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Original article

Respiratory Exchange Ratio in Obese and Non-obese Sedentary Indian Young Adults in Moderate- and Vigorous-intensity Exercise

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ABSTRACT

Introduction: Respiratory exchange ratio (RER) is the ratio between produced CO_2 and used O_2 for body metabolism. It indicates the type of fuel that is metabolized in the body. This study aimed to measure and compare the RER in non-obese and obese sedentary young adults in rest, moderate-intensity, and vigorous-intensity exercise.

Methods: This cross-sectional study was conducted with 23 non-obese and 24 obese sedentary young adults. Resting RER was measured with 12-h fasting after 15-min rest with an automated gas analyzer. Then, RER was measured during steady moderate-intensity and vigorous-intensity exercise on a cycle ergometer. RER was compared between males and females, non-obese and obese in resting, moderate-intensity, and vigorous-intensity exercise by *t*-test.

Results: The Mean age of the non-obese and obese groups was 19.35±1.11 and 19.79±0.78 years, respectively. Males showed higher RER (in resting and moderate-intensity exercise) than females. In comparison to non-obese group, the obese group showed higher RER in resting (0.802±0.018 versus 0.821±0.022, P=0.001), moderate-intensity exercise (0.812±0.013 versus 0.83±0.02, P<0.001), and vigorous-intensity exercise (0.853±0.43 versus 0.914±0.032, P<0.001). Concerning resting value, RER significantly increased during moderate- and vigorous-intensity exercise in both the non-obese and obese groups.

Conclusion: Obese young adults use relatively more carbohydrates as fuel than non-obese in both resting conditions and during exercise. When the intensity of exercise increased, both obese and non-obese showed higher RER which indicates that sedentary young adults use relatively more carbohydrates as fuel in the higher grade of exercise.

Keywords:
Adipose tissue
Carbohydrates
Diet
Obesity
Respiratory quotient
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Introduction

Respiratory exchange ratio (RER) is the ratio between produced CO_2 and used O_2 for body metabolism. Hence, it can be measured by the ratio of exhaled CO_2 and inhaled O_2. It indirectly indicates the relative consumption of carbohydrates and fats for energy production (Pendergast et al., 2000). The oxidation of carbohydrates generates an almost equal amount of CO_2 to inhaled O_2; hence, a ratio becomes around one (Gupta et al., 2017). When fat is predominantly oxidized, CO_2 production reduces; hence, the ratio becomes lower than one (Haugen et al., 2007).

The determinants of RER in resting conditions are different than during different grades of exercise. The resting RER primarily depends on the muscle fiber composition. In contrast, the RER in low-intensity exercise depends on the blood-borne substrate and in high-intensity exercise depends on the muscle substrate and the activity level of the enzyme (Goedecke et al., 2000). Coggan *et al.* studied six endurance-trained and untrained men and found that trained athletes use more fat (indicated by lower RER) during intense exercise than untrained men. The sources of these fats are from the adipose tissue and may also be from intramuscular triglyceride reserve (Coggan et al., 2000). In contrast, sedentary people show an increase in the RER (higher usage of carbohydrates) coupled with a decrease in insulin sensitivity and lower oxidative capacity of muscle (Smorawiński et al., 2001).

In both developed and developing countries, sedentary lifestyles and unhealthy food habits cause obesity across all age groups (Vilchis-Gil et al., 2015; Villareal et al., 2005). A higher RER in sedentary people indicates that the predominant fuel they use is carbohydrates (Rimbert et al., 2004; Schrauwen et al., 2002). Thus, fat accumulates in the body. A study by Hirsch *et al.* found that resting RER is similar (statistically non-significant higher values in the obese group) in obese and overweight males and females (Hirsch et al., 2016). Supporting this finding, Cavuoto *et al.* found that obese and non-obese have similar (statistically non-significant lower values in the obese group) RER in the rest (Cavuoto and Maikala, 2016).

There are conflicting results about the RER with exercise. Some of the studies suggest that there is reduced lipid oxidation in obese during exercise (Chatzinikolaou et al., 2008; Pérez-Martin et al., 2001). In contrast, Goodpaster *et al.* found higher lipid oxidation (lower RER) in obese during exercise (Goodpaster et al., 2002). Furthermore, Evidence is also available that substrate usage may be similar in the non-obese and obese groups during exercise (Geerling et al., 1994; Mittendorfer et al., 2004).

