EFFECTS OF HIGH INTENSITY TRAINING AND MUSIC ON BODY COMPOSITION, FITNESS AND METABOLIC PARAMETERS OF OBESE MALAY WOMEN IN SINGAPORE

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UNIVERSITY OF MALAYA
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EFFECTS OF HIGH INTENSITY TRAINING AND MUSIC ON BODY COMPOSITION, FITNESS AND METABOLIC PARAMETERS OF OBESE MALAY WOMEN IN SINGAPORE

ABSTRACT

Can time-economical high intensity exercise aided by music, augment positive results on body composition_parameters (BMI, weight loss, body fat percentage, waist circumference and waist-to-hip ratio); fitness parameters (modified push-up, modified curl-up, bodyweight squats and resting heart rate) and blood lipid health parameters (fasting cholesterol (LDL & HDL), fasting blood glucose and triglycerides) in the obese, despite the obese's functional limitations? Will adherence to exercise be affected? A twelve-week randomized-controlled trial, quantitative experimental design was conducted on voluntary, pre-menopausal overweight/obese (BMI>24.9 kg/m^2) adult Singapore Malay women ((N = 92): Treatment A = HIT+ synchronous music (n = 31), Treatment B = HIT + asynchronous music (n = 31) and Control C = HIT + No Music (n = 30). High intensity (85% - 95% maximum heart rate) trainings consisted of modified push-ups, modified curl-ups and bodyweight squats. Clinical examinations, anthropometric and fitness evaluations were carried out pre-post intervention and 2-year follow-up on weight and waist were conducted. Analysis: IBM SPSS Statistics v.22 with repeated measure (pre-post-tests) and SPANOVA $p < 0.05$. Results showed significant differences in all parameters in within-subjects-comparisons Time 1 to Time 2 of intervention. For between-subjects-comparison, Curl-Up reported significant difference: Synchronous Music vs. Controls (pre = 9.48 ± 7.22, post = 26.32 ± 10.37 vs. Pre = 8.73 ± 5.09, post = 18.67 ± 5.98, $p = 0.023 < 0.05$). Results proved positively for obesity, fitness and health. Physical activity proved effective in all groups, not withstanding music or non-music, noting that there were no significant differences with

RPE/target heart rate for all groups for HIT undertaken. Non-music and synchronous music are only ergogenically effective for Curl-Up fitness. Post 2-year-follow-up on weight trend showed that most of the groups have almost similar trend in the changes of pre, post-12-weeks and post-2-years intervention, excluding Synchronous Music. As to weight before and after 12 weeks, Synchronous Music showed the most weight reduction and this group showed gradual decrease in weight even after 2 years. No-Music and Asynchronous-Music groups showed an increasing trend in weight after 2 years. As for waist trend, the Synchronous music group shows a consistent decreasing trend in the changes of waist pre and post study and post 2 years. Asynchronous music group showed significant decrease only after 12 weeks, but after 2 years, waist-reduction is not significant. No-Music group showed an increased waist trend post 2-years. This multi-disciplinary research contributes to trans-disciplinary and Asia-Pacific-centric new body of knowledge. Original orchestra arrangement composition and prediction formulae (weight loss and waist circumference) and a 2-year post follow-up weight and waist results are novel findings generated from study. This research is important in behavioural epidemiology framework because of its direct impact on population health.

KESAN LATIHAN SENAMAN BERINTENSITI TINGGI DAN MUZIK PADA KOMPOSISI TUBUH, PARAMETER KECERGASAN DAN METABOLIK WANITA OBES DI SINGAPURA

ABSTRAK

Bolehkah senaman intensiti tinggi yang menjimatkan masa, dibantu oleh muzik, menolong mereka yang obes, walaupun terbatas fungsi fizikalnya, meningkatkan hasil positif pada komposisi badan (BMI, penurunan berat badan, peratusan lemak badan, ukur lilit pinggang dan ratio pinggang-ke-pinggul);, parameter kecergasan (push-up, curl-up dan squats dan dan degupan jantung semasa rihat)dan metabolik (cholesterol berpuasa (LDL & HDL), glucose dalam darah berpuasa dan triglycerides)? Adakah kepatuhan kepada senaman? Kajian kuantitatif rawak selama 12 minggu, ke atas wanita Melayu Singapura (N = 92) pra-menopaus, yang bermasalah berat badan obes (BMI> 24.9 kg / m2) yang terbahagi kepada tiga kumpulan: Rawatan A= HIT + Muzik-Segerak (n = 31), Rawatan B = HIT + Muzik-Tidak-Segerak (n = 31) dan Rawatan Kawalan C = HIT tanpa muzik (n = 30). Latihan berintensiti tinggi (85% - 95% kadar jantung maksimum) melibatkan Push-ups, Curl-ups dan Squats yang diubahsuai. Pemeriksaan klinikal, penilaian antropometri dan kecergasan dilakukan sebelum dan sesudah 12 minggu tempuh kajian dan data berat badan serta ukuran pinggang mereka diambil selepas 2 tahun. Analisis: Statistik SPSS IBM v.22 dengan langkah berulang (pra-pasca ujian) dan SPANOVA p <0.05 Hasil menunjukkan perbezaan yang ketara dalam semua parameter dalam masa-perbandingan Masa 1 ke Masa 2 campur tangan intervensi. Bagi perbandingan di antara kumpulan, Curl-Up melaporkan perbezaan signifikan: Muzik-Segerak vs Kawalan (pra = 9.48 ± 7.22, pos = 26.32 ± 10.37 vs Pre = 8.73 ± 5.09, post = 18.67 ± 5.98, p = 0.023 <0.05). Keputusan terbukti positif untuk pengurusan berat badan, kecergasan dan kesihatan. Aktiviti fizikal terbukti berkesan

dalam semua kumpulan, samada HIT di sertai muzik atau pun tidak setelah mengambil kira bahawa tiada perbezaan yang signifikan dalam kadar RPE / sasaran degupan jantung untuk ketiga-tiga kumpulan untuk semua latihan yang dilaksanakan. Kecergasan Curl-up hanya signifikan dalm kumpulan Muzik SnchronousMuzik dan Tanpa Muzik. Data berat badan dan ukuran pinggang pasca kajian selepas 2 tahun telah diambil. Berkenaan dengan trend berat badan, kebanyakan kumpulan mempunyai trend hampir sama dalam perubahan pra, pasca 12 minggu dan selepas 2 tahun. Ini tidak termasuk Muzik Segerak. Berkenaan dengan berat badan sebelum dan selepas 12 minggu, Muzik Segerak menunjukkan pengurangan berat badan yang paling banyak dan kumpulan ini menunjukkan penurunan berat badan yang konsisten walaupun selepas 2 tahun. Kumpulan Tanpa Muzik dan Muzik Tidak Segerak menunjukkan peningkatan trend dalam berat badan selepas 2 tahun. Berhubung dengan trend ukuran lilitan pinggang, kumpulan Muzik Segerak menunjukkan trend menurun yang konsisten dalam perubahan pra dan pasca intervensi 12 minggu dan selepas 2 tahun. Kumpulan muzik Tidak Segerak menunjukkan penurunan yang ketara hanya selepas 12 minggu, tetapi selepas 2 tahun, pengurangan ukuran pinggang tidak signifikan. Kumpulan Tanpa Muzik menunjukkan peningkatan trend pinggang selepas 2 tahun. Penyelidikan pelbagai disiplin ini menyumbang pendapatan baru dalam ilmu pengetahuan trans-disiplin dan Asia-Pasifik . Susunan komposisi orkestra yang asal dan ramalan penurunan berat badan dan lilitan pinggang dan hasil kajian selepas 2 tahun tentang berat dan ukuran lilitan pinggang adalah hasil penemuan asli yang dihasilkan dari kajian. Penyelidikan ini penting dalam rangka kerja epidemiologi-tingkah laku kerana kesan secara langsungnya terhadap kesihatan penduduk.

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a journey unique
of self-discovery and strength

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In honour of my late adopted father who started me on this journey

Allahyarham Haji Mahmood Bin Haji Omar

(AL-FATEHA)

Love to my adopted mother, Hajjah Rokiah Bte Shairkhan

Blessings to Ben Danial Salle & Masazhari Bin Yayit

on their selfless undying support and patience throughout.

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ACSM : American College of Sports Medicine

BMI : Body Mass Index

CVD : Cardiovascular disease

HDL : High density lipoprotein

HIT : High intensity training

HIIT : High intensity interval training

kg : Kilogram

LDL : Low density lipoprotein

m : Meter

MICT : Medium interval continuous training

RPE : Rate of Perceived Exertion

WHO : World Health Organization

CHAPTER 1: INTRODUCTION

1.1 Background

1.1.1 Singapore's Obesity and Metabolic Health

Singapore has reported the second-highest overweight prevalence in the Association of Southeast Asian Nations (ASEAN), at 32.8 percent, according to 2014 age-standardized adjusted estimates by the World Health Organization (WHO), according to the report "Tackling obesity in ASEAN: Prevalence, impact and guidance on interventions" commissioned by the Asia Roundtable on Food Innovation for Improved Nutrition (The Economist Intelligence Unit Limited, 2017). Singapore's obesity cost US$0.4 – 1 billion in 2016 was an increase of up to 9.64 percent (direct and indirect costs) in healthcare spending. Productive years lost for males amounted to six years and ten years for females negatively impact economic growth.

According to the 2010 Singapore National Health Survey (NHS) (Ministry of Health Singapore, 2011), the top 10 principal causes of deaths are cancers, ischaemic heart diseases and diabetes. Even Singapore's minority group was at risk. The Malays, at just 13.5% of the total population, has the highest obesity rate at 24%, compared with 16.9% for Indians and 7.9% for Chinese.

Age-standardized stroke rate for every 100,000 women in 2013 was 195 for Malays, 131 for Indians and 105 for Chinese. Since 2010, Malays is the ethnic group with the highest rate of heart attacks. Furthermore, according to Lam (2015), epidemiologic trends in Singapore showed a sharp 38% increase in age-adjusted HF hospitalizations (from 85.4 per 10,000 in 1991 to 110.3 per 10,000 in 1998) with notable ethnic differences (hospitalization rates ~35% higher in Malays and Indians as compared to the Chinese; mortality 3.5 times higher in Malays as compared to the Indians and Chinese).

Ng et al. (2014) reported in their paper on "Global, regional, and national prevalence of overweight and obesity in children and adults during 1980–2013: a systematic analysis for the Global Burden of Disease Study 2013" that overweight and obesity were estimated to cause 3·4 million deaths, 3·9% of years of life lost, and 3·8% of disability-adjusted life-years (DALYs) worldwide.

With Singapore's high gross domestic product (GDP) per capita economy, being the top 10th richest country in the world based on the World Economic Outlook Database of April 2015 (International Monetary Fund, 2015), it is imperative that Singapore overcomes obesity. Otherwise, with obesity's costs, it will have a detrimental effect on its economy.

1.2 Statement of problem and rationale for research

Singapore's obesity rates has not been overturned. Overall trends for obesity and overweight, for both males and females, have been rising since 1992. There was a 0.65% annual increase in prevalence of obesity from 6% in 2004 to 10.8% (18 - 69 years old) in the 2010 Singapore National Health Survey (NHS) (Ministry of Health Singapore, 2011). Ministry of Health (MOH) and Health Promotion Board (HPB) (2018) jointly conducted a pilot for the National Population Health Survey (NPHS) from November 2016 to May 2017 tracking the health and risk factors, as well as lifestyle practices of Singapore residents reported that the proportion of obese and overweight Singapore adults (aged 18 – 69 years old) was 8.7% (males) and 36.2% (females) in 2017. There was an increase in the female overweight/obese statistics.

Obesity and its primary comorbidities cost the Singapore health care system approximately $260 million per year, not including the indirect costs of loss of productivity and absenteeism. According to Png et al. (2016), in 2010, total economic costs per working-age patient were estimated to be US$5,646 (US$4,432-US$10,612), of which 42% were excess direct medical costs and 58 % indirect productivity-related losses. Total cost projected is expected to rise to US$7,791 (US$5,741-US$12,756) in 2050, with the share of indirect costs rising to 65%. Simultaneous increases in prevalence infer that the total economic costs of diabetes for the entire working-age population will increase by 2.4 fold from US$787 million in 2010 to US$1,867 million in 2050. Economic growth in Singapore, the third richest country in the world according to Forbes (Greenfield, 2016), will be hampered, if obesity is not overcome.

Physical activity is one of the treatment modality for obesity and its comorbidities. However, when it comes to physical activity in Singapore, 4 in 10 Singapore residents aged 18 – 69, did not exercise at least 30 minutes in moderate intensity activity on 5 or more days per week in 2010 (Ministry of Health, 2011). Those who exercised at least once a week represented only 42%, down by 6 percentage point from 2005 according to Singapore's 2011 National Sports Participation Survey (Singapore Sports Council, 2012). The Malays with its 24% obesity rate, alarmingly recorded the biggest drop (42%) in sports participation level. Except for the senior citizens of 60 years and above, participation levels declined across all age groups. According to The Straits Times report of 21 December 2014 the Malay community is the unhealthiest population in Singapore. They make up 24.4% of people on dialysis and the highest heart attacks incidence in 2011.

Noting that Asians, who have relatively higher body fat than Caucasians, have an increased risk of health problems at lower BMI. Kee et al. (2013) reported that the optimal BMI cut-off value for predicting the presence of diabetes mellitus, hypertension, hypercholesterolaemia or at least one of these cardiovascular risk factors varied from 23·3 to 24·1 kg/m2 for men and from 24·0 to 25·4 kg/m2 for women. Therefore, those with a BMI of 23 and above are considered at risk in Singapore – and that includes 66.2 per cent of the Malay community. Thus, taking the above into consideration, Malays is the targeted subjects for our research.

Aye et al. (2015) in their research studying patterns of physical activity and sedentary behavior in a representative sample of a multi-ethnic South-East Asian population: analyzed participants from the population-based cross-sectional Singapore Health 2012 study showed 37.0% reported high levels of sedentary behavior. Sedentarism is defined as the practice of individuals expending less than 10% of their daily energy in the performance of moderate and high intensity activities (i.e. activities expending at least 4 basal metabolism rate multiples such as brisk walking, gardening activities or playing tennis) (Bernstein, Morabia & Sloutskis, 1999). There was a consistent association between age of participants with physical activity and exercise. Older participants were less likely to meet the guidelines than younger participants. The prevalence of regular exercise was lowest among 30 to 39 years aged participants and females exercised less regularly than males. The Economist Intelligence Unit Limited (2017) reported that with regards to gender, obesity trends in ASEAN countries including Singapore, are caused by women where it is reported that women have higher rates in overweight and obesity classifications. Thus, this research's target subjects consisted of women aged 25 – 55 years old.

The Nurses Health Study tracked patterns of weight gain and the development of diabetes in 78,000 American women as the study wanted to examine whether there were any differences by ethnic group (Shai et al., 2006). Twenty years of tracking these healthy women, it was discovered that Asians, at the same BMI, had more than double the risk of developing type 2 diabetes as compared to the whites, Hispanics and blacks. Another discovery reported was that increases in weight over time were more harmful to Asians than in the other ethnic groups (International Diabetes Federation, 2014).

Several studies by Deurenberg-Yap et al. (2000) and Misra et al. (2017) found that at the same BMI, risks for hypertension, diabetes and cardiovascular disease was higher for Asians than the white Europeans. Early death risks from cardiovascular disease was also higher. Even those at the upper end of the normal BMI category are at increased risk of diabetes (Kobayashi, Chan & Fuller-Thompson, 2018).

Obesity's threat to health and economy presents an urgency of treatment. As with United States' urbanization affecting the epidemiology of public health into obesity (Voss et al, 2013), urban Singapore is facing a similar problem. Physical activity is a treatment modality for obesity, serving as a primary role in weight management as well as weight loss maintenance (Riebe et al., 2018). Even modest weight losses of 5 to 10% of body weight were proven to be associated with significant improvements in cardiovascular risk factors among overweight and obese individuals having Type 2 diabetes at 1 year (Wing et al., 2011).

A dose-response relationship exists between the amount (frequency, intensity, duration) of physical activity and health outcomes (American College of Medicine, 2014, Paterson and Warburton 2010; WHO 2010). Based on the dose-response relationship of physical activity and health outcomes, higher heart-rate physical activity will generally lead to greater benefits (Miller et al., 2014).

