. Finn, et al., (2020), research displayed through data analysis that being overweight or obese is negatively impacting educational outcomes as seen through GPA. Furthermore, the research completed by Rajagopal et al., (2017) concluded that a higher BMI, lack of exercise, and poor weight perception were related to a lower GPA. This study revealed that students who are overweight or obese tend to perform more poorly in school compared to their peers of a healthier BMI, which is significant for adolescents. The work of Garcia-Hermoso et al.,(2020) indicated that maintaining high levels of cardiorespiratory fitness and motor ability was correlated with higher academic achievement over a two-year span. The participants that were considered overweight/obese at baseline, had lower academic achievement scores at follow-up when compared to those with normal weight. Haapala et al.,(2020) found that in boys, MVPA (Moderate-to-Vigorous Physical Activity) was positively associated with GPA at baseline and found that girls who were continuously inactive had lower GPA over the follow-up period than those who were continuously active (2020). In addition, Correa-Burrows, (2018), discovered that in both males and females, the greatest losses in school achievement were related to increased obesity. This study concluded that obesity was associated with lower school grades across high school grades 9th to 12th and is an important factor in academic achievement. Torrijos-Nino et al., (2018), presented results that revealed how academic achievement was positively related to fitness levels, and obese boys had lower grades when compared to boys who were classified as overweight or normal weight. This study also found that optimal cardiorespiratory and speed/agility levels were associated with high academic achievement. Studies utilized throughout this thesis were selected with the intent to express the relationship of obesity and academic

achievement across the globe, not in just a single country. Haamadi et al., (2020) concluded that in Kuwait, GPA among students who were classified as obese was significantly lower than students classified as non-obese. Similarly, Weston et al., (2020) had a desire to study specifically, Black population in the United States to visualize how health affects academic achievement. Results of the study indicated that physical activity had influenced GPA among the participants. This study found that girls had enrolled in physical education less than boys, and that GPA is correlated with physical activity. The studies selected in this synthesis aimed to represent as many populations as possible, with the purpose in mind to not limit the research findings to one population. In Canada, Aime et al., (2014) looked into how college girls' academic achievement was influenced by body weight. The data formed from this study showed that overweight and obese students demonstrated a lower GPA, higher levels of depressive symptoms, and a lower sense of academic self-efficacy when compared to normal-weight students.

The second research question that was examined was, "what role can physical educators play in helping adolescents become physically literate and increase their levels of physical activity?" The results shown throughout several studies displayed the importance that physical activity has on maintaining a healthy body weight and therefore maximizing academic achievement. Physical Education is a tool that adolescents may utilize, in order to combat the issues of obesity on their health and academic achievement. Weston et al., (2020), noted the importance of physical education programs to combat obesity. Weston et al., 2020, took notice that opportunities for physical activity in the United States may be limited due to community resources, and physical education plays a vital role in decreasing obesity and maximizing academic achievement. This study found that girls had enrolled in physical education less than

boys and that GPA is correlated with physical activity. According to the National Physical Activity Plan Alliance, 2018, 64% of children and adolescents with ages ranging from 6–17 years live in a safe environment, however, among black children and adolescents only 53% live in safe communities, compared to their white counterparts. This perceived lack of safety reduces participation in physical activity, which in turn decreases academic achievement. Additionally, this study suggests that physical activity, school attitudes, socioeconomic status, demographic factors, safety, and gender play a critical role in academic achievement (Weston, et al., 2020). Studies examined in this synthesis further revealed the importance and support for physical activity availability. Torrijos-Nino et al., (2018), found that optimal cardiorespiratory and speed/agility levels were associated with high academic achievement. Hapaala et al., 2020, developed a study that was to determine the associations of moderate-to-vigorous physical activity (MVPA) with academic achievement in adolescents. This study discovered that adolescents who were inactive at baseline or at both baseline and follow-up had lesser GPA during follow-up than their continuously highly active peers. They also found that MVPA was positively associated with GPA at baseline and found that girls who were continuously inactive had lower GPA over the follow-up period than those who were continuously active. Garcia-Hermoso et al., (2020) sound that maintaining high levels of cardiorespiratory fitness and motor ability was correlated with higher academic achievement. These above mentioned studies support that obesity impacts academic achievement, but also support increase in physical activity to aide in healthy body weight and improved academic achievement. Physical education class is a modality for students to participate in health-enhancing physical activity, and may be a way to educate adolescents about how they can take care of their bodies and health.