World Health Organization suggests that physical activity or exercise can be moderate-intensity and vigorous-intensity according to Metabolic Equivalents (METs) where moderate-intensity uses 3-6 MET and vigorous-intensity uses >6 MET. However, as MET measurement requires sophisticated instruments and settings, the pulse rate can reliably be used to quantify the intensity of the exercise where attainment of 50 – 70% and 71-85% of maximum achievable heart rate is considered moderate-intensity and vigorous-intensity exercise (Mayo Clinic; American Heart Association). The representation of fuel usage by RER depends on the level of exercise and it is affected by lactic acid accumulation. In our study, we used the criteria of heart rate of 71% - 85% for the attainment of vigorous aerobic exercise. Usually, the lactate starts accumulating in the body after the achievement of 85% of the maximum heart rate (Shen and Wen, 2019).

To the best of our knowledge, there is no literature about the RER in sedentary non-obese and obese young Indian adults in resting conditions and during exercise. Hence, our research question was to what extent sedentary young adults (both non-obese and obese) use carbohydrates and fats (as reflected by RER) for energy production in resting and during different grades of exercise.

Objective

This study aimed to measure the RER in non-obese and obese sedentary young adults in resting conditions and to measure RER in the same sample in moderate-intensity and vigorous-intensity exercise. Then, the RER would be compared in these two groups (non-obese and obese) in resting and in moderate- and vigorous-intensity exercise. The RER would also be compared between males and females.

Materials and methods

Ethics

This study was conducted with the ethical standard set by the WMA Declaration of Helsinki (updated in 2013).

This study was approved by the Institutional Ethics Committee (Ref: 07/IEC, dated 14/08/2019).

Study design

This cross-sectional observational study was conducted with two groups of research participants. One group had an acceptable range of body fat (male <25%, female <30% body fat) and another group was obese (male ≥25%, female ≥32% body fat). We compared the RER among these two groups in two grades of exercise.

Study size

After reviewing previously published literature, we took the study by Balci to be a reference study (Balcı, 2012). The author conducted a study on young men with a mean age of 21.4 ± 8 0.6 years. With the input of $\alpha = 0.05$, $\beta = 0.1$ (power of the study 90%), mean in first group = 0.89, mean in second group = 0.87 (hence, $E = 0.89 - 0.87 = 0.02$), standard deviation of outcome variable $S = 0.02$, and equal participants allocation in both groups ($q1 = q2 = 0.5$), the minimum sample was calculated (from the formula: $N = [(1/q1 + 1/q2)\, S^2\, (Z_\alpha + Z_\beta)^2] \div E^2$) to be 42. With an assumption of high dropout, we added 20% to the minimum sample size. Hence, the final sample size was 51. We aimed to add 26 to each group of normal-weight and obese groups.

Setting

This study was conducted in the research laboratory of the Department of Physiology. The college is situated in a coastal region with an elevation of 16 m. The study was conducted from September 2019 to February 2020.

Participants and recruitment

We recruited the research participants from undergraduate medical students. We first took a medical history of previous diseases and any current physical or mental condition that may hamper the exercise test. Then, we screened them with the Revised Physical Activity Readiness Questionnaire for eligibility to participate in the exercise (Adams, 1999). For identifying sedentary participants, we took a detailed history of their physical activity in the previous month. As there is no standard definition of sedentariness, we considered participants who do not do any exercise or play any outdoor games as sedentary (Magnon et al., 2018). Thus, we made an initial list of 150 volunteers (age group of 18-25 years) as a convenience sample from undergraduate medical students staying in the campus hostel. Then, we screened the participants with Body Mass Index (BMI) for Indians (Normal BMI: 18.0 - 22.99 kg/m^2, Overweight: 23.0 - 24.99 kg/m^2, Obesity: ≥25 kg/m^2) (Mahajan and Batra, 2018; Misra, 2009). Subjects with any acute physical or mental disease or disorder, or having any chronic diseases that may impair the musculoskeletal or cardiorespiratory systems were excluded. Any subject with a family history of cardiomyopathy, sudden death, heart valve defect, or ischemic heart disease was excluded as precautionary. Thus we created a list of 59 normal-BMI and 33 obese participants. The rest of the participants were excluded as they were either in lower than normal BMI or in the overweight group (Figure 1).

Each group of participants measured the body fat percentage after taking standard precautions for measurement of body fat by bioelectric impedance analysis (Mondal et al., 2019). We used Omron Karada Scan™ 701 (Omron Health Care Co., Ltd, Kyoto, Japan) with an accuracy of 0.1% for body fat measurement. Participants in the non-obese group had a body fat of <25% in males and <30% in females. The obese group had a body fat of ≥25% in males and ≥32% in females. The criterion of 32% was considered as there is no standard Indian obese body fat category. However, to ensure keeping participants with acceptable body fat and obese body fat in the proper group, we used the discordant criteria (Casey, 2020; Verma et al., 2019). We randomly selected 26 participants in each group from the curated list. The final analysis was done with 23 participants in the non-obese group and 24 participants in the obese group (Figure 1). These numbers were adequate for our study.