Higher heart rates are augmented by high intensity trainings consisting of the involvements of repeated short-to-long bouts of rather high-intensity exercise interspersed with recovery periods/at a lower intensity. According to Buchheit and Laursen (2013), these entails an optimal stimulus to elicit both maximal cardiovascular and peripheral adaptations where one spends at least several minutes per session in their 'red zone,' (namely, at least 90 % of their maximal oxygen uptake ($\dot{V}O_{2max}$)). High intensity training prescription consists of the manipulation of up to nine variables, including the work interval intensity and duration, relief interval intensity and duration, exercise modality, number of repetitions, number of series, as well as the between-series recovery duration and intensity. Manipulation of any of these variables can affect the acute physiological responses to high intensity training. The reason for using high intensity training in both healthy and clinical populations is that the vigorous activity segments promote greater adaptations through increased cellular stress, yet their short length, and the ensuing recovery intervals, allow even untrained individuals to work harder than would otherwise be possible at steady-state intensity.

However, the obese individual has functional limitations when exercising as their exercise capacity is decreased at submaximal, peak intensity and during recovery. Moreover, at peak effort musculoskeletal pain was an important reason to end the test and not true leg fatigue (Hulens et al., 2001). As a result, maximal output in performance during exercise is compromised. This in turn affects energy expenditure having a bearing on obesity. Thus, the recommendation of a short duration exercise regime.

High intensity training has been shown to be safe for all populations, for the healthy and diseased populations (Hwang et al., 2011, Gibala et al., 2012). Studies on special populations, namely obese young females (Racil et al., 2013), chronic stroke survivors (Globas et al., 2012), patients with cardiovascular and metabolic disease (Shiraev & Barclay, 2012) supported this. For special populations, it is imperative to adhere to guidelines for the delivery and monitoring of high intensity interval training in clinical populations (Taylor et al., 2019).

Furthermore, the most commonly cited barriers to regular exercise participation for the obese is “lack of time” and “boredom of exercise” (Egan et al., 2013). High intensity exercise requires significantly less time exercising per week, yet were able to maintain exercise enjoyment and the participants were more likely to intend to continue and adhere in their exercise programs (Heinrich et al., 2014). Hence the rationale for high intensity exercise.

High intensity training has been shown to be safe for all populations, for the healthy and diseased populations (Hwang et al., 2011, Gibala et al., 2012). Studies on special populations, namely obese young females (Racil et al., 2013), chronic stroke survivors (Globas et al., 2012), patients with cardiovascular and metabolic disease (Shiraev & Barclay, 2012) supported this.

In a further attempt to overcome functional shortcomings of the obese and in order to optimise performance for weight management, physical activity interventions can be ergogenically aided by music. Music is a source of motivation and inspiration that is valued and appreciated within the sport and exercise regime (Simpson & Karageorghis, 2006). Music is demonstrated to elicit pleasant associations as well as masking unpleasant stimuli (for example, heavy breathing associated with exertion) or act as a distraction to internal feelings associated with discomfort (Boutcher & Trenske, 1990). Music assists in exercise performance by reducing the sensations of fatigue, promoting relaxation, increasing physiological arousal and improving motor coordination (Szabo, Small & Leigh, 1999). Furthermore, Karageorghis et al.'s (2010) research on synchronous and asynchronous music reported that women gained the greatest benefits from both music conditions ergogenically and psychologically during circuit type exercise as compared to men. This knowledge that women gained the greatest benefits from both music conditions – synchronous and asynchronous music - ergogenically and psychologically during circuit type exercise, is taken into consideration and we apply it to our study of women in our research.

Previous studies have been carried out to test the effectiveness of synchronous and asynchronous music in treadmill walking (Karageorghis et al., 2009), cycle ergometry (Anshel & Marisi, 1978), 400-m running (Simpson & Karageorghis, 2006) and swimming (Karageorghis et al., 2013). To the best of the author's knowledge, the effects of culture-centric synchronous and asynchronous music have not been researched among overweight and obese Singapore Malay women.

1.3 Objectives of research

It is the premise of this research to intervene with the following specific objectives:

1. To investigate the effects of a twelve-week physical activity intervention programme with music (synchronous or asynchronous music) as ergogenic factor, on body composition parameters (namely, BMI, weight loss, body fat percentage, waist circumference and waist-to-hip ratio); fitness parameters (namely, modified push up, modified curl up, bodyweight squats and resting heart rate) and blood lipid health parameters (fasting cholesterol (LDL & HDL), fasting blood glucose and triglycerides) of adult overweight and obese Malay women in Singapore;

2. Ascertain if adherence to exercise is affected at the end of the study.

3. Propose prediction formulae for body weight and waist reduction through high intensity exercise with/without music.

4. Examine a follow up study on the subjects 2 years post-study for their adherence to exercise

This study will design, apply, assess and analyse a physical activity intervention consisting of circuits, high intensity interval trainings utilizing bodyweight, impacting postural stability and mobility, accompanied by special original orchestra arrangement music as a treatment and prevention strategy for obesity.

1.4 Research Questions and Hypotheses

Thus, the purpose of the current study was to examine the effects of two experimental conditions, namely synchronous music and asynchronous music and a no-music control conditions and physical activity on three relevantly grouped dependent measures: body composition (BMI, weight loss, body fat percentage, waist circumference, waist-to-hip ratio), fitness (push up, curl up, bodyweight squat tests) and metabolic health (blood pressure, blood glucose, cholesterol) parameters. Based on findings (Anshel & Marisi, 1978; Simpson & Karageorghis, 2006) and theoretical predictions (Karageorghis et al., 1999; Karageorghis, Priest et al., 2006), the following hypotheses were tested.

This study will examine whether subjects in the synchronous music + physical activity intervention treatment group will augment the highest body composition, functional fitness and blood lipid health parameters, second highest in the asynchronous music + physical activity and lowest in the no music + physical activity groups at post intervention.

This research hypothesized that there will be a significant relationship between synchronous music to high intensity exercise resulting in reduction of BMI, increased weight loss and increased functional fitness as well as improved metabolic profile.

At the end of this research, this study will attempt to answer whether this physical activity intervention, with the accompaniment of specially choreographed synchronous music, impact body composition positively in terms of increased weight and decreased waist measurements in overweight and obese adult Malay women in Singapore. It will examine whether music is effective at high intensity exercises. It will also examine whether high-intensity exercise detrimental to the obese in terms of adherence and if these subjects are still exercising after 2 years post study.

1.5 Significance of research

This initiative in research while investigating the results of a physical activity intervention, hoped to increase health awareness through physical activity, in a minority population burdened with being the unhealthiest demographic with the biggest drop in sports participation level, specifically 42% across all age groups below 60 years of age. This initiative is in line with the Singapore Sports Council (2012) Singapore's "Vision 2030: Live Better through Sports (National Sports Participation Survey 2011. Final Report.).

There is a scarcity of national obesity prevalence and epidemiological data in countries in the Asia Pacific region, drawing from review conducted by Khoo & Morris (2012) on physical activity and obesity research in the Asia Pacific which examined the impact of physical activity interventions on obesity-related outcomes. In addition to this is the fact that the Asia Pacific population is different in terms of physical, social, psychological and cultural which requires local and regional research. In this regard, Singapore can be used as a translational study for urbanized Asia. This study purports to fill the void of researches on physical activity interventions on obesity-related outcomes in the Asia-Pacific region, researches of which is rather limited. This research will make contributions to the new body of knowledge which is trans-disciplinary in approach and Asia-Pacific-centric.

With contributions of new knowledge from this research on this ethnic demographic –the Malay women - this can be a useful case study for its neighbor, Malaysia, who is struggling with obesity and is the fattest country in South East Asia in 2015. This study is imperative also in the other South East Asian countries riding its globalization wave. This research is applicable as an obesity fitness management targeting the dynamics of a community intervention. As South-East Asia becomes progressively urbanized, noting GDP growth and the need of BMI of 23-25 kg/m2 needed to assist globalization, the results of this research is valuable, not only as a case study in a developed nation's fight against obesity, but can be used as translational to achieve the recommended BMI in the developing countries of South-East Asia. So far no country has overturned their obesity rate successfully. With the new economic cooperation initiative, the United States-Asean Connect (Basu, 2016), Asean will become more e-connected over time, but real action of connectivity will be in mainland S.E.A. A healthier community in one country, will translate positive benefits in terms of better quality of life, higher productivity and economy which permeates into the Asian and thereafter, the global community.

With the application and integration of multi-disciplines, namely cultural (music) and sports (movements) and health science, to improve obesity and fitness management, grouping this research based on grand challenges, i.e. long-term global/local issues requiring trans-disciplinary approach in solution, it professes to strengthen the collaborations amongst different fields of specialization in order to achieve more focused research outputs. This intervention programme can be promoted at national, regional and international levels to combat obesity. Furthermore, this study adds to the advancement of intellectual property ownership in terms of the patent of music and movements.

1.6 Scope of research: assumptions, limitations & de-limitations

The scope of research is based on the assumptions, limitations and de-limitations listed below.

1.6.1 Assumptions of the research

Based on the subjects selected for the proposed study, it is assumed that the results are applicable to all overweight and obese women of the same ethnicity, namely Malays in Singapore.

It is also assumed that the choreographed synchronous and asynchronous music are music preferred, liked and enjoyed by the subjects.

1.6.2 Limitations of the research

Lifestyle factors such as diet and sleep can impact the research outcome. According to Taheri et al. (2004), short sleep duration is associated with reduced leptin, elevated ghrelin and increased BMI. The inability to control their dietary intake over the entire period of study and the difficulty in ensuring that the subjects' adopt an ideal sleeping pattern are possible limiting factors. The following steps were taken during the investigations to ensure that all these factors were controlled.

In terms of dietary intake, subjects were advised to continue their normal diet. Ways to monitor this was through recording of their food intake manually. My Fitness Pal (www.MyFitnessPal.com), a free online calories counter with nutrition facts for over 2,000,000 foods is a free downloadable Smartphone mobile application. Similar information was also referred to from The Singapore Health Promotion website (www.hpb.gov.sg). Subjects were requested to write a 3-day food diary on Friday, Saturday and Sunday, pre and post study detailing the time and portion of their food and water intake. They were advised to sleep 8 hours per day. Their rest and physical activity will also be recorded in their diary.

All groups performed the same exercises and were exposed to instructions from the same instructor. The personality of the instructor was anticipated as an effect of extraneous variable for the study. In order to minimize this effect, the same instructor conducted all instructions for treatment and control groups. In order to avoid the eventuality that subjects' performance will be due to verbal psychological motivation and not from the music intervention, instructor was instructed to refrain from using any motivational terms to psychologically induce increased performance.

Taking into considerations with regards to the eventual case of limitations of male experimenter testing on female subjects, as reported by Anshel and Marisi (1978) in their study where female subjects severely underperformed, despite working at the same relative intensity as their male counterparts in their study. It was reported that these female subjects might not wish to exert themselves maximally in the presence of male experimenters. Thus to counter the effects of social influence in our study, female testers were recruited.

Another limitation is that of genetic inheritance of obesity. While there is strong evidence that certain genes have an influence on body mass and body fat, most do not qualify as necessary genes, i.e. genes that cause obesity whenever two copies of the defective allele are present; it is likely to be many years before the results of genetic research can be applied to the problem the genetic inheritance of the subjects with reference to obesity (WHO, 2000). However, measures were taken during initial interview with the subjects, by exploring whether they had obesity since childbirth. These subjects were then not recruited for this study.

However, it is emphasised that it is not within the scope of this study to conduct genetic racial and obesity studies due to funding and time restrictions.

1.6.3 Delimitations of the study

The research was conducted on overweight and obese women in Singapore and hence the inferences or outcome from these studies may not be applicable to the following sub-populations:

- Overweight and obese females who are smokers.
- Overweight and obese females with medical conditions such as coronary vascular diseases, respiratory ailments, osteoporosis, cancer and/or any other chronic diseases.

1.7 Operational definitions

The clarity of the meaning of key words are important. Thus, this section contains the definitions most widely accepted in the field, as they are used in this study. These definitions are offered as an interpretational framework for comparing studies that relate physical activity, exercise, and physical fitness to health.

In this research we will use physical activity and exercise interchangeably because some of the documents to which we will refer to, use the term “exercise” and others use the term “physical activity” without clearly delineating a difference as noted above.

Body mass index (BMI) or Quetelet index (Quetelet, 1835) is a measure for the human body shape based on an individual’s mass and height. It is calculated as individual weight divided by the square of the height, expressed in metric. Metric: BMI = kg / m^2 where kg is the subject’s weight in kilogramme and m is the subject’s height in metres (World Health Organisation, 2016).

Health has physical, mental, social, and psychological dimensions. Positive health is not merely the absence of disease or infirmity, but the capacity to withstand challenges and to accomplish life's activities with pleasure and energy (World Health Organization, 1946).

Overweight and obesity are defined as abnormal or excessive fat accumulation that may impair health (World Health Organization, 2015).

Physical activity (PA) is being defined as “any bodily movement produced by the contraction of skeletal muscles that results in an increase in caloric requirements over resting energy expenditure” (Caspersen 1985; American College of Sports Medicine, 2013).

Exercise is a subset of physical activity that is planned, structured, and repetitive and has as a final or an intermediate objective the improvement or maintenance of physical fitness (Caspersen et al, 1985).

Physical fitness is a physiological state or attributes that people have or achieve that relates to the ability to perform physical activity (Caspersen et al., 1985). Physical fitness is the ability to perform moderate-to-vigorous levels of physical activity without undue fatigue and the capability of maintaining this capacity throughout life. Physical fitness is defined as outcome of physical activity.

Physical fitness is composed of morphologic factors (body composition, body density and flexibility), muscular performance (power, strength, endurance), motor ability (agility, balance and coordination, speed of movement) and cardiorespiratory capacity (submaximal exercise capacity and maximal aerobic power) (Bouchard, Shepard & Stephens, 1993).

Physical fitness is either health-related or performance-related. Health-related fitness components are aerobic fitness, muscular endurance, muscular strength, body composition and flexibility. Performance-related fitness components are agility, balance, power, speed, coordination and reaction time.

Fatigue is defined as the point when maximum heart rate is achieved or the point of maximal oxygen consumption.

Metabolic Equivalent (MET) is used as an index of the intensity of activities. 1 MET is resting energy expenditure (3.5 ml O^2. $kg^{-1}.min^{-1}$). For example, 3 METS is three times the resting rate. The ratio of a person's working metabolic rate relative to the person's resting metabolic rate. One MET is the energy it takes to sit quietly, or about 3.5 ml $O^2.kg^{-1}.min^{-1}$ (Rahl, 2010).

Cardiorespiratory fitness is the ability of the circulatory and respiratory systems to provide oxygen during sustained aerobic physical activity.

Functional ability is the capacity to perform practical tasks, activities and behaviours that fulfil one's role in society, maintain independence, and enhance quality of life. Duration is the length of time (usually minutes) an activity is continued. Frequency is the number of times an activity is performed within a specified time period, usually expressed as bouts, episodes, or sessions per week.

Intensity (absolute) for aerobic activities is the rate of energy expenditure required to perform the activity; it does not consider the physiologic capacity of the person performing the activity. It can be measured in metabolic equivalents (METs), kilocalories, joules, milliliters of O_2 consumption, or for some activities, speed (e.g., walking at 4 miles/h). Current practice is to categorize absolute intensity into four categories: sedentary ≤ 1.5 METs, light intensity 1.6–2.9 METs, moderate intensity 3.0–5.9 METs, and vigorous intensity ≥ 6.0 METs (Pate, O'Neill & Lobelo, 2008).

Intensity (relative) describes the ease or difficulty with which an activity is performed. It is proportional to one's current maximal capacity. The relative intensity of aerobic activities can be described as percent of aerobic capacity (VO_{2max}), percent of maximal heart rate, or other similar measures. It can also be described by how hard an individual perceives an activity to be: very light, light, moderate, hard, very hard, or maximal (Pate, O'Neill & Lobelo, 2008).

Asynchronous music has no conscious synchronization between one's movement patterns and musical tempo or meter and is just played in the background to make the environment more pleasurable (Karageorghis & Terry, 1997); definition of tempo is the "speed" of a piece of music as measured in beats per minute (bpm) whereas the "meter" relates to how the listener perceives or feels the beat.

Synchronous music is utilized as a type of metronome to regulate a movement pattern, while asynchronous music functions more as a background accompaniment 'without conscious synchronization between movement patterns and musical tempo' (Karageorghis et al., 2010; Hayakawa et al., 2000).

CHAPTER 2: LITERATURE REVIEW

This review focuses on the potential benefits of incorporating higher intensity exercise in terms of its effects on weight loss, fitness and metabolic health parameters for the obese. As high intensity exercises are rather hard to be executed by the obese due to their limitations, music as ergogenics will be used. This literature reviews physical activity interventions using synchronized and asynchronised music. The purpose of this review is to further summarise current cross-sectional and longitudinal studies on these music, physical activity and obese women and to identify the interaction between these 3 parameters.

