

Effects of brisk walking and resistance training on cardiorespiratory fitness, body composition, and lipid profiles among overweight and obese individuals

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Abstract:

The purpose of this study was to determine the effects of brisk walking and resistance training on cardiorespiratory fitness, body composition and lipid profiles in overweight and obese individuals. 54 overweight and obese male and female participants, aged between 21 to 55 years old were recruited for this study. The participants were age-, gender- and weight-matched before being randomly assigned into 3 groups, with 18 participants per group. The brisk walking group was required to brisk walk 3 times a week at an intensity of 60-70% of their respective age-predicted maximum heart rate for 8 weeks. Resistance training group performed the resistance training which involved 3 sets of 8 exercise stations, 3 times a week and 45 minutes per session. For each station, 8-15 repetitions of upper and lower body exercises were carried out by using dumbbells. The control group was asked to continue with their daily routine without participating in any other forms of physical training. Body composition, lipid profiles and cardiorespiratory fitness of the participants were measured at pre, mid and post-intervention. Results showed that there was greater improvement in cardiorespiratory fitness for brisk walking and resistance training groups ($p < 0.01$) at post-intervention compared to pre-intervention value. There were also significant improvements in percentage of body fat, body mass index (BMI), waist-hip ratio (WHR), and free fat mass in the brisk walking group. Similarly, participants in the resistance training group had significant improvement in BMI, WHR, fat mass and HDL-cholesterol. Hence, it is concluded that both brisk walking and resistance training for 8 weeks were appropriate exercise modalities to reduce some of the cardiovascular risk factors among overweight and obese individuals.

Keywords: Brisk walking, Resistance training, Obese, Overweight, Cardiorespiratory fitness

Introduction

Obesity is a well-documented risk factor for cardiovascular disease in the general population (Rimm et al., 1995). Cardiovascular disease is a leading cause of mortality and morbidity in developed and developing countries including Malaysia (World Health Organization, 2000). In Malaysia, cardiovascular mortality has increased 15 folds from 1950 to 1989 and accounts for approximately 30% of total deaths among Malaysian adults (Khoo et al., 1991). Hence, cardiovascular risk factors including obesity have increasingly gained the attention of policy makers and researchers in Malaysia. The Third National Health and Morbidity Survey in 2006 has recorded an abdominal obesity in 17.4 % of the adults aged more than 18 years in Malaysia (Kee et al., 2008).

Obesity is also recognized as a major determinant of many other non-communicable diseases such as various types of cancer, gallbladder diseases, respiratory problems and musculoskeletal disorders. It also induces type 2 diabetes mellitus. Moderate weight loss has been demonstrated to decrease health risks and medical problems in 90% of obese patients. This is attributed to improvements of their heart function, blood pressure, glucose tolerance and lipid profiles (Willett et al., 1995). It has been well-accepted that an effective strategy to ameliorate obesity and lower the health-related risks is through participation in physical activity (NHLBI Obesity Education Initiative, 2000). Regular physical activity has been shown to induce physiological and psychological benefits including an improved lipid profiles, enhanced insulin sensitivity, lowered blood pressure and an increased energy expenditure which has the potential to lower body fat and body mass (Garrow and Summerbell, 1995; McMurdo et al., 1997; Steffen et al., 2001). Hence, participation in regular physical activity should be an integral component of weight loss therapy and weight maintenance (Khoo et al., 1991).

Resistance training is also type of physical activity that has been suggested for reducing body fat (McGuigan et al., 2009). Besides that, adults will benefit from performing activities for a minimum of two days each week that maintain or increase muscular strength and endurance. It is recommended that 8–10 exercises be performed on two or more non-consecutive days each week using the major muscle groups. To maximize development of muscular strength, the resistance used should allow the participants to perform 8–12 repetitions of each exercise without undue fatigue. Muscle strengthening activities include a progressive weight-training program, weight bearing calisthenics, stair climbing, and similar resistance exercises that use the major muscle groups (McGuigan et al., 2009).

This study was conducted to investigate the effects of brisk walking and resistance training on cardiorespiratory fitness, body composition, and lipid profiles on overweight and obese individuals. The findings of this study will provide data about the beneficial effects of brisk walking and resistance training on this group of individuals. It is hypothesized that these 2 exercise modalities may be an effective strategy to overcome obesity and lower the health-related risks among the obese individuals in Malaysia.

