Exploring the Effect of Physical Activity Intensity on Enhancing the Individual's Weight Status (BMI) in the New York City

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Introduction

Obesity and overweight are the growing public health threat, which is a contributing factor to different health conditions including cardiovascular diseases, type 2 diabetes, chronic diseases, and cancer (Black et al., 2010; CDC, 2018; Prioreschi el al., 2017). The mortality of obesity-related diseases causes approximately 300,000 deaths per year (CDC, 2018). The prevalence of obesity in the U.S. is severe in all age groups. According to the CDC report in 2018, the adult obesity prevalence increased from 30.5% to 42.4% from 1999-2000 through 2017-2018 (CDC, 2018). In regard to the childhood obesity perspective, there was an increasing trend in all classes of childhood obesity from 1999 through 2014; specifically, 26.1% met criteria for obesity in 2013–2014 (Skinner, Perrin, & Skelton, 2016). Individual-level obesity becomes a health concern especially in urban cities like the New York City (NYC). Obesity rate showed a wide variation between boroughs in NYC from 6.8% to 31.7% due to the difference in socioeconomic status and the neighborhood poverty (Black et al., 2010).

BMI scale is a commonly used measure to estimate the individual's health condition based on the calculation using height and weight (Berglund, Lytsy, & Westerling, 2016; Prioreschi et al., 2017). If an individual’s BMI is equal to or higher than 30.0 (BMI≥30 kg/m2), they are in the obesity range and at an elevated risk of obesity-related diseases (Kruger et al., 2007). There are many contributing factors that fluctuate one’s BMI level from both social and individual perspectives, such as age, gender, race, nutritional intakes, physical activity, culture, etc. Physical activity is often employed BMI management strategy because of its effectiveness and convenience on weight control. Kruger et al. (2007) explored how physician activity would affect health-related quality of life and vary BMI levels in a national sample of adults. The study showed that physically active adults reported higher health-related quality of life compared to

inactive adults, and the BMI variation was not associated with the quality of life ($P<0.001$) (Kruger et al., 2007). This is evidence to show that physical activity is effective to enhance the health outcomes and the quality of life.

Engaging in appropriate physical activity is recommended as a weight-controlling strategy. According to Blalck et al. (2010), the availability of neighborhood resources was independently associated with obesity rate in the community, where decreased availability of fitness facilities were associated with higher risk of obesity. Findings reveal that opportunities to exercise in the neighborhood and residential land use may reduce the frequency of physical activities and therefore put the population at risk of obesity. Multiple attempts can be made to achieve physical activity, such as indoor/outdoor exercise, traveling to the workplace, and performing daily movements (Duncan et al., 2021). Among those, vigorous and moderate intensity physical activities are beneficial to improve one's overall health condition (Van Waart et al., 2015).

Despite the growth of the current literature, there are many aspects of physical activities and its influence on weight status that remains to be explored. Previous studies have suggested the possible association between physical activities and reduced body weight, but they did not present compelling evidence for the relationship between different intensity of physical activity and BMI variation. The purpose of this study was to address the gap in the literature by examining the effectiveness of vigorous activity and moderate activity on enhancing one's individual's BMI and weight status in NYC. The hypothesis was that NYC residents who participate in vigorous activity would display a healthier mean body weight (lower BMI), controlling for the individual level factors that may fluctuate the body weight. The adjusted variables are age, gender, and race. The findings would represent citywide estimates about

intensity of physical activity and its influence on BMI scale to suggest effective physical activity interventions and improvement for BMI management (NYC Health, n.d.).

Methods

Sample

Cross-sectional data were obtained from the NYC Health and Nutrition Examination Survey (NYC HANES) posted as publicly available datasets on the NYC Health website (NYC Health, n.d.). The survey included a probability sample of 1999 non-institutionalized adult New York City residents with a response rate of 55%. The NYC HANES is a population-based, cross-sectional study with data collected from a physical examination, clinical and laboratory tests, as well as a face-to-face interview and an audio computer-assisted self-interview (NYC Health, n.d.).

Measure

Multiple linear regression was conducted to examine the impact of the frequency of physical activity on the individual's BMI, controlling for the effect of age groups, gender, and race. BMI was the primary outcome variable. Predictors were four types of exercise intensity, including the frequency of walk/bicycling, moderate-intensive activity, vigorous-intensive activity, and muscle strengthening activity.

Analysis Strategy

Secondary data analysis was conducted using two sample t-tests to explore the association between the intensity of physical activity and the individual's BMI. Two sample t-test is an appropriate analysis method for this study because two independent, categorical groups are involved to predict a continuous outcome variable.

Dependent Variables

Individual's BMI levels in the survey were used as the dependent variable. BMI was ranged from 15.65 - 59.43 (kg/m**2). No out of range value was observed.

Independent Variable

Four types of exercise intensity over the past 30 days were considered as independent variables, including the frequency of walk/bicycling, moderate-intensive activity, vigorous-intensive activity, and muscle strengthening activity. Participants could indicate whether they have participated in a certain intensity activity (yes/no) or they are unable to do the activity. Since participants who indicated they were unable to exercise over the past 30 days do not reflect the interest of the study, they were classified as missing and excluded from the data analysis, which leaves 32 missing cases in the vigorous intensity group and 29 missing cases in the moderate intensity group.