Implications

Previous research on the impact of obesity on academic achievement depicts that there are aspects that are related when trying to support adolescents in having a healthy life and academic success in school. Many of the conclusions of the results are intertwined, including the results of this synthesis to offer practical implications which can benefit students in an attempt to maximize not only their health, but their academic success as well.

A student that is best set-up to maximize their health and learning includes one that is engaged in physical activity. For students to be able to maximize their educational outcomes and academic achievement, they should attempt to achieve and maintain a healthy body weight, as measured by BMI. Research also supports that cardiorespiratory fitness and moderate-to-vigorous intensity levels, assist in an optimal weight for learning and health.

It should also be noted that there are guidelines put in place, to aid in an adolescents' understanding of exactly how much exercise they need in order to be healthy and successful. The CDC recommends 150 minutes of exercise per week for adolescents (2020). Other initiatives such as NFL PLAY 60, recommend 60 minutes per day of exercise for adolescents (2020). SHAPE America recommends that schools provide 150 minutes of instructional physical education for elementary school children, and 225 minutes for middle and high school students per week. Simply inputting physical education programs nationally does not necessarily guarantee that obesity will be fully halted, because each school faces a variety of challenges in regard to physical education funds and time demands. It is vital to understand that physical education programs are step in the right direction to meeting the recommended physical activity guidelines and that physical education may need greater support within the school systems. Many physical education programs are viewed as an after-thought by school administration, and at times are not able to provide the recommended class time for students. Even though it is

recommended that students receive 150-225 minutes of physical education weekly, many schools fail to reach these time recommendations. It is often thought that the core subjects may be of more importance to a student's education rather than physical education. Since the No Child Left Behind Act placed an increased emphasis on test scores, physical education has lost some of its seen value. Many schools, however, do not understand that students that maintain a healthy bodyweight, and participate in physical activity, statistically will score better on their testing. Also, a school may lack resources and equipment to use in physical education class, which may limit the activities offered by the educators. When a school invests properly in its physical education program with qualified teachers, adequate resources, and sufficient time allotment, students can best be set up to live a healthy and academically successful life.

Understanding the importance that physical activity increases test scores, schools should allocate more emphasis on their physical education programs. Schools should understand that the more prominent a physical education program that allows enough time for quality physical activity, students can not only improve their body fat percentage, test scores, and cardiovascular fitness, but also live a more overall successful life.

Limitations & Recommendations for Future Research

Following a thorough review of the data available regarding the impact that obesity has on academic achievement in adolescents, the following limitations were noted within the literature. The studies used in this review were limited to information that has been collected by a particular institution in a certain period of time, and these studies were also limited by the variables examined within the research.

Based on these limitations, future research should consider the following recommendations:

1. Future research should continue to develop new variables that can impact the relationship between obesity and academic achievement, such as the individual psychological characteristics of students and situational aspects like household income, or socio-economic status. Future research should concentrate on any new variables that are found through advanced analytic research. As more data is collected over time, more information will be available to researchers to concentrate their work on.
2. Future research should be broadened to cover a larger area. This will lead to more generalizable results.
3. Future research should look at a plethora of data and look at each variable individually to see what has the largest impact on academic achievement.

Summary

The purpose of this synthesis was to review literature on the impact of obesity on academic achievement in adolescents. An exhaustive search of online databases using specific delimiting techniques and key words revealed ten articles that were selected for this synthesis. These articles were synthesized to determine if obesity had an impact on academic achievement, and what are ways schools can help support students and maximize their learning and academic achievement (GPA).

Research revealed that a variety of important variables have the ability to impact academic achievement other than obesity, including perceptions of safety, and socio-economic status. Students that do not maintain a healthy body weight or participate in physical activity,

limit their academic achievement. It is clear that taking advantage of on-campus resources to participate in physical activity like physical education class, can assist to combat the challenges of obesity including health implications and academic achievement implications.

Further research and enhanced analytic data from institutions over time will only help to expand the list of key variables that impact obesity and academic achievement in adolescents. This information will help school administrators and parents to value physical activity and build successful physical education programs across the country. This information will also be beneficial to adolescents in an effort to boost participation in physical education, physical activity, and test scores.