Materials and Methods

Participants

Sixty healthy, male and female participants, with BMI ranging from 25 to 40 and age ranging from 20 to 50 years old were recruited for this study. Participants who were diagnosed with pregnancy, malignancy, arthritis, amputees, chronic disease or type 1 diabetes were excluded from this study. This research was approved by the Human Research Ethics Committee of Universiti Sains Malaysia. Participants who met the inclusion criteria provided their written informed consent.

Experimental Design

After matching the participants in terms of age, gender and body mass, they were randomly assigned into three different groups, i.e. brisk walking group, resistance training group and control group. Body composition, waist-hip ratio (WHR), lipid profile and predicted maximal oxygen consumption (VO_{2max}) of the participants were measured and blood samples were collected before, after 4 weeks and after 8 weeks of the study.

Brisk walking was carried out 3 times a week at 60-70% of predicted maximum heart rate (HR_{max}) for 8 weeks. Resistance training of 3 sets, 8-15 repetitions for upper and lower body exercises using dumbbells (1-5 kg) also were carried out 3 times a week and 45 minutes per session. The control group was asked to continue with their daily routine and diet pattern without participating in any other forms of physical training.

Blood Sampling

Blood sample were collected from the participants after an overnight fast. Six mL of blood was drawn from the antecubital vein and put in a clotting activator tube. Then, the samples were centrifuged for 10 minutes at 4000 rpm and 4°C (Hettich Zentrifuger-Rotina 46RS, Germany). Serum was separated and stored at -80°C freezer (ThermoForma Model 705, USA) for further lipid profile analysis.

Measurements of Anthropometric and Physiological Characteristics

Body height and weight were measured with the participants in light clothing and without shoes, to determine their BMI. Body weight and body fat composition were measured by using electronic body composition analyzer (Tanita TBF-410, Japan). During the measurement of waist and hip circumference, the upper hip bone and the top of the right iliac crest were located. The measurement tape was placed horizontally around the abdominal at the level of iliac crest. The tape was snug but did not compress the skin when the measurements were taken at the end of a normal expiration.

Blood Biochemical Tests

Serum blood collected from the participants was tested for serum total cholesterol, serum total triglycerides, low-density lipoprotein (LDL) cholesterol and high-density lipoprotein (HDL) cholesterol. Cholesterol CHOD-PAP method was used to analyze total cholesterol concentrations. Triglycerides are determined with glycerol phosphate oxidase followed by a POD catalyzed indicator reaction. High density lipoprotein (HDL) cholesterol was determined after low density lipoprotein (LDL) cholesterol was precipitated by phosphotungstic acid with the presence of magnesium ions. LDL cholesterol was calculated from total cholesterol, triglycerides and HDL cholesterol levels. The results are reported in $mmol.L^{-1}$.

Rockport Fitness Walking Test

Rockport Fitness Walking Test was used to estimate VO_{2max} as it is suitable for testing the overweight and obese individuals and practically useful for testing large numbers of participants. During the test, the participants were instructed to walk as fast as they could for one mile. At the end of the test, time to complete the one mile walk and heart rate were recorded. These variables were used to calculate the predicted maximal oxygen consumption by using the formula of Kline et al. (1987):

$$132.853 - (0.0769 \times \text{Weight}) - (0.3877 \times \text{Age}) + (6.315 \times \text{Gender}) - (3.2649 \times \text{Time}) - (0.1565 \times \text{Heart rate})$$

Where:

- Weight is in pounds (lbs)
- Gender Male = 1 and Female = 0
- Time is expressed in minutes and 100ths of minutes
- Heart rate is in beats/minute
- Age is in years

Statistical Analysis

A repeated measure ANOVA was used to analyze pre-, mid- and post-intervention data between the three groups. Significance was accepted at $p < 0.05$. Results were reported as means $\pm$ standard deviations.

Results

Out of the 60 participants enrolled at the beginning of the study, only 54 participants with mean age of 20.9 ± 1.7 years and mean body weight of 60.0 ± 10.7 kg completed the study. Two participants from each group failed to comply with the requirements set in our study. Physical characteristics of the participants are presented in Table 1. There were no significant differences among the 3 groups in terms of age and weight. Out of the 54 participants recruited, 57 % were obese and 43% were in the overweight category. 17 of the participants (35.2 %) were males while the rest were females (64.8 %).

