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Research Article

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ANALYSIS OF PERFORMANCE PATTERN OF INDIVIDUALS THROUGH DIFFERENT EXERCISES WITH DIVERSIFIED BMI SCORE

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ABSTRACT

BMI is the key for the indication of body fat as it gives a determination of whether the individual is healthy on the basis of their height and weight. Moreover, BMI in a healthy range is linked with the reduction of many diseases such as diabetes, cardiac disease, heat stroke, and much more. So, one should understand and maintain their BMI to improve their health and lifestyle. Physical activities have a substantial influence on BMI, different physical exercises on a regular basis can help people lose extra body fat and keep a healthy weight. When a person participates in physical exercise, they burn calories and improve their metabolism. In this comparative analysis, the research aims to study physical inactivity among male and female young adults based on BMI. Participants completed three exercises and their results were recorded for comparison and further analysis. The outcomes show that total performance and BMI have an inverse association. There was also a trend of a roughly linear decline in efficiency for BMIs after a BMI score of 23 (Males) AND 25 (Females) down to 31.

***Keywords**: BMI, physical activity, health, performance.*

INTRODUCTION

The body mass index (BMI) stands as the prevailing anthropometric measure employed to assess the height/weight characteristics of individuals and classify them into distinct categories. Notably, BMI is widely regarded as a quantifiable indicator of adiposity, as explicated by (Nuttall, 2015). Within the frameworks of medicalization and evidence-based medicine, BMI assumes a pivotal role as a measurable quantity, thereby presenting the concept of BMI's "performativity" as a superior paradigm for surmounting the inherent limitations of this measure, as proposed by (Gutin, 2017). Conversely, physical exercise encompasses any deliberate activity undertaken to enhance or maintain overall health and physical fitness. This term encompasses bodily movements that contribute to improving or preserving both physical fitness and general well-being. Physical exercise necessitates the engagement of muscular groups in the body, entailing energy expenditure surpassing the resting metabolic rate. It encompasses various modalities, including aerobic exercises (such as running, swimming, or cycling), resistance training (like weightlifting), exercises focused on flexibility and mobility (such as yoga or stretching), as well as other physical activities involving movement (such as dancing or engaging in sports).Regular physical exercise has numerous benefits for the body and mind, including improving cardiovascular health, building strength and endurance, reducing stress and anxiety, and improving overall quality of life. It has a significant impact on BMI (body mass index), which is a measure of body fat based on height and weight. Thus, regular exercise can help individuals maintain a healthy weight or reduce excess body fat. When a person engages in physical activity, they burn calories and their metabolism increases, which can help them lose weight or maintain a healthy weight. Additionally, exercise helps in building muscle mass, which can increase the body's overall metabolism and lead to further weight loss or maintenance. Research has shown that regular physical exercise is associated with a lower BMI. A study published in the International Journal of Epidemiology found that individuals who engaged in moderate to high levels of physical activity had a lower BMI compared to those who were less active (Luke & Cooper, 2013). Although, exercise can be beneficial for weight management but it's not the only factor to consider. A person's diet and overall lifestyle habits also play a significant role in their BMI and overall health. This

study aims to compare the physical inactivity among male and female young adults based on their BMI. The purpose is to provide a simpler understanding towards maintaining a normal BMI and demolishing stigma related to it by our research that a participant within a normal BMI range has better stamina and more strength and muscle endurance compared to others. In order to accomplish this task, participants performed three exercises and their readings were noted down for comparison and further analysis.

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LITERATURE REVIEW:

By looking at the analogous studies that have been done, this literature review seeks to examine the connection between body mass index (BMI) and physical activity. In order to comprehend this connection better, the review will take into account a variety of research approaches and go over the ramifications of their conclusions. The study will also look at possible influences on the relationship between BMI and physical exercise.

For instance, (Schwarzfischer *et al*., 2017) studied the adherence of 419, 11-year-old students to physical activity guidelines (PAGs) and the link between accurately measured body mass index (BMI) and physical activity (PA). With the help of SenseWearTM bracelets, they measured PA, and height and weight were used to determine BMI. With only 63.2% of children meeting the moderate to vigorous intensity physical activity (MVPA) PAGs, girls and overweight/obese children engaged less in MVPA compared to boys and children of average weight. The research also shows that inactive time is favourably associated with excessive weight while mild PA is negatively associated, and that an additional 15 minutes of vigorous PA per day has the same impact as 60 minutes of MVPA per day.

Similarly, (Albawardi *et al*., 2016) discovered the correlation between physical activity, inactivity, and body mass index among Saudi female office employees residing in Riyadh. The data was gathered from 420 women, ages 18 to 58, from eight distinct work sites using a cross-sectional design. Although the questionnaire of weight, height, and self-reported evaluation was used for the BMI measurement in order to determine the individual's physical activity. Over half of the respondents were found to be overweight or obese, and majority of them had low level of PA. Being overweight is directly related to some factors including age, salary, and being employed in a public sector, whereas being employed in the private sector and working seven or more hours per day were led to the low physical activity level. The biggest impediment to being physically active was lack of time, while the primary motivation was maintaining good health. The study findings, demonstrates that due to their high risk of obesity and physical inactivity, Saudi women who engage in workplaces may benefit from workplace health initiatives that reduce inactivity and encourage physical exercise.