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Author	Title	Source	Purpose	Methods & Procedures	Analysis	Findings	Discussion/
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							Recommendations Research Notes – Commonalities/Differences
García-Hermoso et al	Longitudinal associations of physical fitness and body mass index with academic performance	<i>Scandinavian Journal of Medicine & Science in Sports</i>	The aim of the study was to examine longitudinal associations of changes in physical fitness components and body mass index with academic performance among youth, and whether the physical fitness components are moderators of the longitudinal association between obesity and academic performance in youth.	Participants were enrolled in the UP&DOWN Study. Briefly, the UP&DOWN Study was a 2-year follow-up study designed to assess the relation of physical activity and sedentary behaviors on health indicators (physical fitness, metabolic and cardiovascular disease risk factors, inflammation-immunity biomarkers, and mental health) over time, as well as to identify the psycho-environmental and genetic determinants of physical activity in a cohort of Spanish children and adolescents. 21 Children and adolescents were recruited from schools in Cadiz and Madrid (Spain), respectively. Data were collected from September 2011 (baseline) to June 2014 (second post-test). A total of 2263 youth aged 10.4±3.4 years participated. The present analyses included 1802 children and adolescents (46.8% girls) with complete baseline and 2-year follow-up data on physical fitness, BMI, peak height velocity (PHV), maternal education level, and academic performance.	Preliminary analysis showed no significant interactions between sex, age, and physical fitness variables in relation to academic performance, therefore, all analyses were performed with boys and girls as well as children and adolescents together. All model assumptions were checked (I.E) normality and homoscedasticity). The change in academic performance from baseline to follow-up for each physical fitness component and BMI (persistently low, decreasing, increasing, and persistently high) was examined by analysis of covariance.	Youth in the persistently high cardiorespiratory fitness category had higher scores The Johnson-Neyman technique revealed a significant inverse relationship between change in BMI and language, mathematics/language, and GPA when change in cardiorespiratory fitness was above, but not at or below	The findings from the present study indicate that (a) maintaining high levels of cardiorespiratory fitness and motor ability over a 2-year period was associated with higher academic performance compared with those maintaining lower levels of cardiorespiratory fitness and motor ability
Haapala et al.	Longitudinal associations of physical activity and pubertal development with academic achievement in adolescents	<i>Journal of Sport and Health Science</i>	We sought to investigate the longitudinal associations of moderate-to-vigorous physical activity (MVPA) and pubertal development with academic achievement in adolescents.	A total of 635 adolescents (283 boys, 352 girls) aged 11–13 years participated in the study. MVPA was assessed by the Health Behavior in School-aged Children study questionnaire, and pubertal development was assessed by the Pubertal Development Scale at beginning of the 6th grade (baseline) and end of the 7th grade (follow-up). Grade point average (GPA) at the end of Grades 5 and 7 was computed from data acquired from the school registers. The data were analyzed using linear regression and analyses of covariance.	All statistical analyses were performed using the SPSS Statistical software Version 24.0 (IBM Corp., Armonk, NY, USA). We investigated the differences in basic characteristics at baseline between boys and girls by Student's <i>t</i> test and Mann-Whitney <i>U</i> test for continuous variables, or the χ^2 test for categorical variables. Change in MVPA from baseline to follow-up was investigated by Wilcoxon sign-rank test because of skewed distributions. We investigated	In boys, MVPA was positively associated with GPA at baseline after adjustment for age ($\beta = 0.144$, 95% confidence interval (CI): 0.028–0.260, $p = 0.028$). In girls, the Pubertal Development Scale was positively associated with GPA at baseline ($\beta = 0.104$, 95%CI: –0.004 to 0.211, $p = 0.058$) and follow-up ($\beta = 0.104$, 95%CI: –0.002 to 0.211, $p = 0.055$) after adjustment for age, and these associations strengthened after further adjustment for MVPA ($p < 0.05$). Adolescents who were inactive at baseline or at baseline and follow-up had lower GPA during follow-up than their continuously highly	Lower levels of MVPA were associated with lower GPA in boys at baseline. Girls who were continuously inactive had lower GPA over the follow-up period than those who were continuously active.