2.1 Physical activity for obesity, functional fitness and health management

Increases in the health-related quality of life are seen with physical activity engagement as reported by Sun et al. (2014). Lopinzi and Davis (2016) reported that both bouted and non-bouted physical activity was linked with health-related quality of life. However, even with the amount of compelling evidence on the benefits of physical activity (Department of Health and Human Services 2008; Powell 2011), a third of adults and four-fifths of adolescents of the global population, do not reach public health guideline-recommended levels of physical activity (Hallal, 2012). I-Min et al. (2012) estimated that physical inactivity causes 6% (ranging from 3·2% in Southeast Asia to 7·8% in the eastern Mediterranean region) of the burden of disease from coronary heart disease, 7% (3·9–9·6) of type 2 diabetes, 10% (5·6–14·1) of breast cancer, and 10% (5·7–13·8) of colon cancer. Inactivity itself causes 9% (range 5·1–12·5) of premature mortality, or more than 5·3 million of the 57 million deaths that occurred worldwide in 2008. They further estimated that elimination of physical inactivity would increase the life expectancy of the world's population by 0·68 (range 0·41–0·95) years.

There has been numerous studies conducted at the international level, promoting physical activity as the treatment modality for obesity, namely the Global Recommendations on Physical Activity for Health (WHO 2010) on Identification, Evaluation and Treatment of Overweight and Obesity in Adults (NIH, 1998), the Strategy on nutrition, overweight and obesity-related health issues, the White Paper (European Commission, 2010) on a strategy for Europe on nutrition, overweight and obesity, diet , physical activity and health (EU Platform, 2005) and the monitoring of progress to improve nutrition and physical activity and prevent obesity in the European Union (NOPA, 2008). These initiatives indicates that physical activity is not only the treatment modality for obesity but it is relevant for obesity and fitness management.

According to Jakicic & Rogers (2014), lifestyle interventions that reduce energy intake and increase energy expenditure are the foundation of effective treatment for overweight and obesity. Physical activity can contribute to both initial weight loss, sustained long-term weight loss (Jakicic et al., 2014) and prevention of weight regain (Thomas et al., 2014).

The advocacy for the promotion and adoption of physically active lifestyles as an affordable and effective means to prevent chronic diseases are present in many studies: gestational diabetes mellitus in obese women (Artal, 2015); even the adverse association of diabetes with risk of first acute myocardial infarction is modified by physical activity and body mass index: prospective data from the HUNT Study, Norway (Moe et al., 2015). According to a systematic review by Vasconcellos et al. (2014) investigating the effect of physical activity on aerobic capacity, muscle strength, body composition, hemodynamic variables, biochemical markers, and endothelial function in obese/overweight adolescents, the results indicated that physical activity is associated with significant changes beneficial to fat percentage, waist circumference, systolic blood pressure, insulin, low-density lipoprotein cholesterol, and total cholesterol. The study reported small non-significant changes in diastolic blood pressure, glucose, and high-density lipoprotein cholesterol. It has been proven that modest weight losses of 5 to 10% of body weight were associated with significant improvements in cardiovascular risk factors in overweight and obese individuals with Type 2 diabetes at 1 year, but larger weight losses had greater benefits (Wing et al., 2011). Treatment of dyslipidemia in obesity should be aimed at weight loss by increased exercise (Arca, M., 2015). Beavers et al. (2014) reported that 18-month physical activity and weight loss program resulted in a significant reduction in percent body fat with a concomitant increase in percent body lean mass. Shifts in body weight and composition were associated with favorable changes in clinical parameters of cardio-metabolic risk and mobility. From a clinical perspective, both CRF and PA levels are established independent risk factors for cardiovascular diseases, Type 2 diabetes mellitus and all-cause mortality (Swift et al., 2013). The effect, moderators and mediators of physical activity specifically, resistance and aerobic exercises on health-related quality of life have been proven in survivors of prostate cancer (Buffart et al., 2015).

The importance of physical activity is further intensified by the "Obesity Paradox" constituting "healthy" obesity with supporting epidemiological evidence reporting greater survival in adults with cardiovascular diseases with higher obesity levels compared to lower levels (Lavie, Milani & Ventura, 2009), in patients with peripheral arterial disease (Galal et al., 2008), in patients with hypertension and coronary artery disease (Uretsky et al., 2007) with physical activity as its keyword. Survival rates of heart attack patients are higher even with higher BMIs, compared to those who were relatively thinner who did not exercise. The obesity paradox here may be partially explained by the level of cardiorespiratory fitness. Cardiorespiratory fitness may result in a healthy obesity that suppresses metabolic aging therefore associated with a better life expectancy. According to McAuley et al. (2012), higher cardiorespiratory fitness levels appears to be protective against mortality in all BMI categories. Not only is physical activity beneficial for the reduction of obesity but it has a major role in health-related parameters.

Physical activity is also a strong associate of functionality. Barbat-Artigas et al. (2014) reported that higher levels of muscle quality were associated with higher physical function scores. Nicklas et al. (2015) reported that resistance training improved body composition (including reducing inter muscular adipose tissue) and muscle strength and physical function in obese elderly. Their knee strength, power, and quality of their 400-metre walk gait speed increased. A structured, moderate-intensity physical activity program compared with a health education program reduced major mobility disability over 2.6 years among older adults at risk for disability. Meta-analysis by Chou, Hwang & Wu (2012) reported that exercise is beneficial to increase gait speed, improve balance, and improve performance in assisted daily living in the frail older adults. These findings suggest mobility benefit from such a program in vulnerable older adults.

Monleón et al. (2015) in their study on the effects of eight-month physical activity intervention on vigilance performance in adult obese population, reported that participants improved their cardiorespiratory fitness, BMI, and vigilance performance after the intervention. All in all, findings contribute new empirical evidence to the field that investigates the benefits of physical activity intervention on cognitive processes in obese population.

Physical activity was shown to enhance independence for older adults (Chodzko-Zajko, 2014) as well as in the promotion of healthy aging and enhanced quality of life (in breast cancer survivors by Phillips & McAuley, 2014) as well as the reduction of depression and negative body image perceptions (Zarshenas, Houshyar & Tahmasebi, 2013). In addition, higher intensity physical activity has been associated with greater improvements in health and fitness and increased longevity. Almeida et al. (2014) reported 150 minutes of vigorous physical activity per week predicts survival and successful ageing in a population-based 11-year longitudinal study of 12 201 older Australian men.

Regular physical activity participation is associated with reduced risk of morbidity and mortality (Kokkinos, 2012) and is associated with improved health-related quality of life, namely an improvement in physical functionality, vitality, mental health and the ability to function socially (Klavestrand & Vingard, 2009).

2.1.1 The case for high intensity training

High intensity training has been listed as the Top 10 Fitness Trends in the world from 2014 to 2018 as reported by the Worldwide Survey of Fitness Trends by the American College of Sports Medicine (Thompson, 2017). High intensity training are brief intervals of vigorous activity interspersed with periods of low activity or rest. This induces an acute physiological response (MacInnis & Gibala (2017), Gibala et al., 2012). Majority numbers of high intensity training protocols use high-intensity intervals lasting between 1 and 4 min. High intensity training's objective is to accumulate activity at an intensity that the participant would be unable to sustain for prolonged periods (i.e. 80–95% of peak oxygen consumption (V.O2peakV.O2peak) or >90% of maximum heart rate (HR_{max}). Thus the recovery time must be adequate to allow the subsequent interval to be completed well. High intensity training's duration per session tends to be ≥20 min, which actually makes it comparable with recommendations for moderate intensity continuous training, in terms of duration.

2.1.1.1 Time economy of high intensity training

"Lack of time" and "boredom of exercise" are two of the most commonly cited barriers to regular exercise participation for the obese (Egan et al., 2013). These inability to perform may well lead to potentially poorer adherence (Dishman, 2010). The attraction of high intensity exercises being economical in time, can be an attractive option. Furthermore, according to Bartlett et al. (2011), high-intensity interval running is perceived to be more enjoyable than moderate-intensity continuous exercise and these has great implications for exercise adherence. Gillen & Gibala (2014) also reported that high-intensity interval training is a time-efficient exercise strategy to improve health and fitness.

Enjoyment of exercise is important to counteract boredom. Jung et al. (2014) in their study compared continuous moderate-intensity exercise (CMI), continuous vigorous-intensity exercise (CVI) and high-intensity interval training (HIT). Task self-efficacy, intentions, enjoyment and preference were evaluated after sessions. Subjects reported greater enjoyment of HIT as compared to CMI and CVI, with over 50% of participants reporting a preference to engage in HIT as opposed to either CMI or CVI. Of the three types of exercises, HIT was considered more pleasurable than CVI after exercise, but less pleasurable than CMI. Despite this, the subjects reported being just as confident to engage in HIT as they were CMI, but less confident to engage in CVI. This research highlighted the usage of HIT in inactive individuals, and recommended that it may be a viable alternative to traditionally prescribed continuous modalities of exercise for promoting self-efficacy and enjoyment of exercise.

2.1.1.2 High intensity training is safe for all populations

High intensity training can serve as an effective alternative to traditional endurance training, augmenting similar or even superior changes in a range of physiological, performance and health-related markers in both healthy individuals and diseased and special populations (Hwang et al., 2011, Gibala et al., 2012), obese young females (Racil et al., 2013), chronic stroke survivors (Globas et al., 2012), patients with cardiovascular and metabolic disease (Weston et al., 2014; Shiraev & Barclay, 2012). All these studies examining the effects of high intensity interval exercises on health have demonstrated the positive effects of high intensity exercise trainings, being safe and beneficial.

Guiraud et al. (2012) in their review reporting the effects and interest of high intensity interval training in patients with coronary artery disease and heart failure, as well as in persons with high cardiovascular risk reported that high intensity interval training appears to be a safe and effective alternative for the rehabilitation of these patients.

According to Kelly et al. (2014), Parkinson's disease moderately advanced sufferers adapted to high-intensity exercise training with favorable changes in skeletal muscle at the cellular and subcellular levels that are associated with improvements in motor function, physical capacity and fatigue perception.

Adams (2013) reported that very brief high intensity exercise (Six studies of non-diabetics (51 males, 14 females) requiring 7.5 to 20 minutes/week of HIE and eight studies of diabetics (41 type 1 and 22 type 2 subjects) with six were of a single exercise session with 44 seconds to 13 minutes of HIE, and the others were 2 and 7 weeks duration with 20 and 2 minutes/week HIE, respectively) not only improves blood glucose 1 to 3 days post exercise in both diabetics and non-diabetics, but that high intensity exercise is unlikely to cause hypoglycemia during and immediately after exercise and thus is a safe protocol.

Weston et al. (2014) in a systematic review and meta-analysis of 10 studies to quantify the efficacy and safety of HIIT compared to MICT in individuals with chronic cardio metabolic lifestyle diseases (coronary artery disease, heart failure, hypertension, metabolic syndrome and obesity), reported that HIIT significantly increases cardio-respiratory fitness by almost double.

According to Hoffman et al. (2016), in the first randomized controlled trial with supervised moderate-to-high intensity exercise in patients with mild Alzheimer's Disease, exercise was shown to reduce neuropsychiatric symptoms in patients with mild Alzheimer's Disease, with possible additional benefits of preserved cognition in a subgroup of patients exercising with high attendance and high intensity.

2.1.1.3 High intensity training for obesity fitness health management

A dose-response relationship exists between the amount (frequency, intensity, duration) of physical activity and health outcomes (Paterson and Warburton 2010; WHO 2010). Based on the dose-response relationship of physical activity and health outcomes, higher heart-rate physical activity will generally lead to greater benefits (Miller et al., 2014). Racil et al.'s (2013) 12-weeks interval training investigating the effects of high versus moderate exercise intensity during interval training on lipids and adiponectin levels in obese young females, reported that HIIT positively changes blood lipids and adiponectin resulting in improved insulin sensitivity. This study chose blood glucose as one of its metabolic profile parameters for this matter.

Higher intensity physical activity has been associated with greater improvements in health and fitness. We need different types of activity to maintain different physiologic systems for health, namely cardiovascular fitness activities, ambulatory and strength-training activities as well as balance trainings for functional fitness (Powell, Paluch & Blair, 2011). 500–1000 MET-min/week provides substantial health benefits with light-and moderate-intensity activities at the lower end (left) of the dose-response curve, where benefits are gained or lost more quickly and vigorous activities become important at the high end (right) of the curve, where changes in relative risk are slower.

High intensity training consists of the involvements of repeated short-to-long bouts of rather high-intensity exercise interspersed with recovery periods/at a lower intensity. According to Buchheit and Laursen (2013), these entails an optimal stimulus to elicit both maximal cardiovascular and peripheral adaptations where one spends at least several minutes per session in their 'red zone,' (namely, at least 90 % of their maximal oxygen uptake ($\dot{V}O_{2\max}$)). High intensity training prescription consists of the manipulation of up to nine variables, including the work interval intensity and duration, relief interval intensity and duration, exercise modality, number of repetitions, number of series, as well as the between-series recovery duration and intensity. Manipulation of any of these variables can affect the acute physiological responses to high intensity training. The reason for using high intensity training in both healthy and clinical populations is that the vigorous activity segments promote greater adaptations through increased cellular stress, yet their short length, and the ensuing recovery intervals, allow even untrained individuals to work harder than would otherwise be possible at steady-state intensity.

Even a single extended sprint, which may represent a more time-efficient alternative to sprint interval training (matched for total work, on metabolic health biomarkers), can increase insulin sensitivity and increase fat oxidation in overweight overweight/obese sedentary men (Whyte et al., 2013). Dunn (2009) reported that 12 weeks of HIIT resulted in significant subcutaneous and abdominal fat loss. Airin et al. (2014) investigate the comparative effects between high-intensity interval training and continuous training in inducing the improvement of body weight and body composition among overweight females. The high-intensity interval group showed significant improvement in body fat percentage (2.2 % vs. 0.3 %), lean body mass (−0.5 kg vs. 0.8 kg) and waist-to-hip ratio. Nevertheless, there were no apparent differences in weight and body mass index (BMI) between the two groups. But there was a significant decrease in body weight in high intensity and continuous training groups, respectively, whereas BMI was significantly reduced by 0.5 kg/m^2 for both groups. The high-intensity interval training group showed greater decrease in body fat percentage as well as the improvement of overall anthropometric indices in overweight females.

Trapp et al. (2008) also reported significantly more subcutaneous fat (2.5kg) than those in the steady state aerobic exercise program, after 15 weeks with thrice weekly 20 –minute HIIE in young women (8-second sprint followed by 12 seconds of low intensity cycling versus steady state cycling at 60% VO2max for 40 minutes. This study also found that this 15-week intervention resulted in a significantly reduced abdominal fat (1.5 kg) in untrained young women whereas Dunn (2009) found that 12 weeks of HIIE resulted to a 12 kg decrease in abdominal fat.

The most utilized protocol has been the Wingate test of 30 seconds of an all-out sprints, amounting to 3 – 4 minutes of cycle exercise, performed thrice weekly. As little as 6 sessions of high intensity interval training over 2 weeks or a total of only approximately 15 minutes of very intense exercise demonstrates positive gains in metabolic adaptations (Gibala & McGee, 2008). Ma et al. (2103) reported that extremely low-volume, high-intensity interval Wingate training on recreationally active adult males showed improved exercise capacity and increased mitochondrial protein content in human skeletal muscle. Astorino et al. (2012) also reported enhanced VO2max and O2 pulse and lower power output in active men and women.

The positive effects of high intensity intermittent exercise training on fat loss have been reported in various exercise prescriptions, namely 8-second cycle sprint followed by 12 seconds of low intensity cycling for 20 minutes (Trapp, 2008), 15-second cycle sprint followed by 15 seconds of low intensity cycling for 20 minutes (Whyte et al., 2010) and 2-minute cycle sprint followed by 3 minutes of low intensity cycling for 20 minutes (Boudou, 2003). In Boutcher (2011), repeated brief spinning at an all-out intensity or rest. Length of sprints and recovery varies from 6 seconds to 4 minutes.

"Tabata training" is a term that is used synonymously with high intensity interval training and was first described by the Japanese scientist Izumi Tabata in 1996. It is basically anaerobic high intensity interval training with controlled rest periods. Executing multiple rounds of body weight and plyometric exercises, it improves cardiorespiratory endurance as guided by ACSM guidelines of 2010. Tabata's protocol are four successions of Tabata in 20 seconds of all-out exercise effort, followed by 10 seconds of rest being repeated 8 times. Basically, it is high intensity interval training for a total of 4 minutes of exercise at 74% VO2 max, with 1 minute rest between each segment. Its rate of perceived exertion is in the "hard" range.