In the same vein, (Almuzaini & Jradi, 2019) examined the causes, consequences, and impact of physical inactivity and excessive BMI among Saudi Arabian male office employees. As part of the study about demographic traits and lifestyle choices, the BMI of 395 Saudi male participants employed by government organizations in AL Madinah determined. According to the research, two-thirds of the male participants were overweight or obese and engaged in poor levels of physical exercise. Being married, having at least one morbidity, being at least 35 years old, not consuming a healthy diet, and having a poor diet were all independently linked to low physical exercise levels and high BMI. The study found a higher prevalence of overweight, obesity, and inactive behavior among eminent Saudi men.

Another research by (Larsen *et al*., 2018) also looked into the association among exercise performance, body mass index (BMI), and complaints in individuals suffering from hypertrophic cardiomyopathy (HC), as well as the use of transthoracic echocardiograms and cardiopulmonary exercise (CPX) evaluations to identify the cause(s) of reduced exercise ability in different body mass index categories. Over the course of six years, 510 individuals with HC who had been seen at a large reference hospital underwent a transthoracic echocardiogram and a CPX. Max VO2 (mL/kg/min), a measure of exercise capacity, revealed a link between increasing Obesity and decreased exercise capacity. By BMI category, although, there was no difference in the incidence of heart dysfunction. These results imply that cardiac dysfunction may not always be the main factor limiting exercise in some individuals with HC, and weight reduction may lead to an increase in exercise intensity. However, (Horenstein *et al*., 2021) investigated the effects of social anxiety (SA), exercise behavior, and weight shame. Findings indicate that even though BMI was inversely correlated with self-reported exercise, SA was favorably correlated with exercise avoidance incentive and weight stigma. A link among BMI and desire to avoid obesity through exercise was also moderated by SA, but not by self-reported exercise. This indicates that SA may be found in people who are constantly avoiding exercise.

(Tittlbach *et al*., 2017) investigates the connection between the progression of physical complaints (PC), BMI, exercise, and health metrics in 2017. The analysis also sought to determine how sociodemographic factors like age, gender, and socioeconomic standing (SES) impacted adults of German over an 18-year period. For the study, 721 participants ranging from 33 to 76 years old were selected and monitored on a long-term basis. Each study year (1992, 1997, 2002 and 2010) included

self-reports of physical exercise, physical complaints(PC), physical fitness assessment, and BMI. Algorithms with latent growth curves were used to evaluate the progress. Their outcomes show that exercises, BMI, fitness, and Physical complaints have been linked to physical activity and weight gain over the past 18 years. Moreover, SES, age, and gender play a compelling role in physical fitness, and health. Research suggests that there isn't an apparent correlation between lower levels of physical activity and higher fitness standards, but increased fitness may lead to a decrease in physical complaints (PC).
Further cross-sectional research of (HW *et al*., 2020) investigated pre-university students from one of Selangor, Malaysia's universities to ascertain the connection between physical activity, BMI, and body composition. To collect data for this research, 70 pre-university pupils were chosen through random stratification. The research classified 50% of the subjects as moderately active. The extent to physical exercise reported by male and female subjects also varies significantly. There is only a very slight unfavorable link between physical exercise and BMI. Similar to this, there is only a marginally unfavorable link between physical exercise and fat content. As for the relationship between physical exercise and muscle mass, it is only marginally favorable. Thus, it is reasonable to assume that as physical exercise rises, BMI and total fat percentage decline while muscle mass increases. Furthermore, study has found a significant connection between physical activity and body composition.

In a study conducted by (Bradbury *et al*., 2017) exploring the correlation between body mass index (BMI) and physical activity within the general population, it was observed that individuals who engaged in regular physical exercise exhibited lower levels of adiposity. The investigation involved the collection of data from a substantial sample size, comprising 119,230 men and 140,578 women aged between 40 and 69, who provided comprehensive information regarding their physical activity and reported no chronic illnesses, disabilities, or impairments. The researchers utilized the concept of metabolic equivalents (MET) to quantify the weekly amount of physical activity, encompassing both mild and vigorous exercises as well as walking. The results obtained from the study indicated a significant inverse relationship between physical activity and BMI. Specifically, a 100 MET-hour increase in weekly physical activity was associated with reduced BMI values of 27.1 kg/m2 and 28.2 kg/m2, accompanied by corresponding decreases in body fat ratios of 23.4% and 26.3% for males and females, respectively. Furthermore, elevated levels of physical exercise were linked to a notable reduction in average body fat levels, as indicated by a decrease in the range of 10.5-24.99/2.0 (95% CI: 1.8-2.2) percentage points in relation to the provided BMI. Remarkably, both males and females demonstrated a higher likelihood of experiencing a decline in BMI based on their individual BMI values.