					<p>bivariate associations between MVPA, PDS score, and GPA at baseline and follow-up by Spearman correlation coefficients. We studied whether sex modified the associations of MVPA or PDS score with GPA using analyses of covariance. Because we found that sex modified the association between PDS and GPA at baseline ($p = 0.011$ for interaction), we also analyzed the data separately for boys and girls.</p>	<p>active peers (mean difference = -0.301, 95%CI: -0.543 to -0.058, $p = 0.009$) and all other adolescents (mean difference = -0.247, 95%CI: -0.475 to -0.019, $p = 0.029$). These differences were greater in girls than in boys.</p>	
Kantomaa et al	Physical activity and obesity mediate the association between childhood motor function and adolescents' academic achievement	Journal of the National Academy of Sciences	This prospective study investigated whether childhood motor function predicts later academic achievement via physical activity, fitness, and obesity.	The study sample included 8,061 children from the Northern Finland Birth Cohort 1986, which contains data about parent-reported motor function at age 8 y and self-reported physical activity, predicted cardiorespiratory fitness (cycle ergometer test), obesity (body weight and height), and academic achievement (grades) at age 16 y.	Structural equation models with unstandardized (B) and standardized (β) coefficients were used to test whether, and to what extent, physical activity, cardiorespiratory fitness, and obesity at age 16 mediated the association between childhood motor function and adolescents' academic achievement.	Physical activity was associated with a higher grade-point average, and obesity was associated with a lower grade-point average in adolescence. Furthermore, compromised motor function in childhood had a negative indirect effect on adolescents' academic achievement via physical inactivity (B = -0.023 , 95% confidence interval = -0.031 , -0.015) and obesity (B = -0.025 , 95% confidence interval = -0.039 , -0.011).	These results suggest that physical activity and obesity may mediate the association between childhood motor function and adolescents' academic achievement. Compromised motor function in childhood may represent an important factor driving the effects of obesity and physical inactivity on academic underachievement.
Santana et al	Physical fitness and academic performance in youth: A systematic review.	Scandinavian Journal of Medicine & Science in Sports	This study aimed to review the scientific evidence on the association among components of PF and AP in children and adolescents.	longitudinal studies examining the association between at least one component of PF and AP in children and adolescents		There is strong evidence for a positive association between CRF and cluster of PF with AP	evidence from longitudinal studies for a positive association between cluster of PF and AP; the relationship between muscular strength and flexibility with AP remains uncertain
Hermassi et al	Differences in Fitness and Academic Attainment between Obese, and Non Obese School-Age Adolescent Handball Players: An Explorative, Cross-Sectional Study	Journal of Applied Sciences	This study investigated differences in physical fitness and academic attainment in obese and non-obese adolescent handball players	A total of 31 males (age: 15.5 ± 1.2 years; body mass: 77.8 ± 17.7 kg; height: 1.71 ± 0.10 m; body mass index (BMI): 26.8 ± 6.9 kg/m ² ; body fat: $26.4 \pm 6.34\%$) from the Qatar handball first division participated and were divided into two body fat percentage (%BF) groups (i.e., obese or non-obese). Anthropometrics (height, mass, BMI, and %BF) and physical performance testing ability (T-half test for change-of-direction (COD); squat jump (SJ), countermovement jump (CMJ), and 10 and 15 m sprints; medicine ball throw	The investigation was conducted from January to February 2021 during an in-season period. Testing was performed at the time on a standard indoor handball court (from 6:00 p.m. to 8:00 p.m.), under comparable environmental conditions (temperature: 22.5 ± 0.5 °C; relative humidity: $60 \pm 5\%$), ≥ 3 days after a competitive match	Non-obese participants had superior performances in mathematics ($p < 0.001$) and science ($p = 0.013$), agility T-half test ($p = 0.001$), CMJ ($p < 0.001$), and 15 m sprint ($p = 0.019$). Correlations were found between T-half test and mathematics ($r = 0.500$) and science ($r = 0.484$). For both academic parameters, significant differences between groups were observed, and the non-obese	The non-obese group possessed better jumping ability and agility and superior academic achievement than the obese group. These data suggest poor physical fitness and obese levels of %BF in boys could negatively influence academic achievement, independent of training habits.