Emberst et al. (2013) investigated on the relative exercise intensity and energy expenditure of a Tabata workout. The results of this study indicate that a 20-minute Tabata session, which utilized multiple rounds of body-weight and plyometric exercises, meets ACSM guidelines to improve cardiorespiratory endurance. Additionally, the multiple rounds of exercise were well tolerated by subjects and resulted in an increase in caloric expenditure beyond what would normally be seen if only 4 minutes of exercise was completed.

Smith et al. (2013) in examining the effects of a crossfit-based high-intensity power training (HIPT) program significantly improves VO2max and body composition in subjects of both genders across all levels of fitness.

Skelly et al. (2014) reported that high-intensity interval exercise induces 24-hour energy expenditure similar to traditional endurance exercise despite lower total training volume and reduced time commitment. Fan et al. (2013) reported that even micro-bouts of activity—shorter than 10 minutes—can lower one’s risk of obesity as long as the intensity level is sufficiently high. With each daily minute of higher-intensity activity lowered the odds of obesity by 5 percent for women and 2 percent for men.

2.1.1.4 High intensity training and body composition, fitness and metabolic markers

Even in their review exploring the role of physical activity and exercise training in the prevention of weight gain, initial weight loss, weight maintenance, and the obesity paradox, Swift et al. (2014) reported that unless the overall volume of aerobic exercise training is very high, clinically significant weight loss is unlikely to occur and that exercise training has an important role in weight regain after initial weight loss. Wenji Ghuo et al. (2015) in their cross-sectional study which included 38,201 premenopausal and 94,592 postmenopausal healthy women aged 40 to 70 years in UK Biobank, recruited from 2006 to 2010 supported the roles of a physically active lifestyle and vigorous exercise in maintaining healthy body size and composition. Higher exercise intensity may be associated with lower adiposity, beyond the influence of exercise frequency and duration.

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2.1.1.5 High intensity training improves health

Costigan et al. (2015) reported that high-intensity interval training improved health-related fitness in adolescents in a systematic review and meta-analysis. Gillen et al. (2016) reported twelve weeks of brief intense interval exercise improved indices of cardio metabolic health to the same extent as traditional endurance training in sedentary men, despite a five-fold lower exercise volume and time commitment. On the same note of lower exercise volume and time commitment, acute low-volume high-intensity interval exercise elicit a similar improvement in 24-hour glycemic control to continuous moderate-intensity exercise, in overweight and obese adults as reported by Parker et al. (2017).

2.1.1.6 High intensity training improves functionality and performance

In a randomized trial (HIPFIT) reporting the effects of high-intensity progressive resistance training and targeted multidisciplinary treatment of frailty on mortality and nursing home admissions after hip fracture, Singh et al. (2012) reported that HIPFIT intervention reduced mortality, nursing home admissions, and assisted-daily-living dependency compared with usual care.

Paton & Hopkins (2004) after reviewing 22 relevant training studies on supramaximal, maximal and submaximal intervals and resistance, which includes explosive, plyometrics and weights, reported that the incorporation of explosive resistance and high intensity interval training to a generally low intensity training program will produce substantial gains in performance. However, this study reviews the effects of high intensity training on the performance and physiology of endurance athletes, whose fitness levels are relatively high to start with. It remains to be seen whether the obese will register similar response with their limited capacity in functional fitness as well as physiological limitations.

2.1.1.7 High intensity training and obese adults

Examining 18 literature on the effectiveness of high intensity training on obesity, with regards to cardiopulmonary fitness and body composition, of research durations varying between 10 days to 6 months (Table 1 in Appendix I) in which subjects trained 3 to 5 times per week. It is reported that there is a significant reduction in body fat percentage in HIT, though the overall effect for BMI, weight and waist girth registered no difference for all. Exercise modalities used were cycling, walking, running, sprints and boxing. Adherence was observed at 75% in all except for 8 studies. High intensity training significantly improve $V0_2$max. Wewege et al. (2017) on studies (10 weeks × 3 sessions weekly training), both high and moderate intensity reported significant ($p < 0.05$) reductions in whole-body fat mass and waist circumference with no significant differences between both for any body composition measure, but HIIT required ~40% less training time commitment.

2.2 Music as an ergogenic aid to physical activity

Trappe (2012) has reported the positive effects of music on human physiology and pathophysiology of various populations namely during pregnancy on mother and child (born and unborn) on classic music, heavy metal, techno on cardiovascular parameters, patients undergoing cardiac catherization/open heart surgery, geriatric patients, patients with depressive syndrome, terminally ill patients and patients on intensive care medicine. Vocal music and orchestral produce significantly better correlations between cvd/respiratory.

As the premise of this research is to augment optimal performance from the obese despite their limitations, both at submaximal and peak intensity, and during recovery (Hulens et al., 2001), music is thus used as ergogenic aid. Bigliassi et al. (2013) reported that music is a psychophysiological ergogenic aid to physical exercise and sport. Ergogenic aids are substances that enhance one's performance by reducing fatigue symptoms or by augmenting the training response.

Music is capable of changing psychomotor arousal levels, in a stimulant or sedative manner (Bishop, Karageorghis & Louizhou, 2007, Karageorghis, Drew & Terry, 1996). Music can also narrow attentional focus which can reduce awareness of fatigue in Rejeski (1985). Lopes-Silva et al. (2015) in investigating the influence of music on performance and psychophysiological responses during moderate-intensity exercise preceded by fatigue demonstrated that listening to music changes attentional focus but is not able to reverse fatigue-derived alteration of performance. Time to exhaustion was shown to be lower in the fatigued than the non-fatigued condition regardless listening to music. RPE was higher in the fatigued than the non-fatigued condition, but music had no effect. Listening to music though, decreased the associative thoughts regardless of fatigue status. Heart rate in this study, was not influenced by any treatment in this study.

2.2.1 Music evokes improved performance

There has been much investigations into the use of music as an ergogenic aid to facilitate physical performance. Ergogenic aids are substances that enhance one's performance by reducing fatigue symptoms or by augmenting the training response. Music can provide ergogenic, psychological and physiological benefits for optimal performance. Music has been labelled as a psychological ergogenic aid with a focus on performance during exercise, pre-task and post-task. Music, ergogenically, could be effective in improving performance; decreasing rate perceived of exertion and is capable of bringing better feelings to exercise, according to time of application, physical fitness of subjects, type of exercise and musical components (Bigliassi et al., 2013).

Becket (1990) in studying the effects of music on exercise as determined by physiological recovery heart rates and distance, showed that subjects exercised more with less effort when exercising to music. A study by Yohko et al. (2000) reported increased performance during an explosive exercise and an altered mood state when listening to self-selected music. This study showed that listening to music might be beneficial for acute power performance. Waterhouse, Hudson & Edwards (2010) reported that healthy individuals performing submaximal exercise not only worked harder with faster music but also chose to do so and enjoyed the music more when it was played at a faster tempo. Implications of these findings to counteract "exercise boredom" with music as well as to elicit enhanced performance in exercise resulting in greater results in weight loss among obese subjects, will be examined in our study.

2.2.2 Music's psychomotor arousal levels - stimulant or sedative

Music is capable of changing psychomotor arousal levels, in a stimulant or sedative manner (Bishop, Karageorghis & Louizhou, 2007, Karageorghis, Drew & Terry, 1996). Music may initially distract the feedback system in increased arousal, with external stimulation overpowering the experience-based template. Thereafter, music masks information from the feedback mechanism resulting in either enhanced arousal or reduction of feedback relative to fatigue which may enhance exercise performance. Boutcher & Trenske (1990) in analyzing the effects of sensory deprivation and music on perceived exertion and affect during exercise, indicated that listening to sedative music decreased strength significantly when compared to stimulative music and silence (Pearce, 1981).

2.2.3 Music and attentional focus

Martinez et al. (2015) in their research on affective and enjoyment responses to high-intensity interval training in overweight-to-obese and insufficiently active adults reported that pleasure and enjoyment are higher during shorter interval trials than during a longer interval or heavy continuous exercise. Music can narrow attentional focus which can reduce awareness of fatigue in Rejeski (1985). Lower RPE was reported during low and moderate intensity exercise (Boutcher & Trenske, 1990 and Szmedra & Bacharach, 1998). Lopes-Silva et al. (2015) in investigating the influence of music on performance and psychophysiological responses during moderate-intensity exercise preceded by fatigue demonstrated that listening to music changes attentional focus but is not able to reverse fatigue-derived alteration of performance. Time to exhaustion was shown to be lower in the fatigued than the non-fatigued condition regardless listening to music. RPE was higher in the fatigued than the non-fatigued condition and music had no effect. Listening to music though, decreased the associative thoughts regardless of fatigue status. Heart rate in this study, was not influenced by any intervention treatment.

Pujol, T.J. & Langenfeld, M.E. (1999) suggested that the physiological effects of Wingate test can suppress the effects of music due to the strenuousness of high intensity exercise. Tenenbaum (2001) stated that music is ineffectual at high exercise intensities. This is echoed in by Rad & Hafezi (2013) that listening to motivational music during exercise has had no effect on the performance of elite female swimmers.

Music is also reported to be much less effective as a dissociation tool at high exercise intensities owing to the preeminence of physiological cues (Boutcher & Trenske, 1990 and Tenenbaum et al., 2004). According to Saanijoki (2015), perceived exertion and arousal were higher, and affective state, more negative during the HIT in sedentary middle-age men. However, Heydari & Boutcher (2013) in their study on rating of perceived exertion after 12 weeks of high intensity intermittent sprinting, reported that although high intensity interval exercise resulted in significant increases in RPE (Rate of Perceived Exertion), RPE during the V̇O2 max test was significantly decreased, refuting that music is not effective at high intensity exercises.

Although theories suggest that external stimuli (e.g., auditory and visual) may be rendered ineffective in modulating attention when exercise intensity is high, according to Jones, Karageorghis & Ekkekkis (2014), upon examining the effects of music and parkland video footage on psychological measures during and after stationary cycling at two intensities: 10% of maximal capacity below ventilatory threshold and 5% above. The 34 participants were exposed to four conditions at each intensity: music only, video only, music and video, and control. Findings indicated that attentional manipulations can exert a salient influence on affect and enjoyment even at intensities slightly above ventilatory threshold.

Although Rejeski (1985) concluded that at higher exercise intensities, the response to an affective stimulus such as music is interrupted by the internal feedback with which it competes, however Karageorghis, Jones et al. (2006) argued that appropriate music can make the interpretation of symptoms of fatigue, which predominates attentional processing at high intensities, more positive. Music may also promote in terms of enhanced exercise adherence by means of improvements in positive affect, ((Boutcher & Trenske, 1990; Elliot et al., 2004).

2.2.4 Music’s distraction effect

Yamashita et al. (2006), while studying the effects of music during exercise on RPE, heart rate and autonomic system found that music evokes a ”distraction effect” during low intensity exercise namely 40% of VO2max. This has great implications if the same can be applied to high intensity exercise, which expends more calories thus aiding in weight loss. Thus if listening to music can decrease the influence of stress caused by fatigue, this will in turn increase the "comfort" level of performing the exercise. If music is able to evoke a distraction effect during high intensity exercise, this means that one can expend more calories, thus aiding in the weight loss. Deforche & De Bourdeaudhuij (2015) on investigating the effect of attentional distraction on field running distance and activity intensity during an exercise session in normal-weight and overweight youngsters reported. Both groups ran further during the running test with music and this effect was mediated by a decrease in feelings of annoyance. During the exercise session with music, both groups exercised less at low and high intensity and more at moderate and very high intensity and this effect was mediated by a decrease in RPE, concluding that attentional distraction has a positive effect on running distance on a field endurance test and on activity intensity during an exercise session.

In a study by Jones (2014), music conditions reduced the number of associative thoughts by 10% across all exercise intensities. In examining how practitioners can harness the power of distractive stimuli in music to enhance the experience of high-intensity physical activity, Stork, Kwan, Gibala, and Martin Ginis', (2014) empirical research has shown that auditory distractions during exercise can promote attentional dissociation, as well as more positive affective responses at intensities below ventilatory threshold and up to 10% above.

2.2.5 Music's effects on fatigue

In evaluating the effects of relaxing music on the recovery from aerobic exercise-induced fatigue, it was reported that relaxing music has better effects on the rehabilitation of cardiovascular, central, musculoskeletal and psychological fatigue (Jing

& Xudong, 2008). In their study, heart rates and RPE decreased significantly after the application of relaxing music. Thus the implications of this might assist in the recovery process of the obese after a strenuous exercise.

2.2.6 Music augments performance past fatigue

Though Noakes (2012) as with Mosso (1915), believed that fatigue is a brain-derived emotion that regulates the exercise behavior to ensure the protection of whole body homeostasis, there are many studies reporting ergogenically-driven maximal performance derived past fatigue by various populations when music was used. Gfeller (1988) reported 97% of 70 college students polled, had greater perceived influence of music on performance in aerobics. Music may facilitate focus on music or other external stimuli rather than discomfort.

2.2.7 Music on reduction and management of pain

From various researches, it was proven that music has a marked effect on exercise performance. Maslar (1986) in his review on the effect of music on the reduction of pain as well as Brown, Chen and Dworkin (1989) reported that the "distraction and competing stimuli" of the gate control theory (Melzack & Wall, 1967) argues that music that subjects enjoy may decrease their experience of pain by distracting their attention away from the pain and on to the music itself. Guetin et al. (2012) confirmed the value of music intervention to the management of chronic pain and anxiety/depression. The music intervention appeared to be useful in managing chronic pain as it enables a significant reduction in the consumption of medication. Systematic reviews by Cole & LoBiondo-Wood (2014) provided support for the use of music as an adjuvant approach to pain control in hospitalized adults.

Szabo, Small and Leigh (1999) reported that music aided exercise performance by reducing sensations of fatigue, increasing physiological arousal, promoting relaxation and improving motor coordination. These researchers found that switching from slow to fast tempo classical music produced an ergogenic effect during cycle ergometry and that the subjects completed a slightly higher workload. Hutchinson & Todd (2014) examined self-selected music intensity (i.e., volume) and perceived music usefulness across a range of exercise intensities that were standardized around ventilatory threshold (VT) while completing a maximal treadmill graded exercise test (GXT) and listening to motivational music. Research demonstrated that both music intensity and perceived music usefulness was highest at or immediately after VT, and lowest at the extreme beginning and end of the test. Recreational exercisers preferred louder music than athletes, and made more volume adjustments at points beyond VT. No gender differences were observed for music intensity. Music was perceived as increasingly useful up until the point of VT, after which ratings plateaued and then declined during cool-down; however, a gender × task intensity interaction revealed that whereas males followed a clear quadratic trend, females rated music as increasingly useful until the end point of the graded exercise test.

2.3 Effects of synchronous and asynchronous music on physical activity

Synchronous music is the use of the rhythmic as a type of metronome regulating movement patterns (Anshel & Marisi, 1978; Hayakawa et al., 2000). Asynchronous music has no conscious synchronization between an individual’s movement patterns and musical tempo or meter and is just music played in the background to make the environment more pleasurable (Karageorghis & Terry, 1997).

Various studies have been conducted on exercises using synchronous and asynchronous music, namely in treadmill walking (Karageorghis et al., 2009), cycling (Lim et al, 2014), cycle ergometry (Anshel & Marisi, 1978), 400-m running (Simpson & Karageorghis, 2006) and swimming (Karageorghis et al., 2013). Karageorghis et al.

(2009) researched on walking to exhaustion starting at 75% of maximum heart rate reserve. Findings reported that endurance increased in synchronous and asynchronous with the former being more ergogenic than the latter. The in-task effect was enhanced in the synchronous group as opposed to the control group throughout the trial. However, experimental conditions did not impact significantly upon rate of perceived exertion (RPE) or exercise-induced feeling states. Results of this study indicated that motivational synchronous music can elicit ergogenic and enhance in task during an exhaustive endurance task.

Given that physical performance is enhanced by listening to music, Ramji et al. (2015) varied the amount of music information in an otherwise identical piece of music, from only the rhythm, through a synthesized and scaled down version, to the full original version of music that facilitated synchronization with the running pace, and with tempi where synchronization was impossible. Results finding showed that participants tended to run a greater distance when there was more music information. This effect was stronger in the synchronous conditions. This study's results suggested that the motivational effects of music information during running is mostly related to richer temporal information conveyed by faster metrical levels, when attempting to synchronize with the beat in the music. Musical information increases physical performance for synchronous but not asynchronous running.

Synchronous music yields significant effects in a not-highly trained population performing bench stepping (Hayakawa et al, 2000), cycle ergometry (Anshel and Marisi, 1978), callisthenic-typed exercises (Uppal & Datta, 1990), 400 metre run (Simpson & Karageorghis, 2006) and multi activity circuit tasks (Michel & Wanner, 1973).