Variables

In this study, we categorized the group after measuring body weight and height to calculate BMI, and then in the second stage of screening, we measured the body fat% with the bioelectrical impedance analysis method. Our principal dependent variable was the RER. The independent and other variables include age, sex, blood pressure, weight, height, BMI, body fat%, baseline heart rate, and heart rate at different grades of exercise.

Measurements

The participants were instructed to have the same type of food for the preceding week and suggested to eat

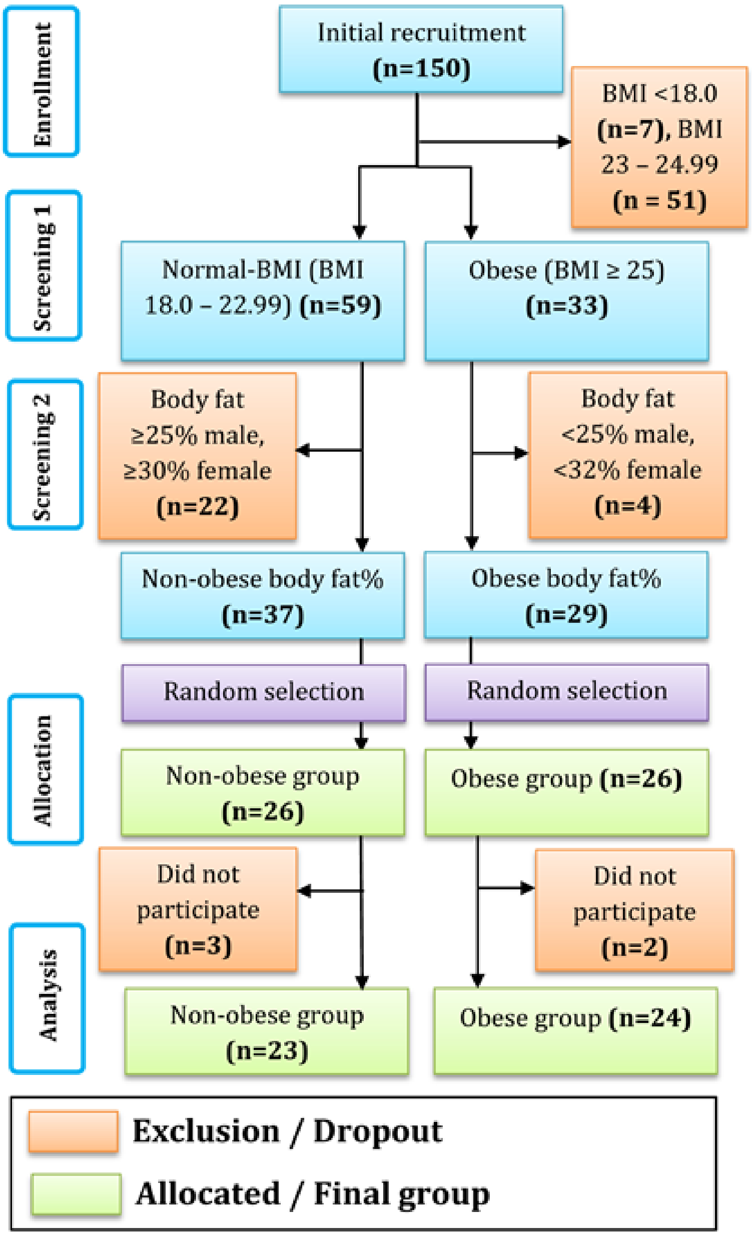

FIGURE 1. Flow chart for research participant recruitment and allocation

from only the campus canteen and avoid food from outside. They were also instructed to refrain from any type of planned exercise. All the pretest criteria for body fat measurement and exercise tests were followed according to the study by Mondal *et al.* (Mondal and Mishra, 2017; Mondal et al., 2019). All the anthropometric measurements and resting RER measurements were done after a period of 12-h fasting. The tests were conducted between 10 am to 12 pm of day. Age was recorded in completed years. Height was measured in centimeters by a portable stadiometer to the nearest mm by a single expert who had previous experience in height measurement. Weight was measured by a digital weighing scale having an accuracy of 100 gm (Omron body composition monitor HBF-701). The BMI was calculated from Quetelet's index (BMI = weight in kg/height in meter^2). The body fat was measured by a portable body fat monitor that uses four electrodes to use the bioelectrical impedance analysis to display the body fat in the percentage of body weight (Omron Karada Scan™ 701; Omron Health Care Co., Ltd, Kyoto, Japan). Resting heart rate was measured manually by counting radial pulse for 1-min after 5-min rest by a single expert observer. The maximum achievable heart rate was calculated by the formula: 208 – (0.7 × age) bpm (Roy and McCrory, 2015). This formula was considered over the classic "220- age in years" for its recent scientific value. Heart rate during the exercise was monitored on the cycle ergometer mounted pulse rate monitor (pressure sensor-based measurement with an error of <3%). This monitoring also helped to maintain the steady-state exercise intensity where achievement of 50% – 70% and 71% – 85% of the maximum achievable heart rate are considered moderate- and vigorous-intensity exercise, respectively. With a submaximal exercise of 10 minutes, a steady-state exercise in the range of desired heart rate for at least one minute was taken final for the reading of RER (Leicht et al. 2008; Mondal and Mishra, 2017). The RER was measured with a calibrated gas analyzer (Exercise Physiology System, AD Instruments, and Sydney, Australia) which collects the inspired and expired gas to calculate the RER in the metabolic (Exercise Physiology & Metabolic Analysis Software) module and displays the result.