				(MBT), and aerobic capacity (Yo-Yo Intermittent Recovery Test level 1 (Yo-Yo IR1)) were determined. Academic attainment was determined through grade point averages (GPA).	to allow for recovery. Participants were advised to maintain habitual dietary intake and avoid caffeine-containing beverages for 4 h prior to testing. Participants arrived for testing >2 h prandial. Participants abstained from vigorous physical activity for 24 h before testing. Assessments were performed over four days in the same sequence to cause similar order effects	athletes showed superior performance than obese subjects (as illustrated in Table 3). The largest group difference was observed in mathematics ($p < 0.001$; $\eta_p^2 = 0.367$), comparable with science ($p = 0.013$; $\eta_p^2 = 0.195$). The association between mathematics and science was $r = 0.547$.	
Hill et al	The relationship between obesity and tertiary education outcomes: a systematic review.	<i>International Journal of Obesity</i>	The study aim was to systematically review evidence on the association between obesity and tertiary education outcomes in young men and women	All of the cross-sectional studies used course level performance such as grade point average (GPA) as their measure of educational achievement. Adding the one longitudinal study that reported on highest degree awarded [15], all 6 of the studies reporting on <i>performance</i> found this was lower in those with obesity. Regarding university <i>completion</i> (award of a degree), six of the eight found this was less likely in those with obesity. Only four studies reported an assessment of university <i>enrolment</i> . Three found this was less likely in those with obesity [Overall, 6/6 cross-sectional studies and 8/10 longitudinal studies reported evidence of lower educational achievement by students with obesity at university in comparison with healthy weight students.	The studies in this review offer compelling evidence that students with obesity do less well in tertiary, primarily university/college, education than their healthy weight peers	e also recorded whether gender differences in educational achievement were tested for. Study and sample characteristics and assessments of educational achievement varied substantially. Therefore no meta-analysis was performed.
Chien-Heng Chu et al	Health-related physical fitness, academic achievement, and neuroelectric measures in children and adolescents	<i>International Journal of Sport and Exercise Psychology</i>	The purpose of this review is to examine the relationships between health-related physical fitness and academic achievement among children and adolescents	These investigations utilized sample sizes ranging of 134 participants with ages ranging from 7 to 16 years. The FITNESSGRAM includes six components, which represent three broad categories of health-related physical fitness: (a) cardiorespiratory fitness; (b) muscular strength, endurance, and flexibility; and (c) body composition. Cardiorespiratory fitness is assessed using the Progressive Aerobic Cardiovascular Endurance Run (PACER), a one-mile run/walk, or a one-mile walk. Muscular strength and endurance of FITNESSGRAM is further divided into abdominal strength and endurance (e.g. using the curl-up test), upper body strength and endurance (e.g. using push-ups), and trunk extensor strength (e.g. using the truck lift). Regarding flexibility, the back-saver sit-	Components of health-related physical fitness appear to be differentially associated with academic achievement. Studies investigating the relation between body composition and academic achievement have relied on BMI as a measure of body composition.	Cardiorespiratory fitness appears to have a positive association with multiple scholastic areas as well as neurocognitive processes involved with the allocation of attentional resources and semantic and syntactic processing that may underlie scholastic performance.	BMI appears to be negatively related to the allocation of attentional resources and action-monitoring processes.

				and-reach test and shoulder stretch test are two commonly used physical fitness tests that are part of the FITNESSGRAM. Finally, body composition is examined by measuring skinfolds or through calculating BMI (Welk & Meredith, 2008).			
Oliveira et al	Cardiorespiratory fitness, but not physical activity, is associated with academic achievement in children and adolescents.	<i>Annals of Human Biology</i>	Aim: To examine the associations of CRF and PA with AA. Subjects and methods: A sample of 640 youngsters (10–18 years) participated in this study	All participants in the study—students, parents and teachers—were informed about the objectives and benefits of the study. Informed written consent was obtained for all students and their legal guardians. The same group of researchers carried out all measures. To be eligible participants, students had to report the absence of physical and mental health problems and participate in physical education classes (compulsory subject under the Portuguese educational system). The data was collected in the school environment, after approval was given by the school directors of every school.	A total of 76 public schools in the school education of the Porto area (Portugal) were invited by letter and email to participate in the study. Of these 41 refused, 17 did not respond and 18 accepted. Due to lack of resources and failure in bilateral negotiations, the data were collected in nine schools, with a total population of 3136 students from 5th–12th grade of the school. Of the 1222 individuals interviewed, after eliminating subjects due to collecting errors and missing information, 640 children and adolescents (358 girls and 282 boys) aged between 10–18 years old with a mean age of 13.35 years (± 2.57) composed the final sample. Subjects with incomplete data were eliminated.	One-way analysis of covariance (ANCOVA) was conducted to determine whether there are any statistically significant differences between AA of different CRF quartiles, controlling for age, BMI, gender, MVPA, SES and SR. Post-hoc pairwise comparisons were tested using the Bonferroni correction for multiple comparisons to determine which CRF and MVPA groups differ from each other. The final ANCOVA models for CRF and for MVPA included only the significant confounders. Effect size was calculated using the estimated marginal means and was categorised as small (0.20–0.50), moderate (0.51–0.80) or large (>0.80). Pearson's correlation matrix was used to evaluate the association between CRF and MVPA.	Our results show that CRF may have an important role in AA. The global political and financial pressure on schools and educators to adjust the curriculum in order to improve AA is increasing. Therefore, achieving and maintaining a healthy level of CRF should be a priority for education in general, and physical education in particular, in order to fully realize the beneficial impact of exercise on academic achievement.
Kyan et al	Does Physical Fitness Affect Academic Achievement among Japanese Adolescents? A Hybrid Approach for Decomposing Within-Person and Between-Persons Effects	<i>Journal of Environmental and Public Health</i>	This study examined if longitudinal changes in physical fitness were associated with changes in academic achievement among junior high school students.	A two-year, with three-time points longitudinal study was conducted in five public junior high schools in two suburban municipalities in Okinawa Prefecture, Japan from April 2015 to July 2017. Prior to the conduct of the study, we obtained an agreement with the municipality's Board of Education and the respective school principals to participate in the study. A total of six schools in the two municipalities were invited to participate in the study. Five schools agreed to participate. Passive informed consent was also obtained from the parents/guardians at the first year of this study.	Descriptive analysis was applied to examine study subject's characteristics at three-time points, and changes for PF, BMI, learning duration, and GPA, and SES variables and motivation at first-time points. For the hybrid regression model, we resolved PF, BMI, and learning duration into within-person and between-persons components. To examine the association between bivariate PF and AA, model 1	The within-person coefficients showed that the change of total fitness scores through two-year time periods is associated with a change in GPA for boys (beta = 0.007, standard error = 0.002, 95 % confidential interval = 0.002–0.011). For girls, the changes of total fitness score showed no significant impact on GPA according to within-person effect. The between-person coefficients showed that total fitness scores on the average of two years is positively associated with GPA only for boys (beta = 0.026, standard error = 0.006, 95%	The main finding of this study was that a positive effect of PF on AA was observed only among boys. Importantly, aside from consistently having high-fitness status, favorable change of PF within the individual through the two-year study period certainly contributed to AA of boys, even after adjusting several potential confounding factors. Therefore, opportunities for increased PF may be important to support AA among junior high school boys, regardless of academic gap