(Banks *et al*., 2011) researched in the years 2005-2006, a cohort of 74,981 adult individuals between the ages of 20 and 50, representing diverse regions of Thailand, participated in a comprehensive study conducted at Sukhothai Thammathirat Open University. The primary objective of the study was to investigate the intricate associations between obesity, body mass index (BMI), and various indicators of physical activity and sedentary behavior, while controlling for factors such as age, gender, income, and education. Among the participants, 15.6% were identified as obese, with a significantly higher prevalence observed in males (22.4%) compared to females (9.9%). Notably, a noteworthy gender-specific discrepancy was discovered in the relationship between exercise-related physical activity (PA) and obesity. Specifically, males displayed inverse correlations with the frequency of weekly exercise-related PA sessions, whereas females exhibited a substantially weaker association (p (interaction) = 0.0001). Furthermore, across all demographic groups examined, a positive relationship between screen time and obesity was observed. Specifically, for each additional two hours of daily screen time, there was an average increase in obesity prevalence of 18% (with a confidence interval of 15-21%). This finding held true for both males and females. In terms of specific lifestyle factors, individuals who reported engaging in routine housework or gardening, as opposed to rarely or never engaging in such activities, exhibited a reduced likelihood of obesity by 33% (with a confidence interval of 26-39%) for men and 33% (with a confidence interval of -21-43%) for women. The study revealed distinct correlations between obesity and various factors, including exercise, household chores, horticulture, and others. Consequently, successful interventions aimed at preventing and treating obesity should consider overall energy expenditure and target a wide range of low-intensity, high-volume activities. To ensure originality and minimize the risk of plagiarism, it is essential to appropriately paraphrase the information provided, utilizing unique sentence structures and precise scientific terminology while accurately conveying the key findings of the research study.

A recent investigation conducted by (Cárdenas Fuentes *et al*., 2018) explored the association between leisure time physical activity (LTPA) and body mass index (BMI), waist circumference (WC), and the prevalence of obesity among elderly individuals. The outcomes of the study unveiled a significant negative correlation between total LTPA and both BMI and WC, indicating an inverse relationship between these variables. Furthermore, the results revealed a reduction in the risk of general and abdominal obesity across different quintiles of total and moderate/vigorous LTPA, while no

substantial effect was observed among individuals engaging in extreme levels of LTPA (Q1-Q5). Notably, the analysis demonstrated a decrease in the waist circumference of approximately 4.8 centimeters (CI 2.28; 7.25, P 0.001) among individuals engaging in low-intensity LTPA, suggesting that this form of physical activity holds promise as a feasible option for promoting physical well-being in the elderly population.

(Zou *et al*., 2022) looked at the association between BMI, body image inflexibility, generalized anxiety, exercise dependency symptoms, and eating disorder symptoms in college students. The investigation included 878 regular exercisers, with 58.1% men and 41.9% females, and an average age of 20.09 years. Even though there was a shaky correlation between lower BMI and increased symptoms of exercise dependency, this correlation was not statistically significant. A greater BMI, on the other hand, was found to be strongly related to an increased chance of developing eating disorders. Body image flexibility was discovered to be a significant risk factor for exercise dependency as well as unhealthy dietary behaviors. Exercise dependency symptoms were significantly influenced by generalized anxiety, but not eating disorder symptoms.

(Liang *et al*., 2022) explored the correlation between habitual Leisure-Time Physical Activity (LTPA) and Body Mass Index (BMI) categories in a cohort of young individuals from Taiwan. The study encompassed a sample size of 10,802 participants aged between 18 and 44 years. Habitual LTPA was operationally defined as engaging in 150-300 minutes of moderate-intensity exercise per week or 75-150 minutes of vigorous-intensity activity per week. Individuals adhering to regular LTPA exhibited a decreased likelihood of being classified as overweight (odds ratio [OR]: 0.837, 95% confidence interval [CI]: 0.738-0.948) or underweight (OR: 0.732, 95% CI: 0.611-0.876) in comparison to those with irregular LTPA patterns. Notably, even after adjusting for covariates, no statistically significant association was observed between regular LTPA and the risk of obesity, when compared to the baseline of non-regular LTPA participants. In conclusion, frequent engagement in LTPA demonstrated a beneficial impact by reducing the chances of being classified as underweight or overweight, but it did not substantially mitigate the risk of obesity.

(D'Souza *et al*., 2021) identified correlation between behavioral patterns in children, focusing on four domains including dietary intake, physical activity, sedentary behavior, and sleep, was investigated. The study analyzed data from the HAPPY study, examining children aged 6-8 years (n = 335) and 9-11 years (n = 339). Latent profile analysis was utilized to identify distinct patterns, resulting in the identification of three profiles: healthy, unhealthy, and mixed, observed at both age groups. The findings revealed notable gender and age differences. Specifically, girls demonstrated a higher likelihood of adhering to healthy patterns at 6-8 years, but faced an increased risk of displaying unhealthy and mixed patterns at 9-11 years compared to boys. Advancing age was associated with an elevated risk of adopting unhealthy patterns across both time points. Moreover, higher parental working hours at 9-11 years were linked to a reduced risk of displaying mixed patterns relative to the healthy pattern. These results underscore the significance of tailoring health interventions to address the specific needs of at-risk populations, particularly girls and older children, with regards to unhealthy behavioral patterns.