Bias

During height and resting heart rate measurement, a single experienced operator measured the parameters which eliminated the inter-observer bias in the measurement; however, the intra-observer variation could not be eliminated. The weight, body fat%, heart rate during exercise, and RER were measured by automatic machines which have an acceptable level of accuracy. However, the errors in those measurements may still be in the final result as those devices are not 100% accurate. Furthermore, the exercise mode we used was predominantly a lower-body (cycling) exercise which may show different metabolic parameters than exercise with a higher percentage of upper-body exercise (e.g., running freehand). However, we used the cycle ergometer for a trouble-free respiratory gas analysis as running (on a treadmill) with the attached instrument which may be difficult for untrained subjects.

Statistical analysis

We expressed the data in mean and standard deviation. RER in a resting condition, moderate-intensity exercise, and vigorous-intensity exercise were first checked for normality by D'Agostino & Pearson omnibus K2 normality test (Zahediasl, 2012). Variables like age, height, weight, etc. were compared statistically by two-way Analysis of variance (ANOVA). RER according to sex and obesity was also tested by two-way ANOVA. The overall RER in each stage of the test (i.e., resting, moderate-intensity, and vigorous-intensity exercise) between males and females were compared by unpaired t-test. The RER between obese and non-obese in three stages was compared by two-way ANOVA with repeated measures. Sex-wise RER in non-obese and obese participants during rest, moderate-intensity, and vigorous-intensity exercise was tested by three-way ANOVA with repeated measures. Pearson correlation coefficient (*r*) was calculated between Body fat% and RER. The statistical analyses were carried out in GraphPad Prism 6.01 (GraphPad Software, CA, USA) and IBM® SPSS® Statistics 20 (Armonk, NY: IBM Corp). For all the tests, a $P < 0.05$ was considered statistically significant.

Results

Participant and descriptive data

A total of 23 (female = 9, male = 14) non-obese young adults aged 19.35±1.11 years and 24 (female = 13, male = 11) obese young adults aged 19.79±0.78 years participated in the study. Overall and sex-wise age, anthropometric data, heart rate, and blood pressure are shown in Table 1.

The age was similar in males and females in the non-obese and obese groups. The height, weight, and BMI were higher in male participants. The body fat was significantly higher in the female and obese groups for the obvious inclusion criteria.

Outcome data

Overall and sex-wise RER during a 15-min rest and in steady-state moderate- and vigorous-intensity exercise are shown in Table 2. Frequency distribution data of RER in non-obese and obese participants is shown in resting (Figure 2a), moderate-intensity exercise (Figure 2b), and vigorous-intensity exercise (Figure 2c). All RER data excluding the RER in the obese group in resting condition showed a normal distribution.

Main result

In resting and different grades of exercise, the obese group showed significantly higher RER in comparison to the non-obese group (P=0.001, P<0.001, and P <0.001 in resting, moderate- and vigorous-intensity exercise, respectively) (Table 2).

TABLE 1: Characteristics of research participants

Variables	Participants	Overall	Female	Male	P_{sex}, $P_{obesity}$
Age (years)	Non-obese	19.35±1.11	19.22±0.97	19.43±1.22	0.88, 0.12
	Obese	19.79±0.78	19.85±0.69	19.73±0.9	
Height (cm)	Non-obese	164.12±7.52	159.33±7.06	167.2±7.52	<0.001*, 0.33
	Obese	165.02±9.62	159.73±7.52	171.26±8.11	
Weight (kg)	Non-obese	58.14±7.4	53.26±4.89	61.28±7.13	<0.001*, <0.001*
	Obese	78.16±11.61	71.36±7.94	86.19±10.17	
BMI (kg/m^2)	Non-obese	21.49±0.98	20.96±0.93	21.84±0.87	0.04*, <0.001*
	Obese	28.59±2.41	27.95±2.37	29.35±2.33	
Body fat%	Non-obese	25.56±3.82	28.77±1.32	22.89±1.72	<0.001*, <0.001*
	Obese	33.05±4.58	36.2±1.02	29.34±4.35	
HR_{rest} (bpm)	Non-obese	75.57±6.13	76.11±7.96	76.36±5.11	0.76, 0.23
	Obese	78.29±5.23	77.92±4.63	78.73±6.07	
HR_{max} (bpm)	Non-obese	194.46±0.78	194.54±0.68	194.4±0.86	0.88, 0.12
	Obese	194.15±0.55	194.11±0.48	194.19±0.63	
Systolic blood pressure (mm of Hg)	Non-obese	121.52±7.63	118.22±6.89	123.64±7.54	<0.001*, 0.28
	Obese	122.58±7.17	118.15±6.41	127.83±3.66	
Diastolic blood pressure (mm of Hg)	Non-obese	82.52±6.35	81.67±4.69	83.07±7.33	0.53, 0.89
	Obese	82.58±5.89	82.15±4.71	83.09±7.27	