Judging the positive effects of music and its ergogenic properties, synchronous music in most studies emerged the most ergogenic as compared to asynchronised music and no music controls. Karageorghis et al. (2009) reported that motivational synchronous music elicited ergonomical enhancement during an exhaustive endurance task. With the obese's limitations in exercise capacity as well as discomfort even at submaximal and recovery letter, the usage of synchronous music might elicit optimisation in performance despite these. Synchronise music also lowers limb discomfort (Lim et al., 2014). Bacon, Myers and Karageorghis (2012) reported that exercise is more efficient when performed synchronously with music than when musical tempo is slightly slower than the rate of cyclical movement.

Asynchronous music decreased RPE by 10% over a no-music control during submaximal exercise (Nethery, 2002; Potteiger, Schroeder & Goff, 2000; Smedra & Bacharach, 1998) but not at high or close to maximum intensities (Boutcher & Trenske, 1990; Schwartz, Fernhall & Plowman, 1990; Tenenbaum et al, 2014).

2.3.1 Increased time-to-exhaustion with synchronized music and neutral music compared to no music

Motivational music has been shown to increase power output with the rate of change in RPE. It has been shown that as exercise intensity increases, RPE increases linearly. Up-beat music that is considered "motivational" has been shown to make exercising on either the treadmill or cycle ergometer feel easier, especially true in cardiovascular exercise. Music significantly lowered the subject's rating of perceived exertion when exercising on a treadmill until exhaustion, particularly in untrained individuals. However, trained athletes also had a lower RPE with music. Thus, exercising for a longer time or at a higher intensity may be possible with music. While listening to music by both trained and untrained athletes, time to exhaustion was longer than without listening to music.

Terry et al. (2012) in reporting the effects of synchronous music on treadmill running among elite triathletes versus the effects of neutral music and non-music, it was reported that time to exhaustion in submaximal and exhaustive running were extended by about 18-19%. Mood responses were more positive in the synchronous runners. RPE was lowest for neutral music and highest in the no-music control. Both synchronous and asynchronous were associated with better running economy than the no-music control. However, in functional terms, this study professed that the motivational qualities of music may be less important than the prominence of its beat and the degree to which participants are able to synchronise their movements to the tempo. Thus music provided ergogenic, psychological and physiological benefits in this laboratory study.

2.3.2 Synchronous music lowers limb discomfort

Lim et al. (2014) investigating the psychophysiological effects of synchronous versus asynchronous music during cycling, reported that synchronizing movement to a rhythmic stimulus does not reduce metabolic cost and that synchronous music has a stronger effect on limb discomfort and arousal when compared to asynchronous music.

Bacon, Myers and Karageorghis (2012) reported that exercise is more efficient when performed synchronously with music than when musical tempo is slightly slower than the rate of cyclical movement.

2.3.3 Synchronous music increased work output and reduces RPE

In a review on the psychophysical effects of music in sport and exercise by Karageorghis and Terry (1997), it was reported that synchronization of submaximal exercise with musical accompaniment results in increased work output and that music reduces the rate of perceived exertion during submaximal exercise. At the same time, music tends to enhance affective states at both medium and high levels of work intensity.

Terry et al. (2012) reported positive effects of synchronous music in elite endurance athletes, namely two elite triathletes and six elite runners during three training runs. Compared to the no-music condition, participants ran, on average, 7.5% and 7.2% further but reported lower RPE and more positive feelings and mood responses when running to synchronous music. Synchronous music also emerged with significant effects in performance improvements in another study of nine elite ultra-distance athletes participating in 24-hr and 48-hr races listened to rotating playlists of synchronous motivational music, neutral music, audiobook and silence delivered by iPhone.

2.3.4 Synchronous music aids endurance and males endured longer than females

Anshel and Marisi (1978), when examining music, particularly if synchronized to physical movement, had a positive effect on the ability to endure the task and found that male subjects endured longer than female subjects. The effects on obese female subjects remains to be seen, hence this study.

To the best knowledge of the author, there was no study conducted till date specifically on overweight and obese women in Singapore, on music and movements, particularly examining the the effects of synchronised and asynchronised music on physical activity interventions. In most studies, synchronous music seems to positively affect output of physical activity as an ergogenic aid.

2.3.5 Asynchronous music effects on RPE

Asynchronous music decreased RPE by 10% over a no-music control during submaximal exercise (Nethery, 2002; Potteiger, Schroeder & Goff, 2000; Smedra &

Bacharach, 1998) but not at high or close to maximum intensities (Boutcher & Trenske, 1990; Schwartz, Fernhall & Plowman, 1990; Tenenbaum et al, 2014).

2.4 Physiological feedback controlled

Tucker (2009) has proposed that exercise is regulated by the effects of the physiological feedback system, which is superimposed on a pre-exercise template, namely a feedback system seeking to maintain homeostasis within narrow limits to prevent exertional levels from causing harm to the body.

Priest et. al. (2004) while investigating the importance of listening to music while they exercised. Younger subjects, aged 16-34, stated that music motivated them more than it did older subjects, aged 35+. Older subjects preferred slower tempo. Music seem to have an effect on exercise intensity and it has been shown that there is a preference for fast tempo music during low (40% HRR) and moderate (60% HRR) intensity exercise, and a very strong preference for fast tempo music during high (75%HRR) intensity exercise. Thus music can act as a positive external stimulus and can interrupt the feedback system reporting homeostatic disturbances, thus creating an ergogenic effect.

2.4.1 Theory of music – mood and movement

According to Murrock & Higgins (2009), the theory of music, mood and movement combines the psychological and physiological responses of music to increase physical activity and improve health outcomes. This study was developed from physical activity guidelines proposed that music alters mood and is a cue for movement. Several studies reported increased positive moods, happiness and vigor while decrease of negative elements such as anger, depression and tension (Boutcher & Trenske, Edworthy & Warring, 2006 and Hayakawa et al., 2000). This in turn makes physical activity more enjoyable resulting in improved health outcomes in weight, blood pressure, blood sugar and cardiovascular risk factor management as well as improved quality of life.

Murrock (2002) in a study to identify the effect of music on perceived exertion and mood in 30 coronary artery bypass graft patients during cardiac rehabilitation, reported significantly enhanced mood while exercising to music.

Music has also been shown to improve mood when endorphinised while exercising. A 10-point bipolar scale developed by Rejeski (1985) has been used to measure exercise induced feeling states. Exercising at a high intensity elicited a higher number on the 10-point bipolar scale when the subjects were listening to music than with no music. This was also true with moderate intensity exercise. Improving mood through motivational music could potentially increase adherence to an exercise program, particularly in males, who are more likely to exercise more than five times per week than females. This increases the likelihood of making exercise part of the lifestyle, thus decreasing the risk for health problems and leading to a greater energy expenditure, as well as improved cardiovascular fitness.

2.4.2 Selection of music guidelines

Karageorghis & Terry's (1997) definition of tempo is the "speed" of a piece of music as measured in beats per minute (bpm) whereas the "meter" relates to how the listener perceives or feels the beat. Gfeller (1988) reported 97% of 70 college students polled, had greater perceived influence of music on performance in aerobics. These are the factors which influenced their aerobic performance: music style (97%), rhythm/beat (94%), tempo (96%), lyrics (77%), volume (66%), mood (37%) and melody. There is a strong correlation between male and female responses in this study indicating that gender is irrelevant when selecting music for aerobic activity.

The emphasis on rhythm determining the response to music in exercise contexts is of importance in the musically intervened groups, findings of which are supported by Gaston (1951), Karageorghis et al. (2006), Karageorghis & Terry (1997), Lucaccini & Kreit (1972). Rhythm in this instance are presented in terms of a synchronous effect linking the periodic distribution of notes with patterns of physical movements (Karageorghis & Terry, 1997; Simpson & Karageorghis, 2006).

2.4.3 Rhythmic music and beat

Rudenberg (1982) and Staum (1983) showed that rhythmic music and percussion pulses, namely external auditory cues, positively affected coordinated walking and proprioceptive control. Application wise, music and auditory stimuli is useful to enhance gait and gross motor skills, thereby leading to improved mobility and stability.

Bacon, Myers & Karageorghis (2012) when investigating whether metabolic improvements in endurance when exercise movements are synchronised with a musical beat are associated with reduced metabolic cost conducted his research on untrained men using slow tempo asynchronous, synchronous, and fast tempo asynchronous. They reported that exercise is more efficient when performed synchronously with music than when musical tempo is slightly slower than the rate of cyclical movement.

Priest, Karageorghis & Sharp (2004) concluded that music prescribed to accompany exercise should be varied in terms of musical idiom and date of release. This is to cater to the different preferences of different groups of exercise participants. Age exerted the greatest influence on musical preference during exercise. It was discovered that older participants preferred quieter, slower and generally less overtly stimulative music. It is further recommended that the music selected should be characterized by a strong rhythmical component.

2.4.4 Timing of music intervention

In a research by Crust (2004), with regards to timing of music intervention, he reported that all conditions of music exposure, namely pre and post as well as during the exercise per se, produced significantly longer endurance times than white noise for a muscular endurance test.

Chtourou et al. (2012) reported that music should be used during warm-up before performing activities requiring powerful lower limbs′ muscles contractions, especially in the morning competitive events as peak and mean power were shown to be significantly higher after music than no music warm-up. Jarraya et al. (2012) in their assessment of the effects of listening to music during warm-up on short-term supramaximal performances during the 30-s Wingate test in highly trained athletes, demonstrated the beneficial effect of music during warm-up before performing activities requiring powerful lower limbs' muscles contractions during short-term supramaximal exercises.

2.5 Inability of music to produce ergogenic effects above body's physiological limitations

However, Copeland and Franks (1991) on studying the effects of loud, fast, exciting music versus soft, slow easy listening music or no music on graded maximal treadmill test reported that music was not able to provide the ergogenic effect above the body's physiological limitations. Due to safety concerns, the obese are limited in their capacity to perform in maximal exercise testings and high intensity exercises. However, if the obese can perform maximally and optimally in submaximal exercise, it will enhance energy expenditure. If listening to music can decrease the influence of stress caused by fatigue, this will in turn increase the "comfort" level of performing the exercise. Thus music can be used as an ergogenic aid by the obese to assist them to perform optimally in their physical activity intervention for weight loss. The effects of music on pain have pointed that music can reduce the experience of pain possibly through the mechanism of distraction. Music with this anagelsic properties is dependent on individual differences in pain threshold and different interactions in music stimuli (Maslar, 1986).

2.6 Music is ineffectual at high intensity exercise

Pujol & Langenfeld (1999) suggested that the physiological effects of Wingate test can suppress the effects of music due to the strenuousness of high intensity exercise. Tenenbaum (2001) stated that music is ineffectual at high exercise intensities. This is echoed in by Rad & Hafezi (2013) that listening to motivational music during exercise has had no effect on the performance of elite female swimmers. Music is also reported to be much less effective as a dissociation tool at high exercise intensities owing to the preeminence of physiological cues (Boutcher & Trenske, 1990 and Tenenbaum et al., 2004). However, Heydari & Boutcher (2013) in their study on rating of perceived exertion after 12 weeks of high intensity intermittent sprinting, reported that although high intensity interval exercise resulted in significant increases in RPE (Rate of Perceived Exertion), whereas RPE during the $\dot{V}O2$ max test was significantly decreased refuting that music is not effective at high intensity exercises.

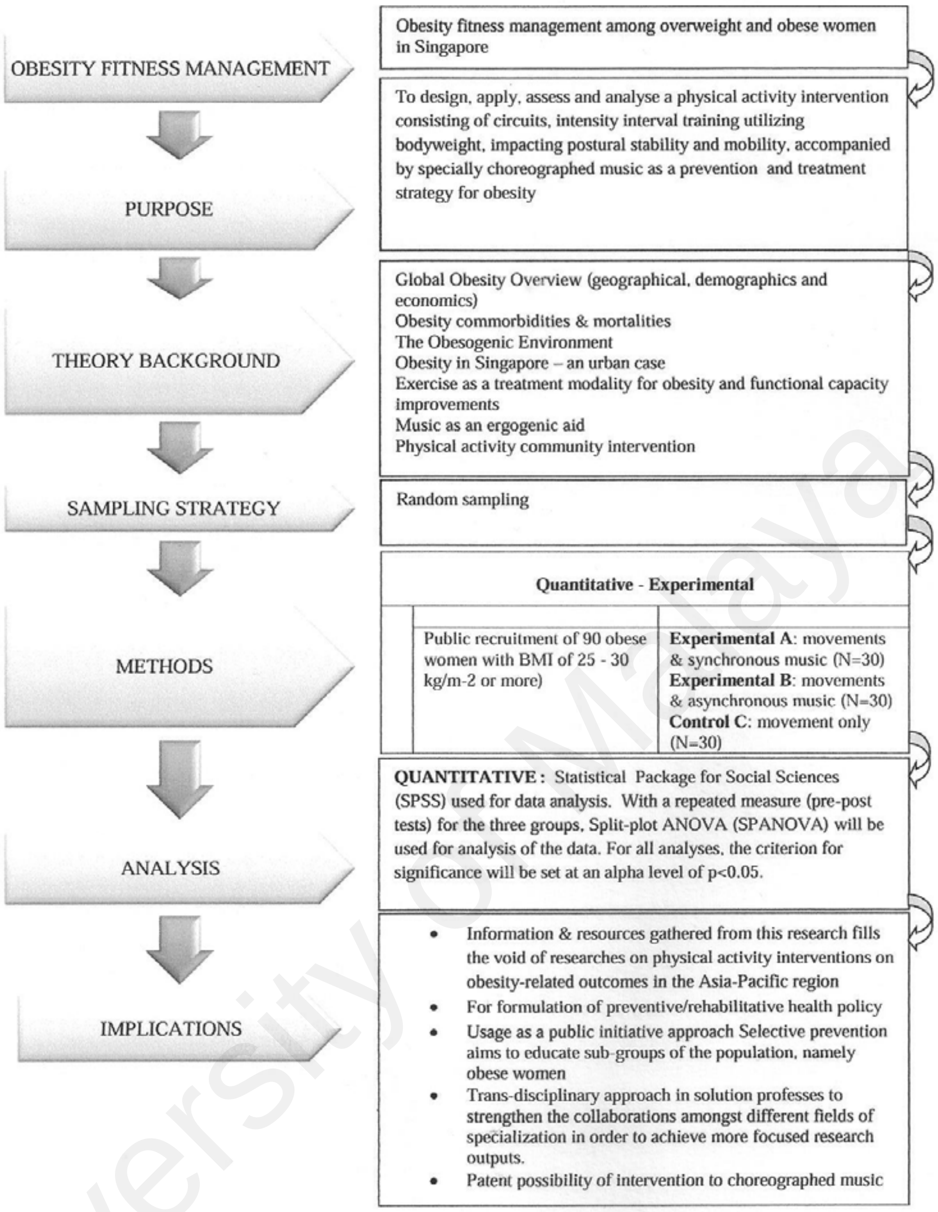
2.7 Physical activity and music– the research intervention

To the best knowledge of the author, there was no study conducted till date, on music and movements, particularly the ergogenic effects of synchronise and asynchronise music on physical activity interventions, specifically on overweight and obese women in Singapore. In most studies, synchronise music seems to positively affect output of physical activity as an ergogenic aid.

After reviewing literature on physical activity on body composition, fitness and health, as well as the ergogenic effects of music and generating hypotheses for this study, the following research treatment intervention framework Figure 2.1 was used for this research. The framework consisted of two independent variables, namely physical activity intervention and music that is postulated to affect dependent variables in obesity management and fitness parameters. These are BMI, body fat percentage, waist circumference, waist to hip ratio, resting heart rates, fitness tests namely Push Up, Curl Up and Bodyweight Squat tests as well as serum lipid analysis on cholesterol, triglycerides and fasting blood glucose as well as blood pressure. This framework illustrates the relationships between physical activity with several indicators of obesity, fitness and functional capacity outcomes. In terms of music used, supported by positive effects of orchestral correlations on cardiovascular disease/respiratory (Trappe, 2012), music was especially composed for this study.

Racil et al.'s (2013) 12-weeks interval training investigating the effects of high versus moderate exercise intensity during interval training on lipids and adiponectin levels in obese young females, reported that HIIT positively changes blood lipids and adiponectin resulting in improved insulin sensitivity. This study chose blood glucose as one of the metabolic profile parameters for this matter.

In establishing these links between physical activity and health in the obese and by using music as an ergogenic tool, it is an important step in this behavioural epidemiology framework because of its direct impact on public health after which, it is imperative to translate this intervention research into practice.