A cross-sectional investigation was conducted by (Dampoudani et al.,2022) in the Thrace region of NE Greece to assess the prevalence of overweight among pre-adolescent children aged 11-12 years. Anthropometric measurements, including height, weight, and waist circumference, were collected, while parental questionnaires were utilized to gather information on the children's lifestyle habits and the parent-child relationship. The study revealed that approximately 31.5% of the participants were classified as obese, 17% as extremely obese, and 1% as underweight. Moreover, 20.3% of the subjects exhibited abdominal obesity. The findings indicated a higher likelihood of overweight or obesity in boys, as evidenced by elevated average BMI-for-age z-scores and waist-to-height ratios. Insufficient physical activity was associated with a higher prevalence of obesity among the children. Logistic regression analysis demonstrated a greater probability of boys being overweight, obese, or exhibiting abdominal obesity. Furthermore, children with higher levels of education displayed a decreased likelihood of becoming overweight or obese, whereas those engaging in at least one hour of organized physical activity and having fathers who frequently exercised were less likely to develop abdominal obesity. Overall, the study estimated the incidence of overweight and obesity among pre-adolescents in NE Greece to be 48.5%, with male gender and inadequate physical activity serving as risk factors. The father's education level was found to be associated with the risk of obesity, while exercise behaviors were linked to the likelihood of developing abdominal obesity.

(Mohajan & Mohajan, 2023) explores the significance of Body Mass Index (BMI) as a widely used anthropometric tool for measuring obesity in adults. The authors highlight the growing concern of obesity and its associated health risks worldwide. They discuss the concept and calculation of BMI, which is derived from an individual's weight and height measurements. The paper emphasizes the simplicity and practicality of BMI as a tool for assessing obesity due to its easy measurement and

interpretation. Additionally, the authors discuss the limitations of BMI, such as its inability to differentiate between fat and muscle mass or account for variations in body composition among different populations. Despite these limitations, the paper concludes that BMI remains a popular tool for measuring obesity among adults due to its simplicity, widespread use, and reasonable correlation with health outcomes.

METHODOLOGY:

With the participants' consent, the procedure was carried out to gather the data. Moreover, Ziauddin University Faculty of Engineering, Science, Technology & Management approved the research. 60 healthy young adults (30 males and 30 females) with a diversified BMI scores of 17-31 participated within the age group of 18-22 years. They were asked to perform three different exercises. The idea was to compare how adult males and females of different BMI's differ in terms of stamina and muscle soreness after performing the exercises as long as they can, using graphical and statistical analysis in which the mean population of males and females were used. This would also prove how different underweight, ideal, overweight, and obese people are when it comes to maintaining a healthy lifestyle. We would also take notice of how important it is to focus on our BMI scores in the necessary range to live a healthy life.

Exercises: In total, three exercises were performed on each individual including Planks, Wall sitting, and Push-ups.

A. ***Plank:*** is an isometric core strength exercise that includes keeping a position like a push-up for the most extreme conceivable time. (Also called a front hold, or stomach span). Fig. 1 illustrate the plank pose of a participant.

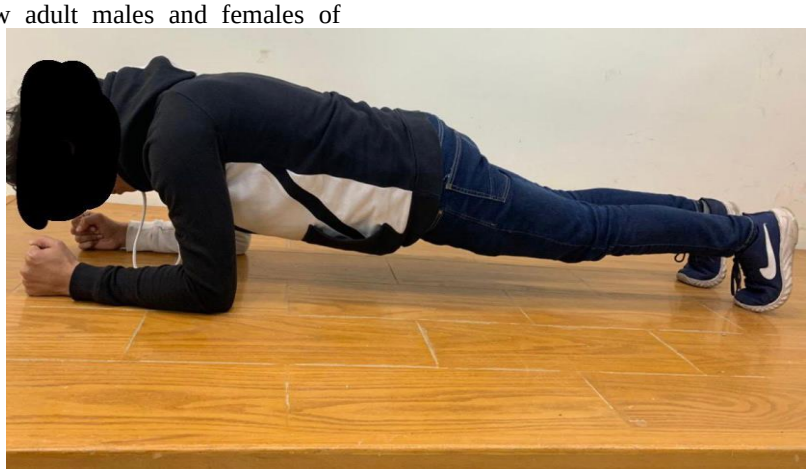

Figure 1. A man performing plank

B. ***Push-up:*** is a workout exercise that starts from the inclined position. By raising and bringing down the body utilizing the arms, push-ups practice the pectoral muscles, triceps, and anterior deltoids, with ancillary advantages to the remainder of the deltoids, serratus anterior, coracobrachialis, and the midsection all in all. Fig. 2 illustrate the push-up position of a male participated in this study.