*Statistically significant *P* value of two-way analysis of variance (ANOVA)

Sample size: Non-obese = 23 (female = 9, male = 14), Obese = 24 (female = 13, male = 11)

TABLE 2: Respiratory exchange ratio in non-obese and obese young adults in resting and during exercise

Respiratory exchange ratio measured during	Participants	Overall	Female	Male	P_{sex}, $P_{obesity}$
Resting	Non-obese	0.802±0.018	0.796±0.016	0.808±0.019	0.004*, 0.001*
	Obese	0.821±0.022	0.811±0.017	0.833±0.022	
	Overall	0.812±0.022	0.805±0.018	0.819±0.024	0.03†
Moderate-intensity exercise	Non-obese	0.812±0.013	0.807±0.009	0.815±0.043	<0.001*, <0.001*
	Obese	0.83±0.02	0.82±0.045	0.842±0.018	
	Overall	0.819±0.02	0.809±0.014	0.827±0.021	0.002†
Vigorous-intensity exercise	Non-obese	0.853±0.43	0.826±0.018	0.871±0.045	0.009*, <0.001*
	Obese	0.914±0.032	0.909±0.036	0.92±0.026	
	Overall	0.884±0.048	0.857±0.051	0.892±0.045	0.21

*Statistically significant *P* value of two-way analysis of variance (ANOVA), †Statistically significant *P* value of unpaired *t*-test between RER of overall female and male

Sample size: Non-obese = 23 (female = 9, male = 14), Obese = 24 (female = 13, male = 11)

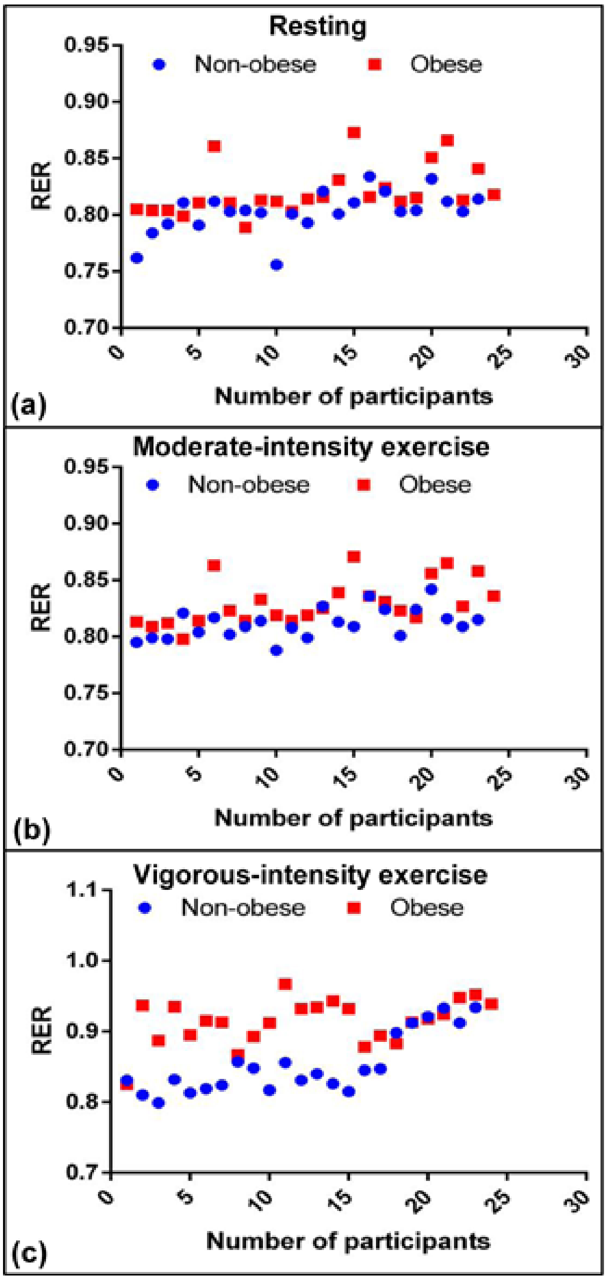

FIGURE 2. Frequency distribution of respiratory exchange ratio in resting, moderate-intensity, and vigorous-intensity exercise. All excluding the RER in the obese group in resting condition showed a normal distribution

RER significantly (ANOVA P <0.001 with all pairs significantly different in post hoc test with Bonferroni correction) increased during moderate- and vigorous-intensity exercise in the non-obese and obese groups (Figure 3).