Table 1. Physical Characteristics of the participants

Variables	Control (n = 18)	Brisk walking (n = 18)	Resistance Training (n = 18)
Age (years)	32.4 ± 9.9	36.8 ± 8.1	34.8 ± 10.6
Weight (kg)	75.0 ± 14.3	74.4 ± 8.5	76.8 ± 12.9
Height (cm)	158.2 ± 9.1	160.2 ± 7.1	160.4 ± 8.5

Changes in body mass index and body composition

The brisk walking group showed a significantly ($p < 0.05$) lower body mass index at post-intervention compared to the pre-intervention value ($29.0 \pm 3.2 \text{ kg.m}^{-2}$ to $28.8 \pm 3.2 \text{ kg.m}^{-2}$) (Fig. 1). Similarly, the resistance training group had a significantly lower body mass index at post-intervention compared to mid-intervention ($p < 0.001$) value and when compared to pre-intervention value ($p < 0.05$) (Fig. 1).

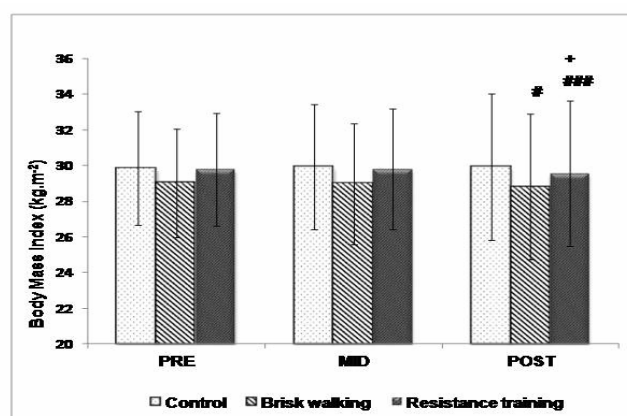


Figure 1: Changes in body mass index

Significantly different from mid-intervention at $p < 0.05$
 ### Significantly different from mid-intervention at $p < 0.001$
 + Significantly different from pre-intervention at $p < 0.05$

There was also a significant reduction in waist hip ratio from pre to mid and post-intervention for both the intervention groups (Figure 2a). For the brisk walking group, waist hip ratio decreased significantly ($p < 0.001$) from 0.83 ± 0.51 at pre-intervention to 0.82 ± 0.05 at mid-intervention and to 0.81 ± 0.04 at post-intervention. The waist hip ratio in the resistance training group also decreased significantly ($p < 0.001$) from 0.84 ± 0.06 at pre-intervention to 0.83 ± 0.06 at mid-intervention and to 0.82 ± 0.05 at post-intervention. The brisk walking group also had a significant reduction in percent of body fat from 39.7 ± 9.3 % to 37.7 ± 8.1 % ($p < 0.001$) at post-intervention period compared to pre-intervention value (Figure 2b). However, there were no significant changes in percent body fat in the resistance training and control groups during the study period.