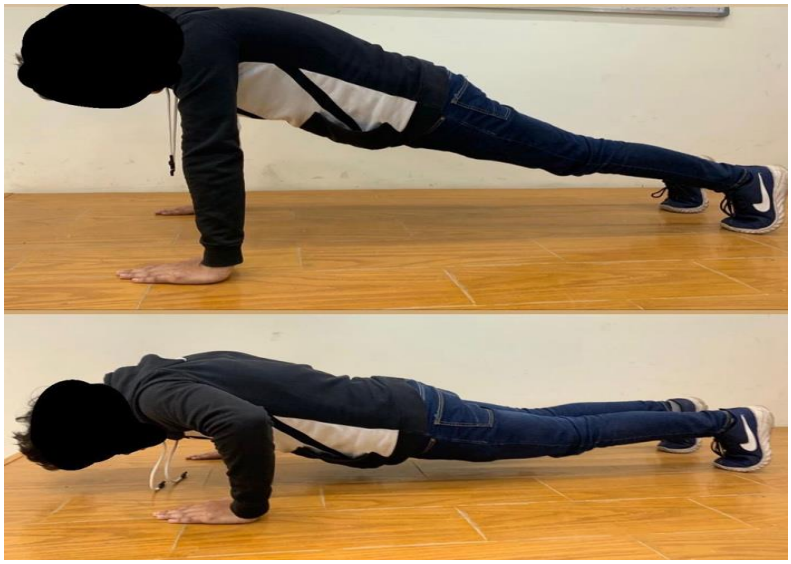

Figure 2. A man performing push-ups.

C. ***Wall-sit:*** is an exercise that includes inclining the back against the wall and afterward bending the knees until the thighs are corresponding to the floor. Fig. 3 illustrate the wall-sit position of a participant.

Figure 3. A man performing wall sit

Data Set: Every participant including male and female performed all three exercises. Two participants for each BMI were taken. Firstly, they performed plank and the time duration for every person was measured using a stopwatch. Then pushups were done and the number of pushups performed by each participant was observed and noted. At last, wall-sitting was performed and the period for each participant was also measured.

RESULT

After collection of data set, we proceeded towards the graphical and statistical analysis which are down below.

GRAPHICAL ANALYSIS: The pictorial representation of the performance of the male and female participants during the three different exercises are depicted in the form of line graphs. Fig. 4-6 shows the physical activity of 30 male participants