					includes only PF at both components. Subsequently, the confounding factors were added into model 1 for model 2. The between-person effects generated conclusions on whether AA is associated with three time-point averages of PF. The within-person effects generated conclusions about the impacts of three time-point changes of PF within-person by comparing the change of GPA in two years. All analyses were conducted separately for boys and girls.	confidential interval = 0.014–0.037). No significant relation in total fitness score and GPA was observed in girls but at least PF did not negatively affect AA.	
Burrows et al	Increased Adiposity as a Potential Risk Factor for Lower Academic Performance	<i>Journal of Nutrients</i>	To explore the association between excess body fat and academic performance in high school students	School grades in high school (9th to 12th) and final grade-point average (GPA) were collected from administrative records of the Ministry of Education (Chile). Since schools may have differed in grading policies, grades (on a scale of 1–7) were transformed into scores (range of 210–825), following the Ministry of Education criteria. The arithmetic average of each subject taken during each academic year was calculated and the result was compared in the conversion table provided by the Department of Assessment, Measurement and Educational Record, University of Chile, which complies with specifications on behalf of the Ministry of Education. The same procedure was used to convert the GPA into a score. Both school grades and GPA were used as continuous variables.	Although BMI is the most commonly used method for diagnosing obesity, it has been criticized because it does not always reflect true body fatness, which may be better assessed using body fat percentage and distribution.	When we explored the association of fatness with school grades, accounting for the effect of diet quality, we observed that in both males and females, the greatest losses in school attainment were related to the combined effect of increased fatness and poor diet quality. In a first analysis, where fatness was approached with obesity (Table 2), the combined effect of obesity and unhealthy dietary habits was associated with lower school grades across high school (grades 9th to 12th and overall GPA) in both sexes.	When we explored the association of fatness with school grades, accounting for the effect of PA on the academic outcome, we observed that in both males and females, the greatest losses in school attainment were related to the combined effect of increased fatness and physical inactivity. When fatness was approached with obesity (Table 5), the combined effect of obesity and reduced time allocation for exercise was associated with lower school grades across high school (grades 9 to 12 and overall GPA) in both sexes.
Torrijos-Nino et al	Physical Fitness, Obesity, and Academic Achievement in Schoolchildren	<i>Journal of Pediatrics</i>	To examine the association of physical fitness and obesity with academic achievement	893 schoolchildren, aged 9-11 years, from Cuenca, Spain. Data were collected from September to November 2010. We measured academic achievement (mean of the grades obtained in several core subjects), physical fitness (cardio-respiratory fitness, muscular fitness, and speed/agility), weight, height, and parental education.	Children with higher physical activity levels have also higher fitness levels. ³ A recent review has shown in children a positive relationship between levels of physical-activity and academic performance and executive function. ¹⁰ Physical activity related neurophysiological	Overall, academic achievement scores were positively related to fitness levels. Obese boys had lower scores for academic achievement than overweight or normal weight boys. Good cardio-respiratory and speed/agility levels were associated with high academic achievement after controlling for confounders (OR 3.06; 95% CI, 1.35-	Academic success is associated with higher fitness levels. Schools should consider strategies to improve fitness as part of their overall strategy for improving academic achievement.