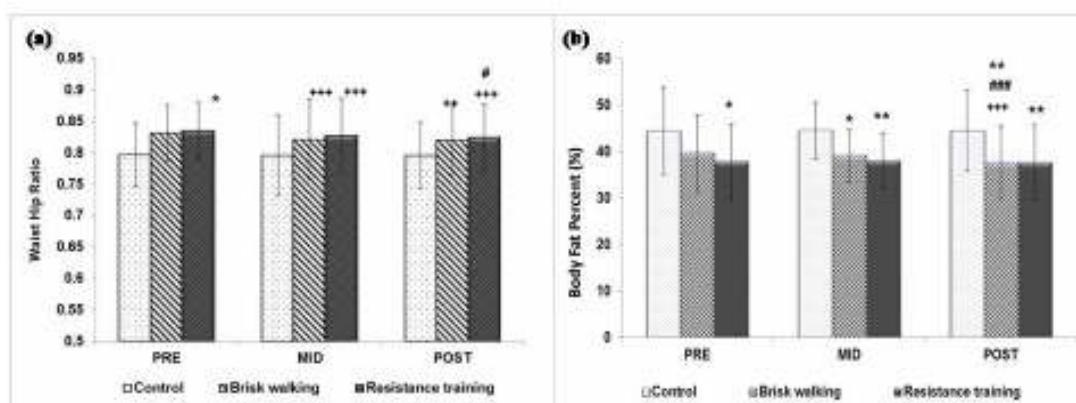


Figure 2(a) Changes in waist hip ratio and (b) Changes in percent body fat

- +++ Significantly different from pre-intervention at $p < 0.001$
- ### Significantly different from mid-intervention at $p < 0.001$
- # Significantly different from mid-intervention at $p < 0.05$
- * Significantly different from control group at $p < 0.05$
- ** Significantly different from control group at $p < 0.01$

Changes in lipid profiles

Total cholesterol levels for the 3 groups did not change significantly during the study (Fig 3a). Similarly, there were no significant changes in triglycerides in the 3 groups following the intervention period (Fig 3b). There were also no significant changes in LDL-cholesterol at post-intervention when compared to pre-intervention values in all the groups (Fig. 4a). However, the brisk walking group had a significantly ($p < 0.01$) higher HDL-cholesterol at post-intervention compared to mid-intervention value (from 1.03 ± 0.30 to 1.13 ± 0.32 mmol.L⁻¹) (Fig. 4b). Likewise, the resistance training group showed a significant increase in HDL-cholesterol at post-intervention compared to pre-intervention (from 1.09 ± 0.28 mmol.L⁻¹ to 1.19 ± 0.36 mmol.L⁻¹) (Fig. 4b).

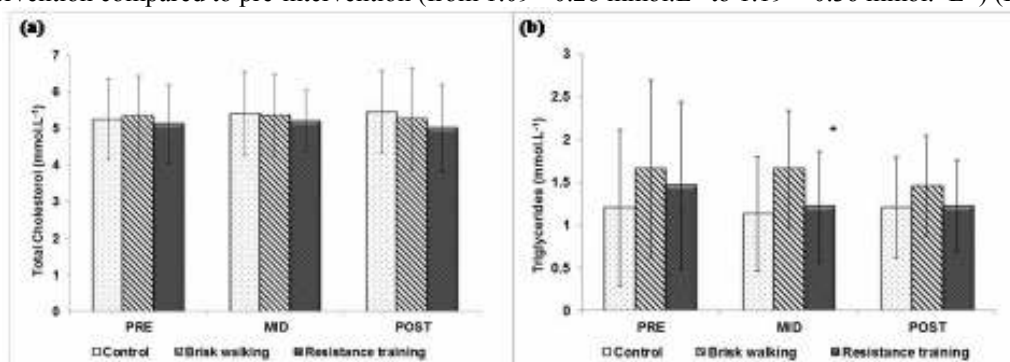


Figure 3(a) Changes in total cholesterol and (b) Changes in triglycerides

- ± Significantly different from pre-intervention at $p < 0.05$

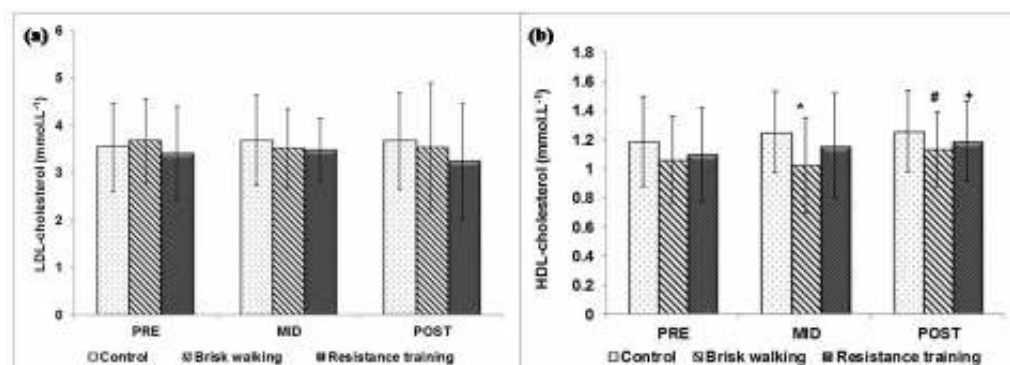


Figure 4(a) Changes in LDL-cholesterol and (b) Changes in HDL-cholesterol

- + Significantly different from pre-intervention at $p < 0.05$
- # Significantly different from mid-intervention at $p < 0.05$
- * Significantly different from control group at $p < 0.05$