Obesity fitness management among overweight and obese women in Singapore

To design, apply, assess and analyse a physical activity intervention consisting of circuits, intensity interval training utilizing bodyweight, impacting postural stability and mobility, accompanied by specially choreographed music as a prevention and treatment strategy for obesity

Global Obesity Overview (geographical, demographics and economics)
Obesity commorbidities & mortalities
The Obesogenic Environment
Obesity in Singapore – an urban case
Exercise as a treatment modality for obesity and functional capacity improvements
Music as an ergogenic aid
Physical activity community intervention

Random sampling

Quantitative - Experimental

Public recruitment of 90 obese women with BMI of 25 - 30 kg/m-2 or more)

Experimental A: movements & synchronous music (N=30)
Experimental B: movements & asynchronous music (N=30)
Control C: movement only (N=30)

QUANTITATIVE : Statistical Package for Social Sciences (SPSS) used for data analysis. With a repeated measure (pre-post tests) for the three groups, Split-plot ANOVA (SPANOVA) will be used for analysis of the data. For all analyses, the criterion for significance will be set at an alpha level of p<0.05.

- Information & resources gathered from this research fills the void of researches on physical activity interventions on obesity-related outcomes in the Asia-Pacific region
- For formulation of preventive/rehabilitative health policy
- Usage as a public initiative approach Selective prevention aims to educate sub-groups of the population, namely obese women
- Trans-disciplinary approach in solution professes to strengthen the collaborations amongst different fields of specialization in order to achieve more focused research outputs.
- Patent possibility of intervention to choreographed music

Figure 2.1: Research framework for intervention

CHAPTER 3: RESEARCH METHODOLOGY

This chapter presents a description of research methodology organized as follows: research design, instrumentation, data collection procedures and data analysis procedures.

3.1 Experimental research design

After reviewing literature on physical activity on body composition, fitness and health and the ergogenic effects of music, experimental research design Figure 3.1 was developed. As reflected in Figure 3.1, this research consisted of a twelve-week randomized-controlled pre-test-post-test between-groups and within-groups experimental design study of subjects with voluntary participation (N= 92) of overweight and obese pre-menopausal adult Malay Singapore women, randomly assigned into experimental groups (physical activity to synchronous music (n=31), physical activity to asynchronous music (n=31) and a control group (physical activity with no music) (n=30). Subjects were randomly (numbers were allocated to each participants and the numbers were drawn from a container randomly) allocated into two treatment groups - exercise with synchronous music (n = 31) and exercise with asynchronous music (n = 31)] and a control group [exercise with no music (n = 30)].

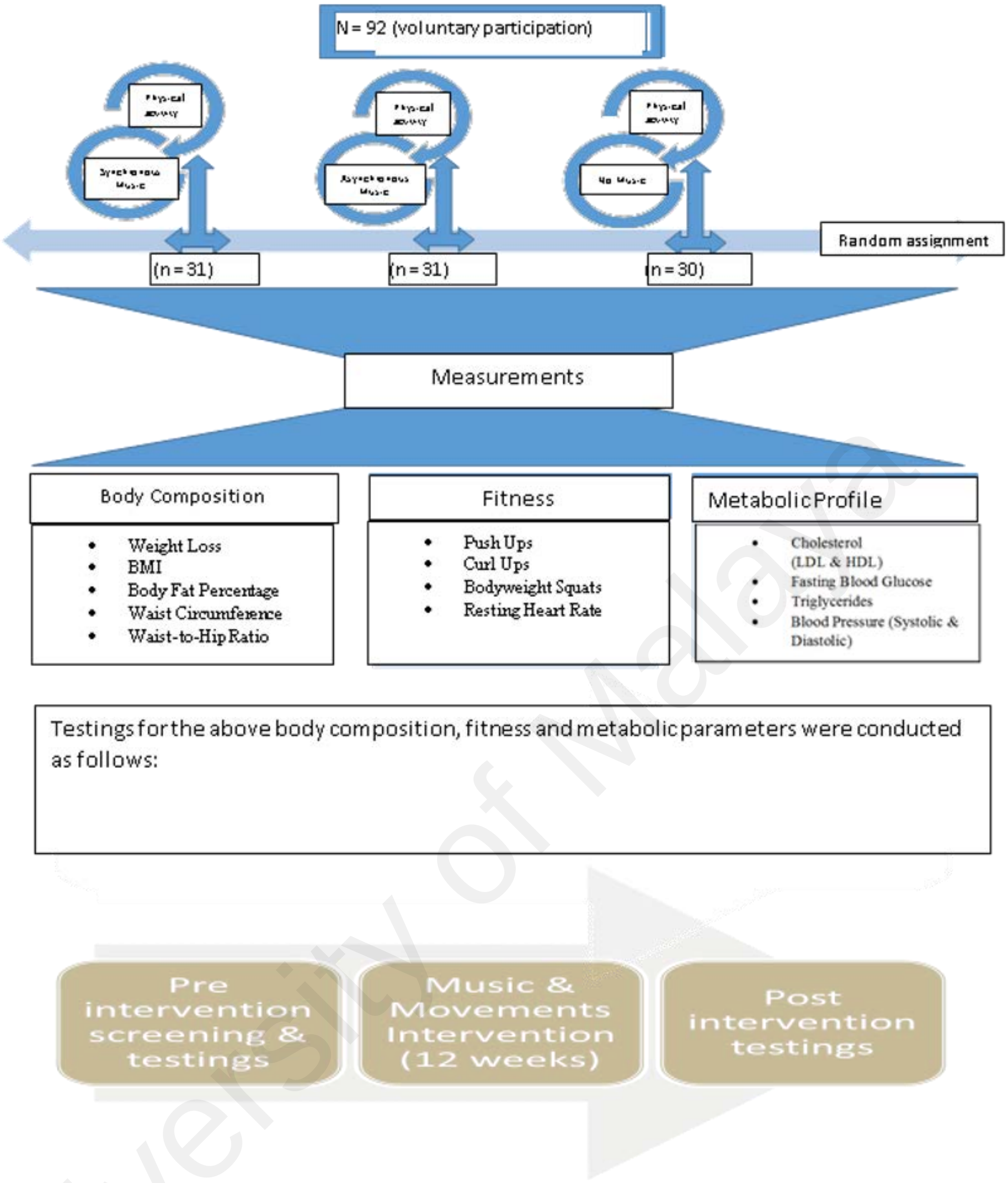


Figure 3.1: Physical activity and music– Experimental Research Design

This is in accordance to the guidelines of experimental study whereby “an experiment that effects of a treatment are compared with those of a different treatment or no treatment at all”; these groups would be called “experimental and control” (Best & Kahn, 2003). Fraenkel & Wallen (2003) and Chua (2011) described that an experimental study usually involves two groups of participants; an experimental group which receives a treatment and a control group which receives no treatment or a comparison group which receives a different treatment. These researchers stated that in experimental research, it is rare to have a pure control group with no treatment at all but rather a control group that receives a different treatment referred to as comparison groups. In terms of experimental studies, a recommendation of a minimum of 30 participants per experimental group was put forth by Fraenkel and Wallen (2003) which was adhered to in this study.

Bonate (2000) stated that baseline homogeneity is imperative to "increase the researcher's ability to detect a significant difference between groups" (p.3). Bonate (2000) also reiterated that a "baseline measurement of the dependent variable of interest must be made prior to imposition of the treatment effect". With regards to the characteristics of pre-test and post test data, Bonate (2000) stated that "two measurements are made on the same experimental unit, one measurement possibly being made prior to administration of a treatment intervention and a temporal distance separates the collection of the post-test measurement from the pre-test measurement" (p. 2). Thus, in order to "maximise the statistical power of an experimental design" (Bonate, 2000), this study's pre-test was administered prior to treatment intervention and post-test was administered after the completion of treatment intervention. The treatment intervention period was 12 weeks for this study. The pre-tests were administered within one week prior to the intervention period and the post-tests, within one week of the completion of intervention. The manipulated independent variables are music and exercise intervention and the dependent variables were obesity, fitness and metabolic profile parameters tested pre and post intervention.

BMI, though a convenient population indicator in the general population (it is more for the government's usage for policy planning and development), is an unreliable measure for evaluating health of individuals. Indeed, the older person is fatter than his/her younger self even though his/ her BMI does not change. This is due to the changes in body composition (bone, muscle and fat) due to factors of aging, health and fitness. Bone is denser than muscles and it is twice as dense as fat and muscles are heavier than fat with physical activity. This will register a high BMI in an individual with strong bones, good muscle tone and low fat. Thus, weight will not be indicative of true fat or obesity in this case, which in turn affects the accuracy of BMI. Thus, the importance of the inclusion of blood composition, metabolic and fitness parameters measurements to be used in synergy to complement the traditional BMI measurement, in determining obesity fitness and health management to identify the fitter or even the fat-but-fit and metabolically obese. Thus, for this study, other body composition measurements in addition to BMI were included. Body composition measured were waist circumference, waist to hip ratio, body fat percentage and weight loss. Functional fitness development were examined through fitness assessments (Push Up, Curl up Test, Bodyweight Squat Tests) and monitoring changes in resting heart rates. Metabolic health profile parameters of cholesterol, triglycerides, fasting blood glucose, systolic and diastolic blood pressures were examined in this study. Metabolic health refers to the status of obesity, cholesterol and triglycerides, and the regulation of blood sugar and blood pressure. Examining the ergogenic effects of music on exercise execution, the music utilized in Experimental Group 1 is synchronous music. Asynchronous music was used in Experimental Group 2 whereas no music was used for the controls in Group C.

3.2 Instrumentation

3.2.1 Questionaires

All participants signed mandatory Consent Form (Appendix A) after listening to the briefing on research participation and procedures by the Researcher before the commencement of the research. All participants were provided with verbal instructions and in writing, detailing the experimental procedures and requirements as well as the possible risk factors involved in the proposed study. The information sheet contained a statement that their involvement is voluntary and that they may withdraw any time during the period of study without any prejudice or penalty. It was explained to the participants that while the data collected during this study will be published in scientific journals and presented at conferences, their identity will not be disclosed. Access to results were only made available to principal researchers of the study. Confidentiality of information was explained clearly to the participants.

3.2.2 PAR-Q and Health Risk Appraisal

All participants signed the PAR-Q (Canadian Society for Exercise Physiology, 2000) as in Appendix B. A health risk appraisal was also conducted, which involved detailed information gathering and a thorough review of the participants' health information, medical history and lifestyle (ACSM, 2013) as shown in Appendix C.

3.2.3 Baseline and post intervention evaluations

Participants underwent a pre-study medical screening conducted by certified physician for medical and exercise clearance, whereby those unsuccessful were excluded from the study. Successful participants were then randomly allocated into two experimental treatment groups and one control group. Procedures for groups' allocation involved allocating numbers to all participants. These numbers written on slip of papers were placed in a container. Numbers were then randomly drawn out from this container and the participants were allocated their groups at random.

The participants attended a pre and post study health screening assessing their blood lipid profile as well as their blood pressure by a certified physician. Body Mass Index (BMI), waist circumference, waist-hip ratio, three-site skinfold fat percentage were assessed at baseline and post study by trained fitness professionals. A battery of postural and functional fitness assessments as purported by the American Council of

Exercise (2010) were also taken, namely the Push Up Test, Curl Up Test, and Bodyweight Squat Test, as also resting heart rates.

Waist circumference, along with measurements of blood pressure, triglyceride and glucose that forms part of the assessment tools, with greater assessment value than BMI, were used in this research (Riedl et al., 2016). Waist circumference and the waist-to-hip ratio were also assessed to be a better indicator of fatness than just mere BMI (World Health Organisation, 2008).

3.2.4 Ratings of perceived exertion (RPE) protocol

The rating of perceived exertion (RPE), measured by the Borg rating of perceived exertion scale (RPE scale) is a frequently used quantitative measure of perceived exertion during physical activity (Borg, 1970; Borg, 1982; Dawes et al., 2005, Roelands et al., 2013 & Rattray et al., 2015). This scale is a tool for estimating effort and exertion, breathlessness, and fatigue during physical work. Perceived exertion is how hard an individual feels like when her/his body is working. This is based on the physical sensations a person feels during physical activity which includes increased heart rate, increased respiration or breathing rate, increased sweating, and muscle fatigue. This is a subjective measure, however, a person's exertion rating may provide a fairly good estimate of the actual heart rate during physical activity (Borg, 1998).

Borg’s RPE scale is used to document the patient's exertion during a physical exercise test and to assess the intensity of training and competition. The original scale was introduced by Gunnar Borg rated exertion on a scale of 6-20.

Borg (1998) further reported that a high correlation exists between a person's perceived exertion rating times 10 and the actual heart rate during physical activity; so a person's exertion rating may provide a fairly good estimate of the actual heart rate during activity. Borg's RPE scale can be compared to other linear scales such as the Likert scale or a visual analogue scale with the sensitivity and reproducibility of the results being very similar, although the Borg may outperform the Likert scale in some cases (Grant et al., 1999). Borg Rating of Perceived Exertion (RPE) scale (Borg, 1982) below were used to measure a participant's ratings of perceived exertion during all intervention sessions. According to Karavatas and Tavakol (2005) who examined the correlation and concurrent validity between heart rate and RPE, they concluded that RPE could be utilized as an accurate tool to measure an individual's exercise intensity; RPE and heart rate are moderately correlated (r=0.58). Furthermore, RPE is easy to understand and implement with the general population (Warburton, Nichol & Bredin, 2006).

Subjects provided their RPE based on Borg's 6 - 20 for the exercise after the completion of the last repetition of their exercises (at the end of their warm up, main and after static stretches) by answering the following question, "How was your workout?" (Foster et al., 2001). The subjects were reminded throughout the study that the RPE value should represent a single rating of intensity for the exercise session segment assessed. They were asked at the end of their warm ups, at the end of their high intensity exercises and after static stretches. The RPE Scale and Trainer's Instructions are provided in Appendix D. They were given familiarization trial prior to commencement of study and also during the intervention for modified curl, modified push up and bodyweight squats. The lack of previous familiarization with strength tests may impair the muscular strength evaluation. Thus, the performance of two to three familiarization sessions is added in for a more accurate muscular strength assessment (Dias et al., 2005).

3.2.5 Heart rate monitoring

Exercise intensity was determined by using the Karvonen method (Karvonen, 1957). The Karvonen Formula is a mathematical formula that helps you determine your target heart rate (HR) training zone. The formula uses maximum and resting heart rate with the desired training intensity to get a target heart rate.

Target Heart Rate = ((max HR − resting HR) × %Intensity) + resting HR example

If the maximum heart rate cannot be measured directly, it can be roughly estimated using the traditional formula 220 minus one's age.

During all sessions, participants' heart rate were monitored to ensure that their heart rates remains at range of 120 beats per minute during the warm up session and between 85% to 95% to be in the high intensity zones during the high intensity exercises segment and less than 110 beats per minute at the end of static stretches.

The Sport tester PE 3000 (Polar Electro OY, Kempel, Finland) is a small, affordable heart rate telemetry units consisting of a strap around the chest that contains electrodes and a transmitter was used in this study. The receiving unit is worn like a wrist-watch and it has memory that can store minute-by-minute heart rate data for up to 16 hours of monitoring. The heart rate telemetry devices valid with about a 2% error (Montoye et al., 1996). The advantages of heart rate monitoring is the high validity and the sensitivity of heart rates to activity intensity.

3.3 Data collection and procedures

3.3.1 Subjects

The subjects recruited needed to meet the following inclusion criteria as follows:

- adult female of age 25-55 years old;

- Singaporean of Malay ethnicity;
- BMI of 25.0 – 29.9 kg/m^2 (overweight) and BMI of 30 kg/m^2 and above (obese) according to WHO's international BMI classifications (WHO, 2015);
- pre-menopausal and not pregnant (you need to report at least eight regular menstrual cycles prior to participation in this study);
- Not taking oral contraceptives or undergoing hormone replacement therapy
- non-smokers;
- Must not suffer from debilitating arthritic or joint problems affecting movements or have prior history of heart problems;
- Not be undergoing treatment for metabolic, cardiovascular, pulmonary disease, osteoporosis or cancer;
- And relatively sedentary in nature as stated in American Council on Exercise (2010) as not participating in at least 30 minutes of moderate-intensity physical activity on at least 3 days per week for at least 3 months. They must not be engaging in one or more of the following activities: walking, jogging, bike riding, swimming, aerobics, dancing, calisthenics, gardening, or weight lifting, five or more times per week. They must not be performing at least 3 hours per week of endurance-type physical activity and not achieving 10,000 steps per day.
- Prior exercise to music experience (based on pilot study)

To ascertain sedentarism, the Model of Sedentarism by Ricciardi, R. (2005) defined sedentarism as follows:

- The individual is not engaging in one or more of the following activities: walking, jogging, bike riding, swimming, aerobics, dancing, calisthenics, gardening, or weight lifting, five or more times per week;

- The individual is in an inactive state in which there is minimal leisure time physical activity;
- The individual are expending less than 10% of daily energy in the performance of moderate and high intensity activities in which the metabolic rate increases at least four times from baseline.
- The individual is not performing at least 3 hours per week of endurance-type physical activity in which the metabolic rate increases at least four times from baseline;

The individual must also not be achieving 10,000 steps per day which according to Hill, Wyatt, Reed, & Peters (2003) has received scientific support as an index for minimum level of physical activity to achieve energy balance.