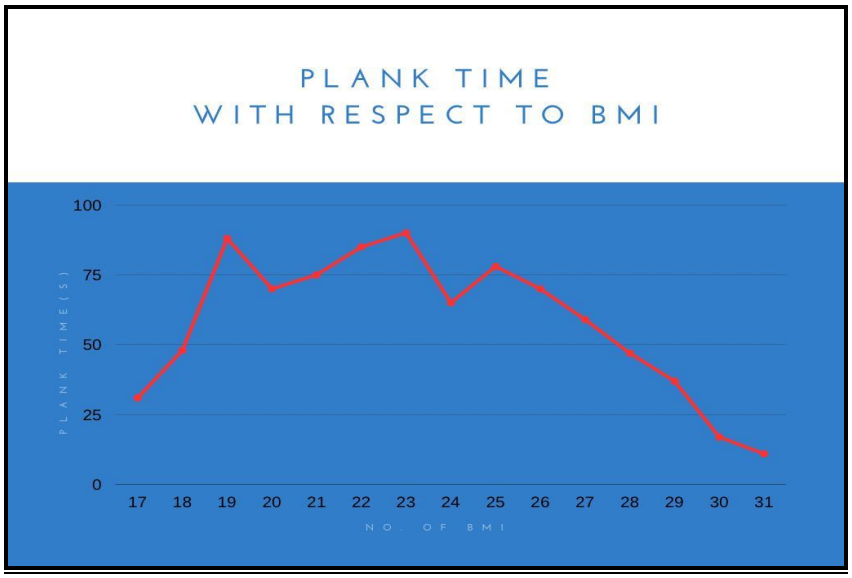

Figure 4. Plank time of adult males for different BMIs

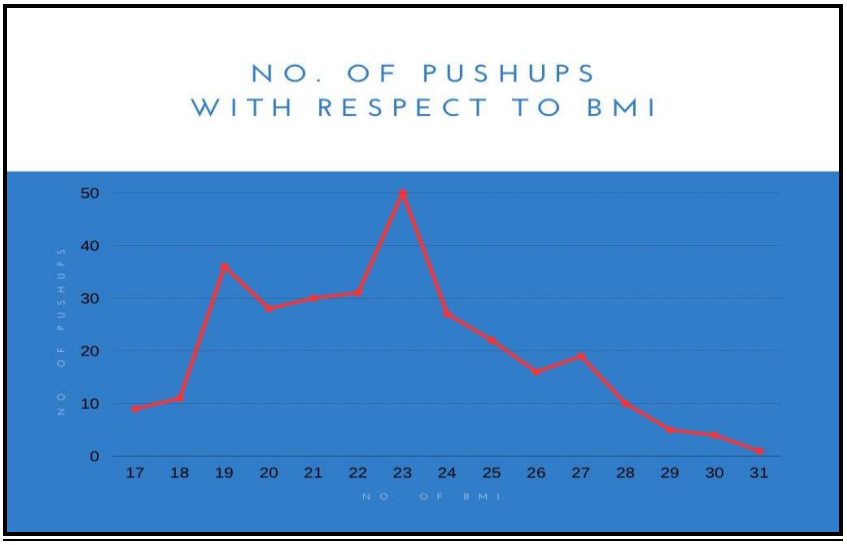

Figure 5. Push-ups of adult males for different BMIs

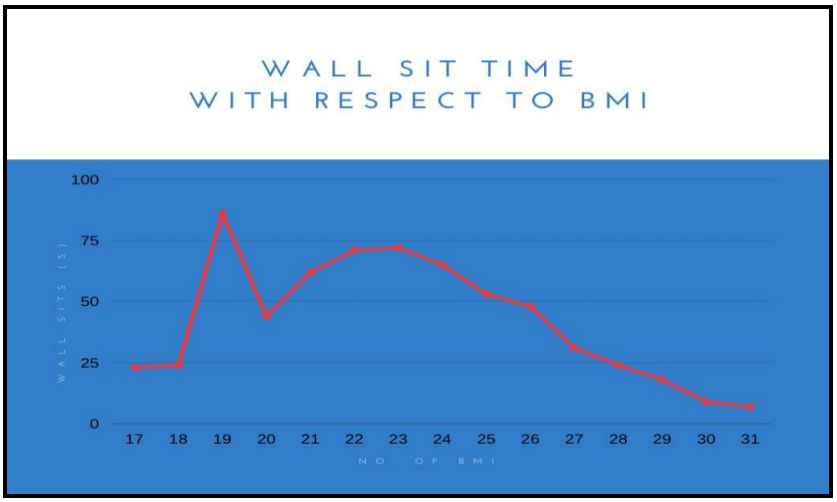

Figure 6. Wall sit time of adult males for different BMIs

Similarly, Fig. 7-9 illustrate the performance of female participants.