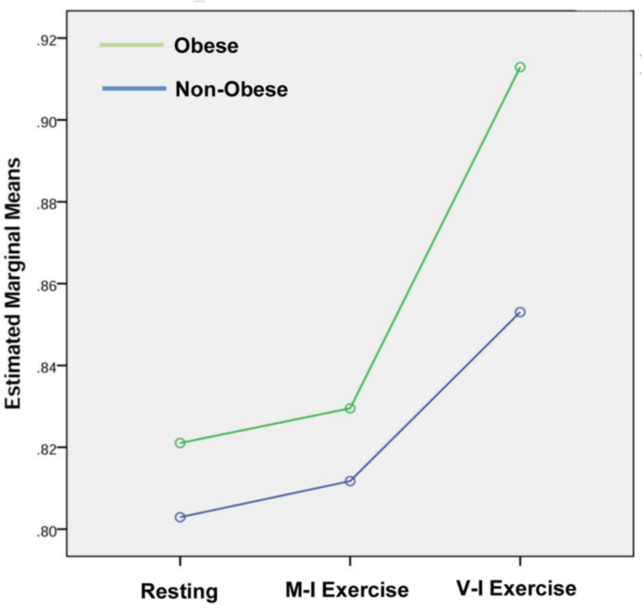

FIGURE 3. Respiratory exchange ratio in rest and during moderate- and vigorous-intensity exercise. M-I: Moderate-intensity, V-I: Vigorous-intensity, Statistics used – Two-way repeated measure ANOVA

Other analyses

In comparison to females, males showed higher RER in resting and during moderate-intensity exercise. However, during vigorous-intensity exercise, there was no gender difference in RER (Table 2).

Non-obese and obese females and males both showed an increase in RER during exercise (Three-way repeated measure ANOVA P <0.001. Pairwise comparison with Bonferroni correction showed significant difference among exercise groups [all P <0.05], between obese and non-obese [P <0.001], and between gender [P =0.025]) (Figure 4a, b).

When we ran multiple regression to predict resting RER from age, sex, height, weight, and body fat%, the variables significantly predicted resting RER, F (5, 41) = 2.8, P = 0.03, R^2 = 0.26. RER during moderate-intensity exercise (F (5, 41) = 3.04, P = 0.02, R^2 = 0.27) and vigorous-intensity exercise (F (5, 41) = 9.76, P <0.0001, R^2 = 0.54) was also significantly predicted by the independent variables. However, individually, only body fat% contributed significantly to the prediction (P = 0.04, P = 0.02, P = 0.003, respectively in rest, moderate-, and vigorous-intensity exercise). The Pearson correlation showed a positive correlation between body fat% and RER in rest (r = 0.48, P = 0.0007) and in exercise (moderate-intensity r = 0.0002, P = 0.0002, and vigorous-intensity r = 0.71, P <0.0001) [Figure 5]