A total of 93 obese women were recruited voluntarily for this study. However, one subject dropped out due to time commitment. She decided not to attend the pre testing and was absent throughout the entire research and during the post testing.

For this experimental study, 92 respondents met the SPANOVA subgroup requirements of at least 30 subject numbers per group, as per Chua (2014). According to Thomas & Nelson (1996), the power of an experiment is the probability that it can detect a treatment effect. Past investigations noted that the power of sampling at 0.80 is a reasonable and realistic for investigation on behaviorism. For that purpose, investigators also used power and effects of size sampling based on recommendation guidelines on size sampling in research (Cohen, 1988 & 2013). Research sampling size is based on sampling power and effect of size.

The medium of recruitment was through word of mouth. Language Medium was English as English is the first language in all Singapore schools. Apart from the subjects having to fill in the Consent Form, the principal investigator also interviewed their legibility according to the scope of the study prior to the intervention.

All subjects obtained medical clearance from certified physician prior to exercise intervention and they were willing to participate and sign a consent form. All participants were screened by the appointed physician for medical problems. If a participant had a prior history of health problems (heart disease, pulmonary disease, stroke), was physically unable to perform the exercise intervention, was taking medication (e.g., asthma medication) that could impact exertion or coordination during physical activity or had a condition that limited maximal output during physical activity, she was excluded from participation in this study.

Subjects, who were overweight and obese adult, Malay Singaporean females, were non-smokers, pre-menopausal and must not be pregnant. Subjects were willing to be randomly assigned to either the experimental or control groups. Subjects attended intervention sessions of 30 minutes thrice per week for 12 weeks duration on alternate days. All subjects were willing to be tested for baseline and post experimental health and fitness assessments.

3.3.2 Venue of study

The Invitation-to-Partipate Briefing was conducted at the Tampines Changkat Community Club at 13, Tampines Street 11, Singapore 529453. The briefing sessions, fitness assessments and interventions were held in an air-conditioned studio in Physiology Department of National University of Singapore, Singapore. The medical screenings were conducted at the Green Cross Clinic at Block 824, Street 81, Singapore 520824. Dr Chu Siu Kong was the appointed physician for this study. The principal investigator were physically present on site during all seminar briefings, fitness assessments and interventions, to ensure that the study will be executed as documented.

3.3.3 Ethical approval and informed consent

Before the commencement of this study, ethical clearance was sought from the University of Malaya Ethics Committee and National University Singapore Ethics Committee. Ethics approval was granted by University Malaya Ethics Committee and National University of Singapore Approval Number: NUS 2591 NUS-IRB Reference Code: B-15-066 as attached in Appendix E. All participants were required to sign an informed consent form (Appendix A) prior to participating in the health and fitness screenings/assessments or performing any exercise trial.

3.3.4 Blood lipid laboratory measurements

A blood sample of 10 mL was collected through venipuncture from each subject after fasting for 10 hours, into vacutainer tubes containing EDTA. Blood was drawn at rest on day 0 and after the 12-week exercise program. The samples were kept at room temperature and transported within 2 hrs to a central certified laboratory at Green Cross Medical Centre. Plasma glucose, total cholesterol, triglyceride, HDL-cholesterol, and LDL-cholesterol were measured by an autoanalyser (Hitachi 747 autoanalyzer, Japan).

For biochemical analysis, sera were prepared as soon as possible following phlebotomy and stored at -80 °C until analyzed. Total cholesterol, high-density lipoproteins (HDL), LDL, very low-density lipoproteins (VLDL) and triglycerides were analyzed using a ROCHE Modular system (Japan) Autoanalyzer and the enzymatic colorimetric method employing a ROCHE model Kit. Serum insulin levels were measured using the Olympus IMMULYTE (DPC, Diagnostic Product Corporation, Los Angeles, CA, USA) hormone analyzer.

3.3.5 Anthropometric and Girth Measurements

Anthropometric measurements are used to evaluate health and dietary status, body composition changes and disease risks over time (Fryar, Gu & Ogden, 2012).

Circumference measurements have been recognized as simple indicators for nutritional assessment and prevalence of disease.

Physical examination, height and weight measurements as well as blood pressure measurements were performed by the same certified physician pre and post study to ensure tester consistency. Each subject's height was measured and conducted with the head of the subject in the Frankfurt plane and bare-footed with light clothing using the Harpenden Anthropometry Set according to the Heath-Carter Somatotype Method and recorded in centimeters. Weight of the subjects recorded in kilograms by a precision scale when the subjects were barefooted and only wearing light clothing. Blood pressure was recorded using a mercury sphygmomanometer and appropriately sized cuff after the subjects had rested for 10 minutes in supine position. Inclusion criteria consisted no apparent disorders of cardiovascular system, hematological or endocrinological, or any other systemic disease and medical clearance by the certified physician to participate in the study was a mandatory procedure for all subjects.

Anthropometric measurements of the subjects were taken manually after subjects had changed into tight-fitting clothing made from a mixture of Lycra and cotton. Anthropometric measurements of the subjects were taken manually after subjects had changed into tight-fitting clothing made from a mixture of Lycra and cotton. Height were measured to the nearest 0.1cm and body weight were measured to the nearest 0.1kg, using the Seca body meter (Seca, Germany) and the Omron HBF 514C body composition monitor and scale (Omron Healthcare Inc., USA).

3.3.6 Waist circumference and Waist-Hip Ratio (WHR)

All circumference measurements for chest, waist and hip were taken to the nearest 0.1 cm using Myotape (AccuFitness LLC, USA). All pre and post study girth measurements of the subjects were taken by trained fitness professionals. The same fitness professionals measured the same participants for the pre and post- tests to ensure tester consistency.

Waist circumference was taken in centimetres without compression of the soft tissue at midway level between lower rib margin and iliac crest using non stretchable measuring tape. The hip circumference was also taken in centimetres using the same measuring tape at its widest portion of the buttocks, with the tape paralleling the floor. Both measurements were taken while the subject was standing with feet closed together, arms by the side and body weight evenly distributed. They were reminded to wear the same clothes post intervention measurement. The measurements were taken at the end of a normal expiration. Waist to Hip ratio (WHR) was calculated by taking the waist circumference (cm) and dividing by the hip circumference (cm).

Although body mass index (BMI) are most frequently used and considered as the easiest indicator for overweight and obesity status, many studies have shown that waist and hip circumferences may be more strongly related to obesity-related diseases (Bosy-Westphal et al., 2006) and abdominal adiposity with coronary heart disease in women (Rexrode et al., 1998). Taking into consideration the presence of greater lean mass in non-abdominal regions, hip and thigh circumferences show a protective effect with health risk (Janssen, Katzmarzyk & Ross, 2004). Yusuf et al. (2005) have even reported that greater hip circumference has been linked to a reduced likelihood of myocardial infarction.

Waist Circumference has been reported to be the best with excellent correlation with abdominal imaging and high association with cardiovascular risk factors, especially diabetes (InterAct Consortium et al., 2012).

In a 2011 study where 60,000 subjects were tracked for up to 13 years, it was found that WHR was a better predictor of ischaemic heart disease mortality (Morkedal et al., 2011). Similarly too, waist circumference is an important predictor of obesity-related morbidity and mortality in adults (International Diabetes Federation, 2006).

The reliability of single measurements of waist and hip circumference and the ratio of waist circumference to hip circumference, according to Sonnenschein et al. (1993) showed that BMI was positively correlated with waist circumference (r=0.88), hip circumference (r=0.89) and waist-hip-ratio (r=0.52). Intraclass correlations for waist, hip and waist/hip ratio were 0.89, 0.81 and 0.74 respectively.

3.3.7 Body Mass Index (BMI)

Overweight and obesity, characterized by an imbalance between intake and expenditure of energy, are basically abnormal or excessive fat accumulation presenting a risk to health (World Health Organisation, 2016).

Body mass index (BMI), a simple index of weight-for-height, is used in clinical practice for definition of overweight and obesity in adults. The US Center for Disease Control and Prevention recommended against using BMI diagnostically (Center for Disease Control, 2016) but instead as a measure to track populations' weight status and as a screening tool for identification of weight problems in individuals. After all, high BMIs are associated with future health risks including the prediction of morbidity and death. Table 3.1 showed the International Classification of BMI in adults. BMI of between 18.5 kg/m2 and 24.9 kg/m2 reflects a healthy weight, BMI between 25.0 kg/m2 and 29.9 kg/m2 being overweight and BMI of ≥30.0 kg/m2 is obese in its various severities of mild, moderate and extreme. It provides the most useful and convenient population-level measure of overweight and obesity as it is the same for both sexes and for all ages of adults (World Health Organisation 1995, World Health Organisation, 2004).

Table 3.1: Body Mass Index Classification (International)
(World Health Organisation, 2015)

Classification	**International BMI (kg/m^2)**
Underweight	<18.5
Normal weight	18.5 to 24.9
Overweight	25 to 29.9
Obesity (Mild)	30 to 34.9
Obesity (Moderate)	35 to 39.9
Obesity (Extreme)	>40

It must be noted however that the existing international definition of obesity may actually underestimate obesity and health among non-Caucasian populations (Hunma et al., 2016). This following studies showing that many Asian populations, including Singaporeans, have higher proportion of body fat and increased risk for cardiovascular diseases and diabetes mellitus, compared to Caucasians at the same BMI (Deurenberg et el., 1998). For interpretation of health risks for Asian populations, lower BMI cut offs are used (World Health Organization Expert Consultation, 2004). The Asian BMI cut-offs reflects an emphasis on health risk rather than weight. Public health action points was identified at 23.0, 27.5, 32.5 and 37.5 kg/m2 along the BMI continuum.

The "Low Risk" classification denotes a healthy range. As BMI of below 18.5 kg/m^2 comes with the risk of developing problems such as nutritional deficiency and osteoporosis while “Moderate Risk” range between 23.5 kg/m^2 to 27.4 kg/m^2 increases the risk of developing heart disease, high blood pressure, stroke, diabetes. The “High Risk” range of ≥27.5 kg/m^2 increases the risk of developing heart disease, high blood pressure, stroke and diabetes.

However, according to WHO Expert Consultation as reported in Lancet (2004), it must be noted that Asian descent population have different associations between BMI, percentage of body fat, and health risks than those of European descent, with a higher risk of type 2 diabetes and cardiovascular disease at BMIs lower than the WHO cut-off point for overweight, 25 kg/m^2, although the cutoff for observed risk varies among different Asian populations

Asians also tend to have higher amounts of abdominal fat at lower BMIs. The original BMI cut-offs may be insufficient as in identifying Asian individuals with a high risk of obesity-related morbidity and mortality. In this regard, the Western Pacific Regional Office of WHO (WPRO) in 2000, proposed an alternative definition of overweight (BMI 23.0 kg/m^2 – 24.9 kg/m^2) and obesity (BMI ≥ 25.0 kg/m^2) for Asian populations (Anuurad et al., 2003). The validity of WPRO’s definitions in Asian cohorts have been confirmed in multiple studies. With BMI above 25 kg/m^2, the respective mortality risk was higher among Asians in comparison to their American counterparts. High BMI was ranked the 23rd most important health risk factor for South-East Asia in 1990 and by 2010 it was ninth in rank (Institute for Health Metrics and Evaluation, 2015). For standardization purposes, international BMI classifications were used in this study as in Table 3.1 above.

Although BMI has studies observing its limitations in terms of health (Tomiyama et al., 2016), it is a convenient measurement tool for the population. Its values are age-independent and the same for both genders. WHO classifies BMI of 25.0 – 29.9 as overweight and BMI of 30 and above as obese (WHO, 1995, WHO, 2004). BMI was calculated using the formula: BMI= weight (kg)/ height (m)^2. Pre and post study height and weight measurements of the subjects were taken by trained fitness professionals. The same fitness professionals measured the same participants for the pre and post- tests to ensure tester consistency.

3.3.8 Skinfold Body Fat Percentage

Skin fold thickness measurements were made to the nearest 0.1mm at the triceps, abdominal and thigh with a Holtain callipers (Holtain Ltd, UK). This was achieved by the measurer gently grasping the fold of skin and underlying subcutaneous adipose tissue of the subjects, with the amount grasped depending on the thickness of this tissue. All measurements followed the procedures recommended by Lohman et al. (1988) and were taken in duplicate on the right side of the body with the subject standing in an upright position. Caliper placed directly on the surface of the skin surface, 1 cm away from the thumb and finger, perpendicular to the skin fold, halfway between the crest and base of the fold. Maintain the pinch while reading the caliper. Wait only 2 seconds before reading the caliper. Duplicate measurements taken at each site and retest if the measurements are not within 1 to 2 mm. Do not retest immediately after the first reading. Do allow time for the skin to regain normal texture and thickness. Rotate through the measurement sites.

BMI has been reported to be highly correlated with body fat percentage as measured by dual x-ray absorptiometry (Flegal et al., 2009). Skinfolds, using calipers, are taken from 3 sites, namely the suprailiac, triceps and abdominal and calculated using the Jackson & Pollock equations (1985) and Jackson, Pollock & Ward (1980). The suprailiac site utilizes the diagonal fold, in line with the natural angle of the iliac crest taken in the anxillary line immediately superior to the iliac crest. Triceps use vertical fold, on the posterior (back) midline of the upper arm, hallway on the upper arm between the acromion and olecranon proceses, with arm freely to the side. Abdominal is the vertical fold 2cm on the right of the umbilicus.

The 3-Site Skinfold Equation was used, as follows:

% Body Fat = (0.41563 x sum of skinfolds) – (0.00112 x square of the sum of skinfolds) + (0.03661 x age) + 4.03653, where the skinfold sites (measured in mm) are abdominal, triceps and suprailiac.

Stalker (2012) in studying the reliability and validity of the body caliper in evaluating body composition, reported that the reliability of the body caliper was assessed by an intraclass correlation coefficient and was proven reliable (ICC=.997). The validity of this instrument was assessed and proven valid by 96%.

Furthermore, according to Temple et al. (2014) when evaluating the accuracy of the most commonly used anthropometric-based equations in the estimation of percentage body fat (%BF) in both normal-weight and overweight women using air-displacement plethysmography (ADP) as the criterion measure, in Jackson, Pollock & Ward (JPW equations) (1980) whose 3 sites provided the most accurate estimation of %BF when compared with ADP in all three groups consisting of forty-three female participants aged between 18 and 55 years. Group 1 included all participants, group 2 included participants with a BMI<25·0 kg/m2 and group 3 included participants with a BMI≥25·0 kg/m2.

3.3.9 Fitness: Curl up (partial), push up tests (modified) and bodyweight squats.

The partial curl up test or the maximum number of push-ups that can be performed without rest are used to evaluate the endurance of the abdominal muscle groups and upper body muscles respectively (Canadian Society for Exercise Physiology, 2003). According to Diener (1995), half sit up (partial curl up) has very high test-retest reliability ($r = 0.98$), moderately high inter apparatus reliability ($r = 0.71$), and high intertester reliability ($r = 0.76$). The correlation of the half sit-up test with the full sit-up test of the National YMCA was 0.67 and the correlation with isometric abdominal strength was 0.38. The proposed half sit-up test was found to be reliable and is proposed as an alternative method of evaluating abdominal strength and endurance. According to Sidney & Jette (1990), correlations between curl-up performance and age, stature, body weight, BMI, girths, body fat, trunk flexibility, aerobic fitness, upper body strength and muscular endurance were significant ($p < 0.0001$), but accounted for less than 16% of the total variance. Fitter individuals (and/or those with less excess body fat), as well as younger individuals, are able to perform more curl-ups than less fit, fatter or older individuals. The partial curl-up is recommended as a better test of abdominal muscular endurance, replacing the one-minute speed sit-up with anchored feet.

According to Baumgartner et al., 2002, the correlation between revised push-up scores and number of bench press executions with a percentage of the body weight was 0.80 for women. The interscorer objectivity and stability reliability coefficients are very acceptable. However, although it has good validity, it produces many zero scores for women (Wood & Baumgartner et al., 2004). Thus they conducted a study to determine the objectivity, reliability, and validity for the bent-knee push-up test (executed on hands and knees) for college-age women and to determine the relationship between the revised push-up test (executed on hands and toes) and bent-knee push-up test scores. The interscorer objectivity coefficient for the bent-knee push-up scores was .997. A stability reliability coefficient of .83 was reported. The correlation between the bent-knee push-up and revised push-up scores was .75 and the correlation between the bent-knee push-up and bench press scores was .67. The correlation between the revised push-up and bench press scores was .68. Both tests appear effective, however, the bent-knee test is probably more appropriate with lower strength level college-age women. The modified push up - the bent-knee push-up test (executed on hands and knees) was adopted for this study taking into consideration the physiological limitations of this study's subjects namely sedentary overweight and obese women, who might not have the strength to execute a push up or a revised push up.