Changes in cardiorespiratory fitness

Estimated maximal oxygen uptake was significantly ($p < 0.001$) higher in the brisk walking group after the 8 weeks program compared to its pre-intervention value (from $28.3 \pm 8.8 \text{ mL.kg}^{-1}.\text{min}^{-1}$ to $33.5 \pm 7.9 \text{ mL.kg}^{-1}.\text{min}^{-1}$) (Fig 5). Similarly, estimated maximal oxygen uptake in the resistance group was also significantly ($p < 0.01$) higher at post-intervention compared to pre-intervention value (from $27.5 \pm 8.2 \text{ mL.kg}^{-1}.\text{min}^{-1}$ to $29.3 \pm 7.83 \text{ mL.kg}^{-1}.\text{min}^{-1}$) (Fig 5). There was no observable change in estimated maximal oxygen uptake in the control group during the same study period.

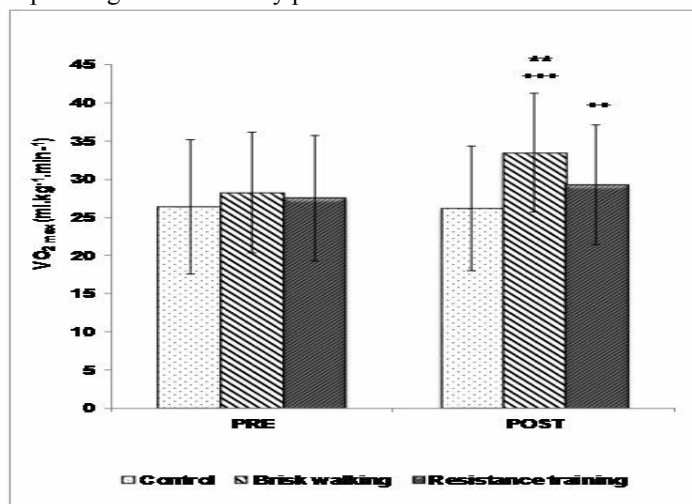


Figure 5: Changes in estimated maximum oxygen uptake

+++ Significantly different from pre-intervention at $p < 0.001$

++ Significantly different from pre-intervention at $p < 0.01$

** Significantly different from control group at $p < 0.01$

Discussion

The results of this study showed that a number of the measured parameters related to cardiovascular risk factors such as body mass index (BMI), waist hip ratio and percent body fat, demonstrated a trend of improvement in both the brisk walking (BW) and resistance training (RT) groups after 8 weeks of intervention albeit the absence of statistical significance in some of these parameters.

There was a positive improvement in terms of lower BMI in both the exercise intervention groups after 8 weeks. Therefore, these data demonstrated that even though there was no statistical difference in body weight changes, BMI may be altered through regular physical training. Similarly, the waist hip ratio in both the BW and RT groups decreased following the 8 weeks of intervention period. In the present study, percent body fat also decreased significantly for the BW group at the post-intervention when compared to its respective pre and mid-intervention values. However, percent body fat did not change in the control and the RT groups during the same period.

These findings corroborated with the work of other researchers who have suggested that exercise is an effective tool in reducing waist circumference or waist hip ratio even though there was no substantial weight loss (Ross et al., 2004). The reduction of waist circumference is of particular clinical importance since the increased risk of insulin resistance, diabetes, metabolic syndrome, and mortality is associated with excess abdominal adiposity (Janssen et al., 2002; Ross et al., 2002; Kuk et al., 2006). Azeem (2011) has also reported a significant reduction in BMI and waist and hip circumference in obese males following a 12-week brisk walking programme at a frequency of 5 times per week, 45 min per session. In a systematic review of literature, Murphy et al. (2007) reported that walking resulted in a significant reduction in body fat, BMI and diastolic blood pressure and an increased $\text{VO}_{2\text{max}}$. Melam et al. (2016) have also demonstrated that BW for 45 min, 5 days per week for 10 weeks significantly reduces BMI, waist hip circumference. Chaudhary et al. (2010) have also reported that both aerobic training at 60-70% of maximum heart rate and resistance training 3 times per week for 6 weeks resulted in a significantly lower BMI and body fat percentage.