					changes in the brain have been hypothesized to explain the positive influence of physical fitness on academic performance, such as that physical activity increases brain blood flow, improves neuroelectric functionality, and stimulates the release of brain derived neurotropic activity that facilitates learning and maintains cognitive functions by improving synaptic plasticity. ¹¹	6.91; $P = .007$ and OR 4.25; 95% CI, 1.91-9.44; $P < .001$, respectively).	
Weston et al.	Physical activity and GPA: Results from a national sample of Black students	<i>Journal of Human Behavior in the Social Environment</i>	The purpose is to evaluate the relative impact of extracurricular activities, school attitudes, and the impact of demographics on the Personal Health and Physical Education Grade Point Average of over 1,000 Black high school students.	The data for this research came from the High School Longitudinal Study (HLSL), which the National Centre for Educational Statistics (NCES), a primary federal entity for collecting and analyzing data related to education, designed. The baseline survey was administered to 9 th grade students in 2009, and the sample size included 944 schools with over 23,000 students and their parents, school counselors, administrators, and teachers. The survey sampled public, private, and Catholic schools and randomly selected 9 th grade students from within each school. Follow-ups began in 2012 when the majority of the students would be in the 11 th grade. In 2013, high school transcripts were collected. Finally, the last follow-up occurred in 2016, when most students were three years into their post-secondary education phase, in which many students were either in college, employed, or had never attended college.	To investigate the effect of participating in physical activity on Phys Ed GPA, three models were employed, analyzed for all students, and then analyzed separately for male and female students. This analytic strategy resulted in nine models in total. The first domain of Extracurricular Activities included Participated in Sports (the main independent variable) and Hours Spent on Extracurricular Activities. The second domain is a series of school attitudes variables including Feels Safe at School and School Pride. The third domain introduces demographic variables such as Female, Urbanicity, South, Socioeconomic Status, Born in U.S.A. and Two Parent Household. Ultimately, these three models were analyzed again, first for female students only and then again for male students only, resulting in nine total models.	The results of the investigation indicated that physical activity (Participated in Sports, hours spent on extracurricular), socioeconomic status, related factors (urbanicity, regionality, Two Parent Household, and Born in USA), school attitudes (Feels Safe in School and School Pride), and gender influenced GPA in personal health and physical education.	Full article: Physical activity and GPA: Results from a national sample of Black students (oclc.org)