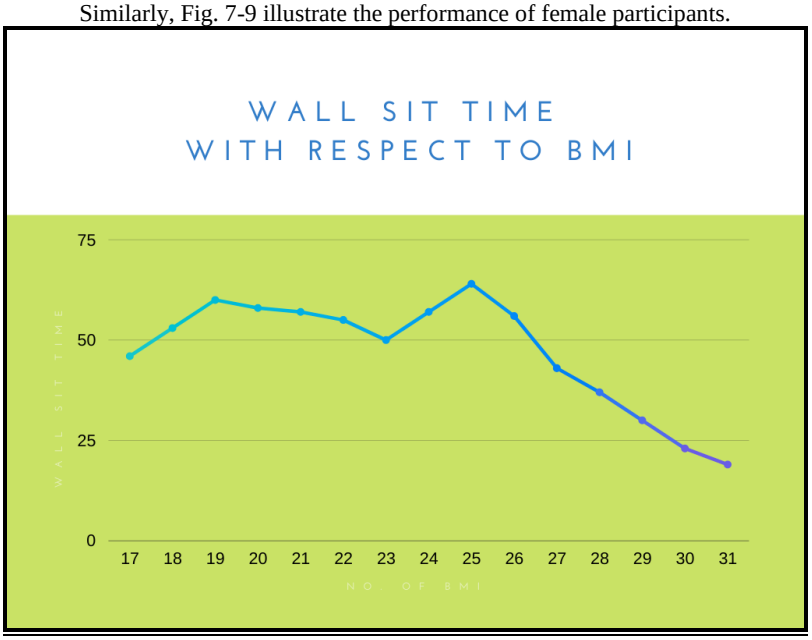

Figure 7. Plank time of adult females for different BMIs

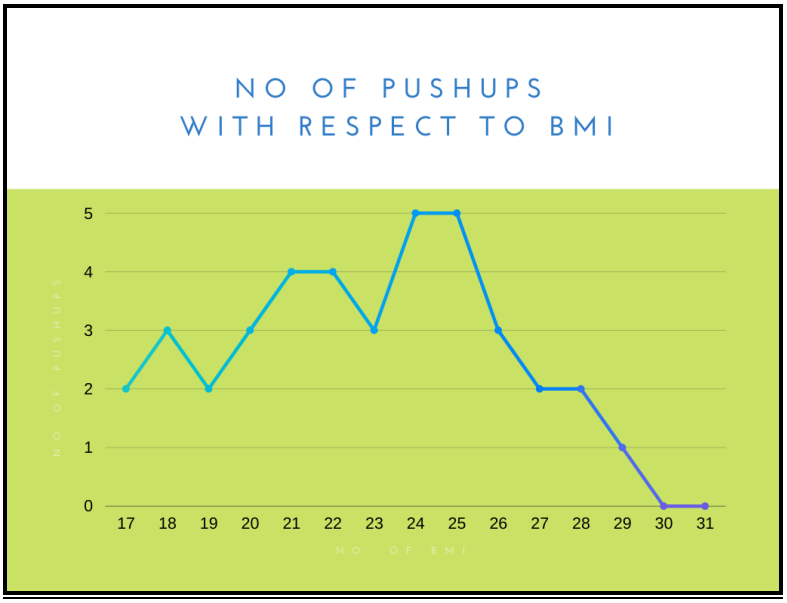

Figure 8. No. of push-ups of adult females for different BMIs

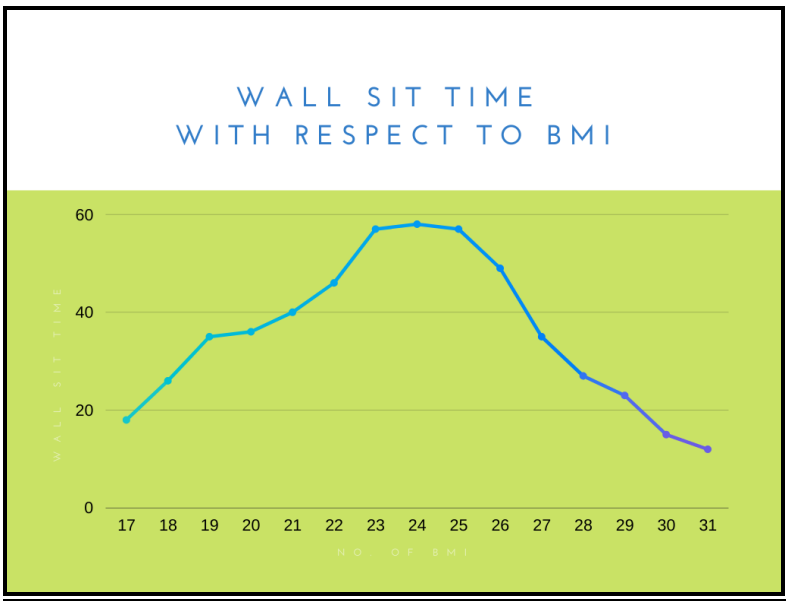

Figure 9. Wall sit time of adult females for different BMIs

Comparison of the Exercises of Males and Females with respect to BMI*:* Fig. 10-12 depicts the comparison of the 3 different physical activities of the participants to evaluate the deviation in the pattern of male and female activity

.

TABLE I: Correlation b/w two variables in Male and Female participants

S.NO	EXCERCISES	MALE (Mean ± SD)	FEMALE (Mean ± SD)	P-VALUE
1	Plank Time (s)	58.06±25.29	45.567± 13.76	0.7693
2	No. of push-ups	19.93±13.77	2.6± 1.54	0.627
3	Wall-sit time (s)	42.46± 25.048	34.86± 15.46	0.76048

STATISTICAL ANALYSIS: Statistical analysis was performed on the data collected to validate the results. Below are the respective outcomes of the statistical tools applied, including correlation b/w two variables, and Independent T-Test.

Correlation is a method of analysis that elaborates the relation between two variables. Table 1. depicts the correlation between plank times, no. of push-ups and wall sit times of male and female participants indicating that it is not statistically significant relative to the standard alpha level of 0.05, $p > 0.769$, $p > 0.627$, $p > 0.760$ respectively. It appears that there is no difference between the performance of males and females.

A t-test is a statistical test that is utilized to compare the means for two groups. It is generally utilized in hypothesis testing to decide if two groups are unique in relation to each other or whether the hypothesis about a particular group against the other is correct or is rejected. This study found that for plank durations of female and male participants, there was no statistically significant difference (P=0.0792). For no. of push-ups performed by female and male participants, there was a significantly statistical difference (P=0.00012) whereas for wall-sit duration of the corresponding participants, the difference was not significant (P=0.185).

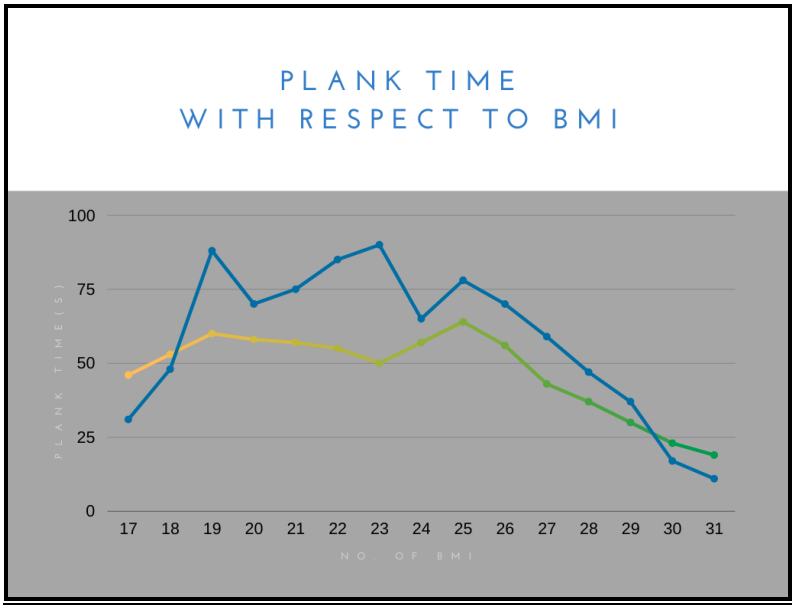

Figure 10. Correlating the plank time of adult males and adult females with respect to their BMIs