Hanson and Jones (2015) have highlighted that group walking is effective and safe and it brought about wide ranging health benefits including lowering of BMI, total cholesterol and increased $\text{VO}_{2\text{max}}$. They further reported that walking groups appear to be acceptable intervention to participants with high levels of adherence and a low risk of serious side effects. Thus, brisk walking is an appropriate and feasible exercise modality for the overweight and obese individuals except for the overly obese ($\text{BMI} > 40.0$) and individuals with chronic knee pain (Chen, 2014). Furthermore, it is a low-impact aerobic exercise that is easy to perform and detrimental side effects are minimal. Regular exercise has been shown to have a positive effect on the mobilization and use of fatty acids from adipose tissues. Hence, this fat burning benefit of regular exercise may have contributed to fat loss in any weight loss program (Hu et al., 2001). The current study did not demonstrate any improvement in total cholesterol and LDL-cholesterol in both BW and RT groups. This finding could be attributed to the fact that all the participants in this study were normocholesterolemic individuals. Hence, the two different exercise modes

did not seem to elicit any beneficial effect on the total cholesterol levels in the 2 groups. The absence of significant decreases in total cholesterol in both the BW and RT groups in the current study could have also been attributed to insufficient stimuli compared to the different training loads reported in other studies that have indicated a significant reduction in lowering total cholesterol (Gregory, 1990; Ohta et al., 1990).

Brisk walking and resistance training seem to have a positive effect on HDL-cholesterol following the 8 weeks program. These data were similar with the finding from Blumenthal (1980) who reported that a 10-week aerobic exercise training elicited increased HDL-cholesterol level among healthy adults. The issue of training intensity is particularly relevant because moderate-intensity training has been generally recommended for promoting health benefits (Pate et al., 1995). It has been reported that a minimum intensity of 75% of maximal heart rate is required to induce favorable HDL-C changes in healthy middle-aged men (Stein et al., 1990). King et al. (1995) reported that both high- and low-intensity training 73–88% and 60–70% peak heart rate, respectively promoted a modest 3 mg.dL⁻¹ rise in HDL-C concentration in previously untrained individuals. The intensity of BW for 8 weeks in the current study was similar to the studies mentioned above. Hence, the positive outcome of increased HDL-C indicated that this exercise intensity was adequate to induce beneficial changes to lipid profile among the overweight and obese participants in this study.

There was a significant improvement in estimated maximum oxygen uptake for both BW and RT groups. Ahmadizad et al. (2007) have also shown that VO_{2max} increases from baseline levels after resistance exercise training. Another study has also demonstrated that both moderate- and high-intensity training elicited significant improvements in VO_{2max} by the 8th week of the program (Barlow et al., 1995). A more recent study also demonstrated a similar trend of higher VO_{2max} as well as lower BMI and percent body fat following 12 weeks of either aerobic exercise (30 min walking on the treadmill at 60% of heart rate reserve) or 30 min of resistance training (4 sets of 8-12 repetitions at 10RM) 5 days per week (Ho et al., 2012). Blair et al. (1996) reported that a low cardiorespiratory fitness level is an important independent predictor of all-cause mortality in both men and women. Thus, a higher VO_{2max} is associated with reduced risk of chronic diseases and death (Wei et al., 1999; LaMonte & Blair, 2006). Farrel et al. (2002) also demonstrated that it is imperative to consider cardiorespiratory fitness levels when examining the impact of overweight status and obesity on mortality. Obese individuals with higher cardiorespiratory fitness levels generally have lower mortality rates compared to sedentary normal weight counterparts (Blake et al., 2000).

Conclusion

Both the exercise intervention program elicited some beneficial effects among overweight and obese participants. There was a significant decrease in BMI and waist hip ratio for BW and RT groups, significant decrease in percentage of body fat for BW group, significant decrease in HDL-cholesterol for RT and significant increase in estimated maximum oxygen uptake for BW and RT groups. Thus, brisk walking and resistance training exercise of 8 weeks at the prescribed intensity seem to have elicited substantial beneficial effects in ameliorating some of the cardiovascular risk factors among the overweight and obese individuals.