<p>Finn et al</p>	<p>School Engagement in Relation to Body Mass Index and School Achievement in a High-School Age Sample</p>	<p><i>Journal of Obesity</i></p>	<p>. Research has documented an inverse relationship between body mass index (BMI) and school achievement but has failed to empirically explain it</p>	<p>Method 2.1. Participants. A sample of 196 students from a large suburban high school in the northeast were included in the present study. Once the study gained approval from the Internal Review Board from Canisius College, participants completed surveys during three separate periods of a health class during the school day. Most (95%) of the participants were in grade 9 (average age 14.65). The sample was evenly split between males (47%) and females (53%). About 70% of the respondents reported race as white, 15% as African American, 6% Hispanic, and 9% other.</p>	<p>2.3. Data Analysis. Because obesity and school achievement are often associated with demographic characteristics, mediation analyses controlled for gender and race [7, 32]. The purpose of the present study was to examine whether engagement in school can be used to explain the link between obesity and achievement among adolescents. Specifically, regression analysis was used to test whether this relationship was mediated by three different indicators of school engagement.</p>	<p>3.1. Descriptives. Descriptive statistics and correlation coefficients for the sample are given in Table 1. Gender was not significantly correlated with any of the other variables. Race was significantly correlated with both BMI and GPA; lower BMI and higher GPA were more typically associated with white students. Greater classroom participation and less presenteeism were also more likely among white students. Race was unrelated to level of school identification. Average student BMI for the sample was 22.84. The average BMI breakdown by gender and race was 22.7 for males, 22.9 for females, 22.1 for white, and 24.3 for nonwhite. As expected, the inverse correlation between BMI and GPA was statistically significant ($r = -0.17, p = 0.019$) for the entire sample. The correlations further reveal important relationships for the three engagement measures.</p>	<p>School Engagement in Relation to Body Mass Index and School Achievement in a High-School Age Sample - Document - Gale Academic OneFile (oclc.org)</p>
<p>Rajagopol et al</p>	<p>Association between school performance and body mass index</p>	<p><i>The</i></p>	<p>The purpose of this paper is to determine the relationship between grade point average and other factors, including: body mass index, exercise habits, and weight perception. Data</p>	<p>Data from School-Based Health Promotion Centers (SBHC) in one middle school in Central Kentucky were used for this study. The middle school serves a low-income population, as more than 80% of the student body qualifies for free and reduced lunch. Students in sixth, seventh, and eighth grades were screened at the SBHC for a variety of behaviors and lifestyle characteristics via the Perkins Adolescent Risk Screen (PARS). This screening included data on student exercise status, weight perception, and many other factors. Students were excluded if their parents did not give consent for the screening. Body Mass Index was calculated by dividing the student weight in kilograms by the height in square meters. Later, student grade point averages were obtained from the school and matched to the student's ID number. A Pearson product-moment correlation was conducted to determine the relationship between GPA</p>		<p>As GPA increased, BMI decreased. The relation between GPA and BMI was statistically significant ($r = -0.446, p < 0.01$). There were significant differences in GPA for all groups (see Table 1). In addition, those with a poor weight perception had significantly higher BMI's than those with a good weight perception ($t = -2.54, p < 0.05$).</p>	<p>Overall, a higher BMI tends to be associated with a lower GPA. In addition, not exercising and poor weight perception also seem to be associated with lower academic performance.</p> <p>Association between school performance and body mass index: EBSCOhost (oclc.org)</p>

				and BMI. T-tests were used to determine if there were significant differences in GPA depending upon BMI category overall and for male and female students separately. T-tests were also used to determine if there was a significant different in BMI and GPA depending on a student's level of risk for weight perception and exercise.			
Al Hammadi et al	Differences in educational attainment between obese and non-obese Kuwaiti female university students	<i>Journal of Nutritional Science</i>	The present study aimed to test whether academic attainment differed between female undergraduates with obesity (defined by body mass index (BMI)), and those who were non-obese in Kuwait, a country with very high obesity prevalence.	The present study recruited a convenience sample of first- and second-year Kuwaiti University College of Social Science students between March and May 2019. Sampling and recruitment have been described in detail elsewhere ²¹ . In brief, all first- and second-year Social Science undergraduates were invited to take part by the researcher. Students were considered suitable for inclusion if they were female, Kuwaiti nationals, <20-0 years of age and did not have any condition or illness which would have altered their weight status (e.g. pregnancy and long bone fracture). Students were excluded if they were male, non-Kuwaiti nationals, 20-0 years or older and had any condition or illness affecting their weight status, or reported any other chronic disease. The aim of these inclusion and exclusion criteria was to provide a relatively homogenous sample, and one which was relatively free of a number of potential confounders (e.g. non-Kuwaiti nationality and age). Of the 2169 students contacted, 525 expressed an interest and 400 of these were eligible and were entered into the study. All participants gave informed written consent to participation, and the study was approved by the University of Strathclyde Psychological and Health Sciences Ethics Committee.	Data were analysed with SPSS version 26 (IBM Corp., Armonk, NY, USA) and Medcalc (Belgium). The data were tested for normality, and summary data were described as mean (standard deviation (SD)) or median (range) depending on the distribution of variables which was assessed by plots of the data and D'Agostino–Pearson tests in MedCalc. We compared the GPA between students categorised as obese by the BMI versus those considered non-obese by the BMI using two-sample <i>t</i> -tests. We also compared the percentage with obesity among the GPA quartiles using both χ^2 tests and calculated odds ratios for risk of being in the lowest GPA quartile by obesity. <i>P</i> -values of <0.05 were used to indicate statistical significance. The power of the present study was difficult to assess at the outset, and the power was fixed as this was part of a wider study of the ability of BMI to identify excessive fatness among female Kuwaiti adolescents ²¹ .	The present study found that undergraduates with BMI-defined obesity had poorer overall academic attainment than those who did not have obesity, and this difference could not be explained by socio-economic status.	Differences in educational attainment between obese and non-obese Kuwaiti female university students Journal of Nutritional Science Cambridge Core