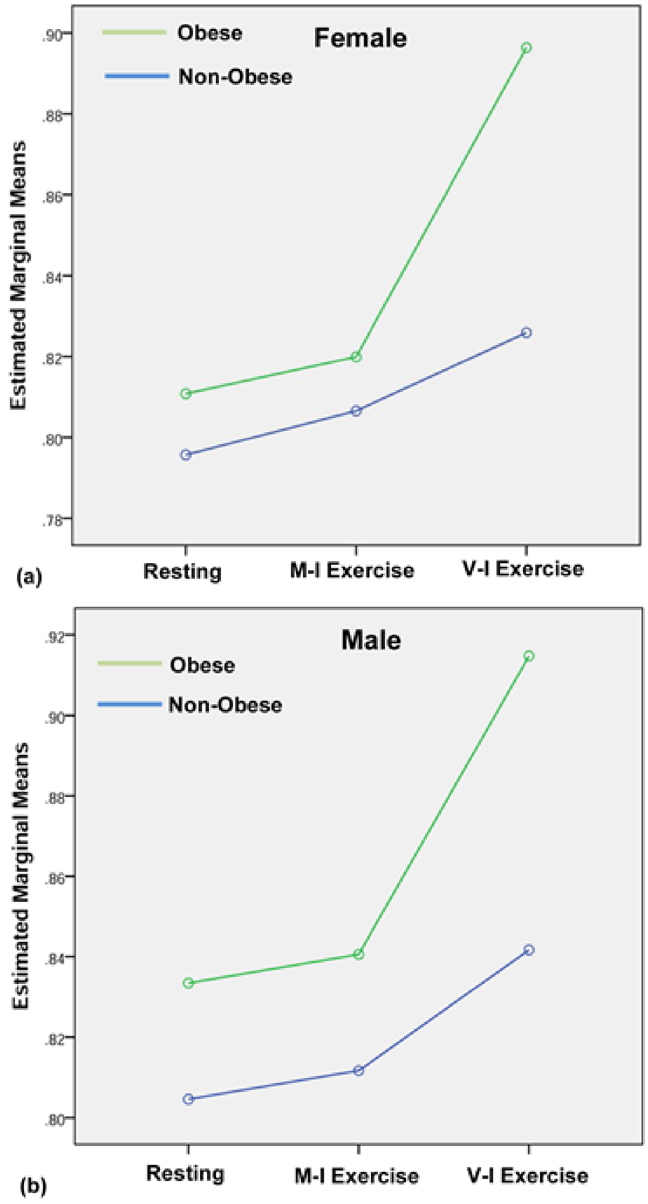

FIGURE 4. Respiratory exchange ratio in non-obese and obese participants during rest, moderate-intensity, and vigorous-intensity exercise – (a) female (b) male
M-I: Moderate-intensity, V-I: Vigorous-intensity, Statistics used – repeated measure three-way ANOVA

Discussion

Resting RER

Our research participants were sedentary young adults. We found that resting RER is higher in obese in comparison to non-obese participants. This indicates the consumption of a relatively higher percentage of carbohydrates and a lower percentage of lipids as a fuel for generating energy in obese individuals. The underlying reason may be lower lipid oxidation in obese (Houmard, 2008). Furthermore, in resting conditions, females showed lower RER which indicates that females may be capable of oxidizing fat more effectively than males. The underlying cause may be a higher uptake and oxidation of free fatty acid in females. This higher usage of fats may be attributed to a higher β-adrenergic and lower α-adrenergic activity in females (Arad, 2020).

RER during exercise

Sedentary young adults, irrespective of their gender and body fat status showed a higher RER in moderate- and vigorous-intensity exercise in comparison to resting RER. This indicates that they start using more carbohy-

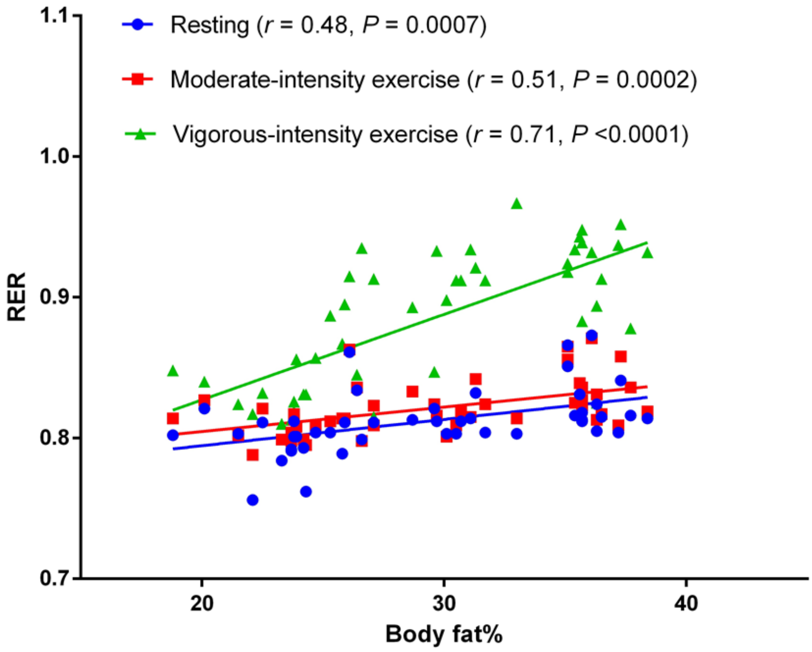

FIGURE 5. Correlation between body fat% and respiratory exchange ratio in resting, moderate-intensity exercise, and vigorous-intensity exercise. r = Pearson correlation coefficient, RER = Respiratory Exchange Ratio

drates during exercise. In a fasting state, the muscle energy is provided by free fatty acid from plasma. During moderate-intensity exercise, the source of energy is fatty acids from plasma and muscle triglycerides along with carbohydrates from blood glucose and muscle glycogen. During vigorous-intensity exercise, fuel from fatty acids decreases and nearly two-thirds of energy comes from carbohydrates (Mul, 2015).