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References

- Ahmadizad, S., Haghighi, A. H., & Hamedinia, M. R. (2007). Effects of resistance versus endurance training on serum adiponectin and insulin resistance index. *Eur J Endocrinol*, 157(5), 625-631.
- Azeem, K. (2011). Effect of Twelve Weeks Brisk Walking on Blood Pressure, Body Mass Index, and Anthropometric Circumference of Obese Males. *Int J Med Health Biomed Bioengineer Pharma Engineer*, 5(11), 530-532.
- Barlow, C. E., Kohl III, H. W., Gibbons, L. W., & Blair, S. N. (1995). Physical fitness, mortality and obesity. *Int J Obes Relat Metab Disord*, 19(Suppl 4):S41-44.
- Blair, S. N., Kampert, J. B., Kohl, H. W., Barlow, C. E., Macera, C. A., Paffenbarger, R. S., & Gibbons, L. W. (1996). Influences of cardiorespiratory fitness and other precursors on cardiovascular disease and all-cause mortality in men and women. *JAMA*, 276(3), 205-210.
- Blake, A., Miller, W. C., & Brown, D. A. (2000). Adiposity does not hinder the fitness response to exercise training in obese women. *J Sports Med Phys Fitness*, 40(2), 170-177.
- Blumenthal, J. A., Williams, S. R., Williams Jr, R. B., & Wallace, A. G. (1980). Effects of Exercise on the Type A (Coronary Prone) Behavior Pattern1. *Psychosom Med*, 42(2), 289-296.
- Chaudhary, S., Kang, M. K., & Sandhu, J. S. (2010). The Effect of Aerobic Versus Resistance Training on Improving Cardiovascular Fitness in Obese Sedentary Females. *Asian J Sports Med*, 1(4), 177-184.
- Chen, C. K. (2014). Brisk Walking the Underused Modality to Alleviate Obesity. *J Obes Weight Loss Ther*, 4, e112. doi:10.4172/2165-7904.1000e112
- Farrell, S. W., Braun, L., Barlow, C. E., Cheng, Y. J., & Blair, S. N. (2002). The Relation of Body Mass Index, Cardiorespiratory Fitness, and All - Cause Mortality in Women. *Obes Res*, 10(6), 417-423.