Control Variables

Demographic variables were controlled to remain constant in the data analysis and adjust the effect of variables on the causal pathway. Age, gender, race and ethnicity were included as control variables because the previous literature has proven their association with BMI level variation. Participants would respond to the survey questions in regards to their demographic information.

Results

After missing values of exercise frequency have been removed, the dataset contained 349 observations that had meaningful values in 4 types of exercise frequency. Multiple linear regression was conducted to examine the impact of the frequency of physical activity on the individual's BMI, controlling for the effect of age groups, gender, and race. Data analysis method

was selected because multiple variables are used to predict a continuous outcome. The dependent variable was the participant's BMI which is collected through physical examination. The independent variables were the number of times participants walked or bicycled over the past 30 days, the number of times participants did vigorous activities over the past 30 days, the number of times participants did moderate activities over the past 30 days, and the number of times participants did strengthening activities over the past 30 days. Control variables were age groups, gender, and race. Participating in moderate-intensive activity would result in 0.356 times decrease in BMI ($p=0.024$). The number of times participants did muscle-strengthening activities over the past 30 days was negatively associated with the individual's BMI, which resulted in 0.046 times decrease in BMI ($p=0.0025$). The number of times participants did strengthening activities over the past 30 days was associated with the individual's BMI ($p=0.0059$). As participants attempted one additional strengthening activity, there was a 0.306 times decrease in BMI. There was an age difference in all exercise groups. People aged 20-29 had lower BMI on average whereas people aged over 60 had higher BMI on average ($p<0.0001$). Average BMI increased by 0.6 times as age increased by 10 units. Additionally, gender and racial differences existed in the study population. Females experienced a 1.52 times faster decline of BMI compared to male ($p=0.0056$). Non-hispanic white experienced the slowest decline rate of BMI whereas other hispanic experienced the fastest decline rate of BMI ($p=0.0021$). The rate of decline of BMI between racial groups are (low to high): non-hispanic white, non-hispanic black, non-hispanic asian, hispanic, and other hispanic, and the interval between every racial group is 0.68. Age group, race/ethnicity, the frequency of walking or bicycling, vigorous activities, and moderate activities were not significantly related to the individual's BMI in all groups. Results presented a statistical correlation between the individual's BMI and the frequency of exercises.

Discussion

Individual-level obesity becomes a health concern especially in urban cities like New York City. Understanding benefits of exercise intensity provides evidence for intervention design for weight control purposes. Findings suggest that physical activity is negatively associated with BMI, where moderate-intensive, vigorous-intensive, and muscle-strengthening activities are all effective for BMI control. Therefore, the study shows that participating in intensive exercises is beneficial for weight control. However, the findings of retrospective data review are limited by self-reported bias, and loss to follow up; therefore, further study should explore the effect of physical activity on the individual's BMI with the presence of other health indicators that influence weight status. Overall, findings represent citywide estimates for NYC about intensity of physical activity and its influence on BMI scale to suggest effective physical activity interventions and improvement for BMI management.

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Appendix

Characteristics		N (%) (n=1972)
Race/Ethnicity		
	Non-Hispanic White	30.89
	Non-Hispanic Black	21.60
	Non-Hispanic Asian	13.16
	Hispanic	32.93
	Non-Hispanic Other	1.42
Age Group		
	20 – 29	26.17
	30 – 39	22.82
	40 – 49	21.70
	50 – 59	15.42
	60+	13.89
Gender		
	Male	41.68
	Female	58.32

Table 1. Summary Table of Demographics

Predictors	Estimate	S.E.	P-value
# of walked or bicycled	1.074	0.299	P=0.0003
Age group	0.611	0.097	P<0.0001
Race/ethnicity	0.113	0.106	P=0.287
Gender	0.520	0.267	P=0.051

Table 2. Summary Table of Walk or Bicycled Activity

Predictors	Estimate	S.E.	P-value
# of moderate activity	-0.356	0.282	P=0.024
Age group	0.648	0.097	P<0.0001
Race/ethnicity	0.193	0.105	P=0.0663
Gender	0.485	0.268	P=0.070

Table 3. Summary Table of Moderate-intensive Activity

Predictors	Estimate	S.E.	P-value
# of vigorous activity	-0.149	0.276	P=0.063
Age group	0.633	0.100	P<0.0001
Race/ethnicity	0.185	0.104	P=0.078
Gender	0.469	0.269	P=0.082

Table 4. Summary Table of Vigorous-intensity Activity

Predictors	Estimate	S.E.	P-value
# of muscle-strengthen activity	-0.046	0.280	P=0.0025
Age group	0.595	0.098	P<0.0001
Race/ethnicity	0.150	0.105	P=0.153
Gender	0.424	0.268	P=0.113

Table 5. Summary Table of Muscle-strengthen Activity