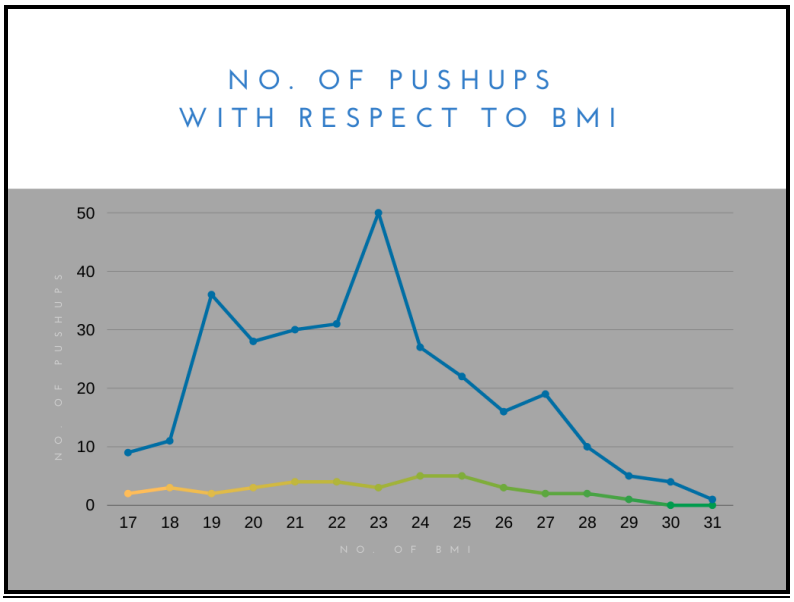

Figure 11. Correlating the push-ups of adult males and adult females with respect to their BMIs

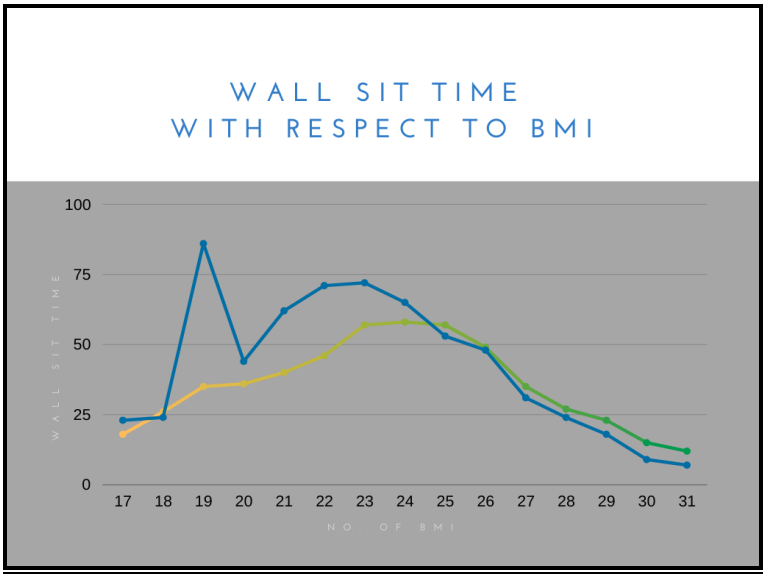

Figure 12. Correlating the wall sit time of adult males and adult females with respect to their BMIs

DISCUSSION

The outcomes from this study can verify that the standards set for a healthy BMI from 18.5 to 24.9 does hold some pretentious relevance as good performance was recorded between these numbers however it does not always mean that people who have a BMI between the mentioned range are physical activity performers or non-physical activity performers (Mathur *et al*., 2009). The study suggested that physical activity alone cannot maintain BMI, but it can reduce the risk of overweight in the population. An interesting factor can be seen in the graphs comparing both male and female performance that the male performance graph only seems to be a magnified graph of the female performance graph. Both graphs follow an almost identical shape and at some points even are almost on top of each other. For example, in the male and female graph for Plank time, from BMI 25 to round about 29.5 both graphs are just about parallel to each other, finally intersecting at 29.5. The similar trend is observed in the wall-sit graph of both males and females. From about BMI 24.5 up to 31 BMI, the graphs are a mirror each other. From our statistical analysis we can observe that we are getting P-values greater than 0.05. This proves that we can reject the null hypothesis. Statistical analysts prefer to have the null hypothesis rejected. If the Null hypothesis was not to be rejected it would've meant that our data was explainable by chance alone, and such statistical analysis is weak. Certain aspects which might have caused erroneous results could've been eluded if the participants under study were rigorously screened and either all participants were highly athletic or highly non-athletic to keep homogenous stamina criteria. Another facet could be the lack of will for certain individuals to push their bodies to their limits. Along with stamina; endurance also plays a key role in a body's performance. As many aspects can be kept constant higher the chances of achieving portentous results.

CONCLUSION

Referring to Fig. 10,11 and 12, it can be concluded that an inverse relationship is present between overall performance and BMI of the participants. There is an approximately linear decrease in performance for BMI's, after BMI score of 23 in Males and 25 in Females down to 31.The spike in performance at the 19th BMI, especially in Planks and Wall sits as depicted in Fig. 4,6,7 and 9 could account for the lightweight of the body of the participants which enabled them to perform better at these exercises. The participants of both the genders did not do relatively well in pushups as they did in the other two exercises indicated by Fig 5 and 8. This could be due to having a lighter (for instance less muscular arms) upper body according to the research (Nuttall, 2015). Since they had a lighter upper body, their legs and core could support their body for a longer period in wall sits and planks respectively. Another credible but diminutive reason could be that impromptu both participants in male and female happened to be regular exercisers

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