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- Garrow, J. S., & Summerbell, C. D. (1995). Meta-analysis: effect of exercise, with or without dieting, on the body composition of overweight subjects. *Eur J Clin Nutr*, 49(1), 1-10.
- Gregory, J., Foster, K., Tyler, H., & Wiseman, M. (1990). *The dietary and nutritional survey of British adults*. HMSO Publications Centre.
- Hanson, S., & Jones, A. (2015). Is there evidence that walking groups have health benefits? A systematic review and meta-analysis. *Br J Sports Med*, 49(11), 710-715.
- Ho, S. S., Dhaliwal, S. S., Hills, A. P., & Pal, S. (2012). The effect of 12 weeks of aerobic, resistance or combination exercise training on cardiovascular risk factors in the overweight and obese in a randomized trial. *BMC Public Health*, 12(1), doi:10.1186/1471-2458-12-704
- Hu, F. B., Manson, J. E., Stampfer, M. J., Colditz, G., Liu, S., Solomon, C. G., & Willett, W. C. (2001). Diet, lifestyle, and the risk of type 2 diabetes mellitus in women. *New Eng J Med*, 345(11), 790-797.
- Janssen, I., Katzmarzyk, P. T., & Ross, R. (2002). Body mass index, waist circumference, and health risk: evidence in support of current National Institutes of Health guidelines. *Arch Intern Med*, 162(18), 2074
- Kee, C. C., Jamaiah, H., Safiza, M. N., Geeta, A., Khor, G. L., Suzana, S., & Wong, N. F. (2008). Abdominal Obesity in Malaysian Adults: National Health and Morbidity Survey III (NHMS III, 2006). *Malays J Nutr*, 14(2), 125-135.
- Khoo, K. L., Tan, H., & Khoo, T. H. (1991). Cardiovascular mortality in peninsular Malaysia: 1950-1989. *Med J Malaysia*, 46(1), 7-20.
- King, N. A., & Blundell, J. E. (1995). High-fat foods overcome the energy expenditure induced by high-intensity cycling or running. *Eur J Clin Nutr*, 49(2), 114-123.
- Kline, G. M., Porcari, J. P., Hintermeister, R., Freedson, P. S., Ward, A. N. N., McCarron, R. F., & Rippe, J. M. (1987). Estimation of VO₂max from a one-mile track walk, gender, age, and body weight. *Med Sci Sports Exerc*, 19(3), 253-259.
- LaMonte, M. J., & Blair, S. N. (2006). Physical activity, cardiorespiratory fitness, and adiposity: contributions to disease risk. *Curr Opin Clin Nutr Metab Care*, 9(5), 540-546.
- McGuigan, M. R., Tatasciore, M., Newton, R. U., & Pettigrew, S. (2009). Eight weeks of resistance training can significantly alter body composition in children who are overweight or obese. *J Strength Cond Res*, 23(1), 80-85.
- McMurdo, M. E., Mole, P. A., & Paterson, C. R. (1997). Controlled trial of weight bearing exercise in older women in relation to bone density and falls. *BMJ*, 22:314(7080), 569.
- Melam, G. R., Alhusaini, A. A., Buragadda, S., Kaur, T., & Khan, I. A. (2016). Impact of brisk walking and aerobics in overweight women. *J Phys Ther Sci*, 28(1), 293-297.
- Murphy, M. H., Nevill, A. M., Murtagh, E. M., & Holder, R. L. (2007). The effect of walking on fitness, fatness and resting blood pressure: a meta-analysis of randomised, controlled trials. *Prev Med*, 44(5), 377-385.
- National Heart Lung and Blood Institute. (2000). Clinical guideline on the identification, evaluation and treatment of overweight and obesity in adult.
- Ohta, T., Kawamura, T., Hatano, K., Yokoi, M., Uozumi, Z., Okamoto, N., & Hashimoto, S. (1990). Effects of exercise on coronary risk factors in obese, middle-aged subjects. *Jpn Circ J*, 54(11), 1459-1464.
- Pate, R. R., Pratt, M., Blair, S. N., Haskell, W. L., Macera, C. A., Bouchard, C., ... & Kriska, A. (1995). Physical activity and public health: a recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. *JAMA*, 273(5), 402-407.
- Rimm, E. B., Stampfer, M. J., Giovannucci, E., Ascherio, A., Spiegelman, D., Colditz, G. A., & Willett, W. C. (1995). Body size and fat distribution as predictors of coronary heart disease among middle-aged and older US men. *Am J Epidemiol*, 141(12), 1117-1127.
- Ross, R., Janssen, I., Dawson, J., Kungl, A. M., Kuk, J. L., Wong, S. L., & Hudson, R. (2004). Exercise - induced reduction in obesity and insulin resistance in women: a randomized controlled trial. *Obes Res*, 12(5), 789-798.
- Ross, R., Freeman, J., Hudson, R., & Janssen, I. (2002). Abdominal obesity, muscle composition, and insulin resistance in premenopausal women. *J Clin Endocrinol Metab*, 87(11), 5044-5051.
- Steffen, P. R., Sherwood, A., Gullette, E. C., Georgiades, A. N. A. S. T. A. S. I. A., Hinderliter, A., & Blumenthal, J. A. (2001). Effects of exercise and weight loss on blood pressure during daily life. *Med Sci Sports Exerc*, 33(10), 1635-1640.
- Stein, R. A., Michielli, D. W., Glantz, M. D., Sardy, H., Cohen, A., Goldberg, N., & Brown, C. D. (1990). Effects of different exercise training intensities on lipoprotein cholesterol fractions in healthy middle-aged men. *Am Heart J*, 119(2), 277-283.
- Wei, M., Kampert, J. B., Barlow, C. E., Nichaman, M. Z., Gibbons, L. W., Paffenbarger Jr, R. S., & Blair, S. N. (1999). Relationship between low cardiorespiratory fitness and mortality in normal-weight, overweight, and obese men. *JAMA*, 282(16), 1547-1553.
- Willett, W. C., Manson, J. E., Stampfer, M. J., Colditz, G. A., Rosner, B., Speizer, F. E., & Hennekens, C. H. (1995). Weight, weight change, and coronary heart disease in women: risk within the 'normal' weight range. *JAMA*, 273(6), 461-465.
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