Our further finding is about the comparison of non-obese and obese during exercise. We found that the rise in RER is higher in obese. Hence, obese sedentary young adults use relatively more carbohydrates during exercise. Pérez-Martin *et al.* conducted a study in France with 32 sedentary overweight subjects and age and sex-matched normal-weight subjects. They found that fat oxidation is lower in the overweight group in similar exercise intensity when compared to normal-weight subjects (Pérez-Martin et al., 2001). Chatzinikolaou *et al.* conducted a study in Greece with nine lean and eight obese men. They found that during 30 min of circuit resistance exercise, obese men showed higher RER than lean men (Chatzinikolaou et al., 2008). Although the sample is of different ages and ethnicity, the finding of our study supports the fact that obese subjects use higher carbohydrates during exercise.

In contrast to our finding and finding by Pérez-Martin *et al.* and Chatzinikolaou *et al.*, Goodpaster *et al.* (who studied seven obese and seven lean American subjects in the age range 25-40 years) reported that in moderate exercise, obese sedentary men use more fatty acid and less carbohydrates (Goodpaster et al., 2002). Whether higher lipid oxidation occurs during exercise still remains a topic of never-ending research and perhaps will be continuing because of the diversity of sample characteristics, exercise mode, and measured parameters (Geerling et al., 1994; Mittendorfer et al., 2004).

The literature supports that physically active people can use lipids as a source of energy more effectively than sedentary people. Endurance training further increases the capability to use lipids as a fuel (Rimbert et al., 2004; Schrauwen et al., 2002). The research participants of the current study were taken from sedentary young adults. That may be the reason why we found a lower capability of using lipids as fuel during exercise. Hence, an increase in physical activity to reduce body fat or endurance training may be suggested for sedentary young adults. This would help them to use more fats as an energy source; hence, there will be less fat for storage (Ramos-Jiménez et al., 2008).

Gender difference

RER during rest and moderate-intensity exercise showed higher values in males. However, during vigorous-intensity exercise, there was no gender difference in RER. We had no intersex in our sample; hence, we could not show any result with comparison in three groups. This may be a topic of future research. The lower RER in females is suggestive of higher fat usage during rest and moderate-intensity exercise (Mittendorfer et al., 2004). Hence, in moderate exercise, females can burn more fat than males. A study by Toth *et al.* with 12 American elderly men and women showed that in older men, the oxidation of fat is more in comparison to women (Toth et al., 1998). This discordant finding may be due to different ages, ethnicity, and difference in measurement methods.

RER and body fat

Multiple regression analysis showed that RER can be predicted with combined parameters of age, sex, height, weight, and body fat. However, individually only the body fat% can significantly (statistically) predict the RER in sedentary young adults. There was a significant positive correlation coefficient between the body fat% and RER. This indicates that the higher the body fat, the higher the RER which indirectly indicates higher utilization of carbohydrates as a fuel for energy production. Hence, a decrease in body fat may help increase fat oxidation. An exercise program to reduce body fat may increase fat oxidation in the body (Beatty J and Melanson, 2019; Kyle et al., 2001).

Generalizability

The two-stage screening (by BMI and Body fat %) for non-obese and obese participants ensures that the study allocated the participants to the correct categories – obese and non-obese. The study result was obtained for the sedentary young adults with a mean age of 19.57±0.97. Hence, the result of this study may be extended to similar subjects in the population. Future studies with a larger sample with different age groups recruited from different parts of the country would provide more generalized results.

Limitation

This study has several limitations. Although the participants declared that they did not participate in the exercise, their daily level of activity (sedentariness) and their daily used METs were beyond our capability to measure. We instructed the subjects to take food from the campus canteen only. However, different subjects were tested on different days. Hence, there may be variations in the type of food they consumed. For the measurement of pulse rate, we used the sensor available on the cycle ergometer. However, use of an electrocardiograph would provide us more accurate results. It was not possible due to the potential discomfort of the subjects, especially female subjects. The pattern of fuel usage from RER depends on the level of lactic acid accumulation. Although we used aerobic exercise where the maximum heart rate never exceeded 85% of the maximum achievable heart rate, the underlying lactate levels were not measured. Hence, the result of this study should be interpreted with caution.

Conclusion

In sedentary young adults, males use relatively higher carbohydrates (higher RER) than females for energy production. An increase in obesity increases carbohydrate metabolism when compared to non-obese sedentary young adults in rest, moderate-intensity, and vigorous-intensity exercise. There is a gradual increase in RER in moderate-intensity and vigorous-intensity exercise. Hence, an increase in exercise intensity increases the usage of carbohydrates as a fuel source in sedentary young adults.

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Conflicts of interest

There are no potential conflicts of interest to declare.

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