3.3.10 Metabolic Health Parameters

The presence of three or more of the following components in an individual are associated with metabolic syndrome (AHA/NHLBI, 2005), according to the AHA and the National Heart, Lung and Blood Institute:

- Elevated waist circumference (Women: > or equal to 35 inches 0r 88cm)
- Elevated triglycerides (150 mg/dL)
- Reduced HDL cholesterol (Women: < 50 mg/dL)
- Elevated blood pressure (> or equal to 130/85 mm/Hg
- Elevated fasting blood glucose (> or equal to 100 mg/dL)

The guidelines for assessments on cholesterol, triglycerides, blood glucose, blood pressure is attached in Appendix H (American Council on Exercise, 2010).

3.4 Familiarization

For the pilot as well as the main research, subjects underwent three familiarization trials pre-testing. Pilot work by Atkinson et al. (2004) indicated that familiarization session reduces systematic and random errors associated with a 10km time trial distance. Further research by Altareki et al. (2006) stated that at least one familiarization trial is needed to reduce learning effects possibilities for a time trial protocol. Study by Selvanayagam, Riek & Carroll (2011) showed that single session of strength training shares similar neural mechanisms to ballistic motor learning and that the changes that occurred were at least partly due to neural adaptation by assessing muscle responses to motor nerve stimulation.

3.5 Exercise intervention and justification

There is a strong dose-response relationship between the volume (duration, frequency and intensity) of resistance and/or endurance exercises, the duration of training and the amount of fat loss (total and regional), according to Haskell et al. (2008). With no caloric restriction, 150 minutes per week of exercise has shown modest weight loss (2 to 3 kg) while 225 to 420 minutes per week has shown 5 to 7.5 kg weight loss in studies with 12 to 18 weeks (American College of Sports Medicine, 2009). Furthermore, overweight and obese adults should accumulate 150 or even more than 225 minutes of exercise per week (American College of Sports Medicine, 2018). High intensity exercise has shown fat loss results in lesser time commitment in terms of duration of exercise activity (Trapp, 2008; Whyte et al., 2010; Boudou, 2003, Boutcher, 2011 and Smith et al., 2013).

The timeframe of 12 weeks was chosen after examining the impact of the high intensity training on cardio-metabolic risk factors, anthropometric measures of obesity and cardiovascular fitness in both healthy and clinical populations with cardiovascular and metabolic disease by Kessler, Sisson, & Short (2012). Their research reported the effects of high intensity training versus continuous moderate exercise in 14 of the 24 studies featuring high intensity interval training, exercise programme of which ranging from 2 weeks to 6 months. All of the 17 studies measuring aerobic fitness and all of the

7 studies measuring insulin sensitivity showed significant improvement in response to high intensity interval. Minimum of 12 weeks was necessary to demonstrate improvement in fasting glucose in four of seven studies (57%). Minimum of 8 weeks of HIT was needed to demonstrate improvement in HDL-C in three of ten studies (30%). There was no study reporting that HIT resulted in improvement of total cholesterol, low-density lipoprotein cholesterol (LDL-C), or triglycerides. 12 weeks of HIT was needed for reduction in blood pressure to emerge in five studies of participants not already being treated for hypertension. Minimum period of 12 weeks was necessary to see consistent improvement in the six studies that evaluated anthropometric measures of obesity in overweight/obese individuals. Of the 13 studies with a matched-exercise-volume continuous moderate exercise group, improvement in aerobic fitness in response to HIT was equal to (5 studies), or greater than (8 studies) in response to continuous moderate exercise. High intensity training proved to be safe and effective in patients with a range of cardiac and metabolic dysfunction. In conclusion, high intensity training was reported to promote superior improvements in aerobic fitness and similar improvements in some cardio-metabolic risk factors in comparison to CME, when performed by healthy subjects or clinical patients for at least 8–12 weeks.

Cochran et al. (2014) reported that even a single session of exercise lasting less than 10 minutes including warm-up, performed three times per week for 6 weeks, was sufficient to improve maximal aerobic capacity.

According to Gillen & Gibala (2014), as little as 3 high intensity interval training sessions per week, involving ≤10 min of intense exercise within a time commitment of ≤30 min per session, including warm-up, recovery between intervals and cool down, has been shown to improve aerobic capacity, skeletal muscle oxidative capacity, exercise tolerance and markers of disease risk after only a few weeks in both healthy individuals and people with cardio-metabolic disorders.

Physical activity intervention as shown in Figure 3.2 was performed, thrice weekly for 12 weeks. Dynamic warm ups were utilized as opposed to static stretching warm ups because of its effects on power and agility (Mcmillian et al., 2006). Herman and Smith (2008) reported that even a four-week dynamic stretching warm-up intervention elicited longer-term performance benefits. The exercise training interventions consisted of dynamic warm ups and walking (5 minutes) (Mahmood, 2015, pp. 95-113), intensity intervals and bodyweight exercise which included modified pushups, modified curl ups, bodyweight squats, dynamic cool down and static stretches (5 minutes). The intensity intervals of the bodyweight movements were executed in sets of 10, 12 and 15 repetitions, respectively, with 90 seconds of rest in between the sets. Midway through the 12 weeks of intervention, their rest will be shortened to 30 seconds intra sets. The twelve static and dynamic stretches were quadriceps stretch, Adductor stretch, hamstring stretch, Tibialis anterior stretch, Gastrocnemius stretch, Oblique stretch, Latissimus dorsi stretch, Pectorals stretch, Deltoids stretch, triceps stretch and Sternocledomastoid stretch as shown in Appendix F. Fitness evaluations, namely push up, curl up and bodyweight squat test were conducted at baseline and post intervention.

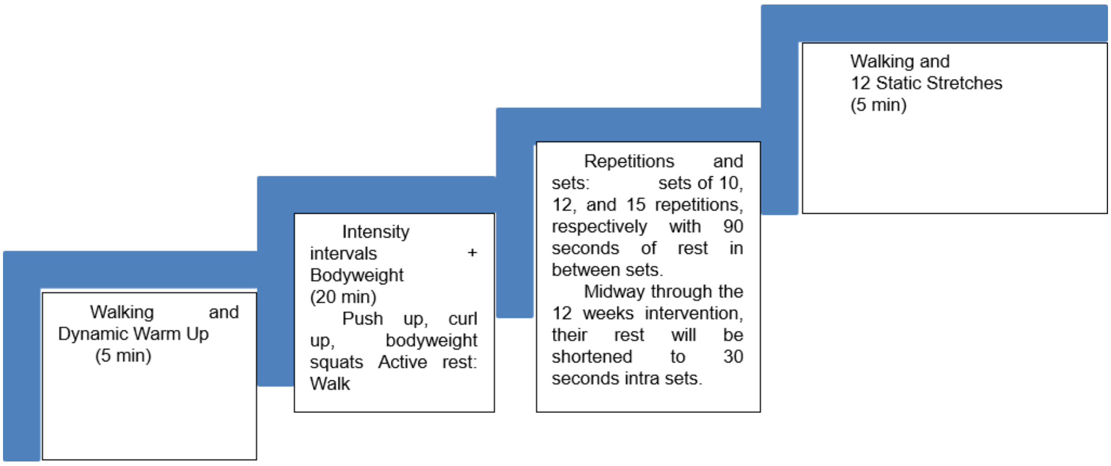


Figure 3.2: Physical activity intervention

Warming up and stretching for improved physical performance and prevention of sports-related injuries were incorporated in the programme (Shellock & Prentice, 1985 and Woods et al., 2007). A systematic review and meta-analysis were undertaken by Fradkin et al. (2010) investigating the effects of warming-up on performance improvement in physical activities. Warm-up was shown to improve performance and that performance improvements can be demonstrated after completion of adequate warm-up activities, and there is little evidence to suggest that warming-up is detrimental to sports participants. Dynamic stretching has been shown to be beneficial in decreasing presynaptic inhibition (Clark et al., 2014). The 12 static stretches were performed dynamically after the walking warm up at the beginning of the exercise.

Physical activity intervention consisted of walking as warm up (Mahmood, 2015) and cool down (pp. 95-113). According to Yamaguchi & Ishii's (2014) recommendations that the optimal "repetition" or "distance" x "set" of dynamic stretching was "10-15 repetitions", intensity intervals and bodyweight exercises of 20 minutes, dynamic cool down and static stretches of 5 minutes at the end. Dynamic stretching replicating the moves of static were incorporated after the warm up.

According to Mohammadtaghi et al. (2010), dynamic stretching during the warm up was most effective as preparation for agility performance. According to Chatzopoulos et al. (2014), dynamic stretching protocol is more appropriate than static stretching for activities that require balance, rapid change of running direction (agility) and movement time of the upper extremities. The intensity intervals of the bodyweight movements were executed in three sets of 15, 12, and 10 repetitions, respectively with 90 seconds of rest in between sets. Midway through the 12 weeks intervention, their rest will be shortened to 30 seconds intra sets.

A study by Farah et al. (2012) on the effects of rest interval length on rating of perceived exertion during a multiple-set resistance exercise, showed that in the 30 seconds rest interval session, the RPE increased between sets in all exercises, while in the 90 seconds rest interval session, the RPE increased from the first set to the second set in three exercises. RPE in the 30 seconds rest interval session was higher than that in the 90 seconds rest interval session in the third set. The results suggest that RPE increases for shorter rest intervals than for longer rest intervals. Therefore, the RPE could be considered an indicator of muscle recovery during resistance exercise. Thus in this study with obese as the subjects, a shorter rest interval is designed into the intervention only midway through the study as the subjects improved in fitness. The intervention were executed by the experimental groups three days per week for twelve weeks.

In accordance to the guidelines above, the exercise prescription consisted of a combination of variety of exercise movements, namely Bodyweight Squats, Curl Ups and Push Ups in circuits-intensity interval training utilizing their own bodyweight, impacting postural stability and mobility. The dynamic warm ups utilized walking and dynamic movements of the 12 static stretches, namely Quadriceps Stretch, Adductor

Stretch, Hamstring Stretch, Tibialis Anterior Stretch, Gastrcnemius & Soleus Stretch, Obliques Stretch, Latissimus Dorsi Stretch, Pectorals Stretch, Deltoids Stretch, Triceps Stretch and Sternocleidomastoid/Scalene/Trapezius Stretches (Appendix F). The cool down consisted of walking and these 12 static stretches.

3.6 Pilot Study

Prior to the treatment period, a pilot study was conducted to examine the feasibility of the research procedures, particularly to test the appropriateness of the tasks, namely the execution of research design and to observe the effectiveness of generating treatment outcomes and response of obese/overweight subjects.

For data analysis and statistical methods, the Statistical Package for the Social Science version 22.0 (IBM SPSS Statistics, Armonk, NY, USA) was used for data entry and descriptive statistical analysis. Data were expressed as means ± standard deviations. A matched pair t-test determined the significance of differences between pre and post-intervention data. Level of significance was $\alpha = 0.05$.

Obese subjects (N=28) completed a guided three-months-twice-per week exercise in order to assess effects of dependent variables, namely body composition, blood lipid metabolic profiles and fitness at Time 1 (baseline, prior to intervention) and Time 2 (12-weeks after intervention). The mean and standard deviation of age for the studied subjects were 33.6 and 7.6 years old, respectively. About 78.5% of the subjects were in the ≤ 30 years old and 31 - 39 years old groups; the rest were in the ≥ 40 years old group, as reflected in Table 3.2.

Table 3.2: Distribution of subjects (n=28)

Demographic Variables	Male Mean ±SD n (%)	Female Mean ±SD n (%)	Total Mean ±SD n (%)
Gender	8 (28.6)	20 (71.4)	28 (100)
Age	34.1 ± 8.7	33.5± 7.3	33.6 ±7.6
≤ 30	4 (50.0)	9 (45.0)	13 (46.4)
31-39	2 (25.0)	7 (35.0)	9 (32.1)
≥40	2 (25.0)	4 (20.0)	6 (21.4)

The data for anthropometric measurements and body composition variables taken during pre and post intervention are presented in Table 3.3 Significant ($p<0.01$) decreases were reported in body weight, body fat percentage, skin fold thickness, circumference measurements and BMI, but the magnitude of changes was generally small. The largest changes were obtained from skinfold thickness consisting of skinfolds of the triceps, thigh and abdominal ranging from 10.71% to 15.44%. There was no significant ($p=0.197$) decrease in waist-to-hip ratio (1.10%).

Table 3.3: Pilot Study: Changes in anthropometric measurements and body composition pre- to post-training

Measurements	Pre-training (Mean±SD)	Post-training (Mean±SD)	Paired Differences (Mean±SD)
Weight	88.51 ± 17.07	82.51 ± 16.59	5.99 ± 5.12
Body Mass Index(BMI)	33.45 ± 4.67	31.18 ± 4.69	2.27 ± 1.87
Skinfolds			
Body Fat Percentage	43.51 ± 6.75	40.24 ± 7.87	3.26 ± 3.23
Triceps skin fold	31.66 ± 8.86	27.14 ± 7.72	4.52 ± 5.84
Thigh skin fold	49.79 ±14.06	44.46 ± 14.39	5.33 ± 7.24
Abdominal skin fold	44.88 ± 14.61	37.95 ± 12.53	6.93 ± 10.10
Girth Circumference			
Waist circumference	102.51 ± 11.76	97.69 ± 11.20	4.83 ± 5.90
Waist-to-hip ratio	0.91 ± 0.08	0.90 ± 0.07	0.01 ± 0.04

Paired sample t-test (Table 3.4) was conducted to evaluate the impact of physical activity training on body mass and body composition in a 3-month interval. There were statistically significant decrease in body mass and body composition from pre-training to post-training (p<0.05). The eta squared statistic indicated large effect size, with a substantial difference in the body mass and body composition before and after intervention based on Cohen's (1988) interpretation. However, the waist-to-hip ratio (WHR) showed moderate effect (0.061). The Laborer's Health and Safety Funds indicated that a WHR greater than 1.0 for men or 0.8 for women is associated with a greater risk of diabetes or hypertension (high blood pressure). Also, WHRs above 0.95 for men and 0.8 for women indicate a heightened risk of heart attack (Laborers' Health and Safety Fund of North America, 2006).

Table 3.4: Paired sample t-test of anthropometric measurements and body composition pre- and post- training

Paired statistics	Correlation *R*	T	Sig.	Eta squared
Weight (pre) Weight (post)	0.954	6.197	0.000	0.587
Body fat (pre) Body fat (post)	0.913	5.337	0.000	0.513
Triceps skin fold (pre) Triceps skin fold (post)	0.760	4.096	0.000	0.383
Thigh skin fold (pre) Thigh skin fold (post)	0.871	3.894	0.001	0.360
Abdominal skin fold (pre) Abdominal skin fold (post)	0.733	3.630	0.001	0.328
Waist circumference (pre) Waist circumference (post)	0.869	4.328	0.000	0.410
Hip circumference (pre) Hip circumference (post)	0.936	5.936	0.000	0.566
BMI (pre) BMI (post)	0.920	6.424	0.000	0.604
Waist-hip ratio (pre) Waist-hip ratio (post)	0.877	1.324	0.197	0.061

3.6.1 Limitations of pilot study

There were several limitations discovered in the pilot study. Several participants were unfamiliar to exercising with music. These subjects were uncoordinated and clumsy and was not able to synchronise to the music as is required for Treatment Group A, exercising to synchronous music. This affected their concentration and coordination tremendously, thus affecting their execution of the physical activity intervention. Balance was affected during execution of the exercises as well. This in turn affected safety as they struggled for balance while coordinating to follow the movements of the high intensity training.

After further investigation post pilot study, it was found that the affected individuals had no prior experience of exercising to music. Thus for the main research study, measures were taken as an inclusion criteria that the subjects recruited for the main study must have prior exercise-to-music experience. This is to ensure the safety of the subjects when executing high intensity exercise. It is also to ensure that the criterion of subjects for the study will be standardized throughout.

Additional information received from the pilot study was that the music was not liked by the group. Thus, a special original orchestra arrangement was composed by the Cultural Centre of University of Malaya integrating popular and culturally-sensitive music for the main study.

The most notable findings in this pilot study was that for those subjects who did not have any music background and for those who had not followed a group exercise class before, they had difficulty, was too uncoordinated and clumsy. They took a long time to follow and adapt to the movements shown by the instructor. Apart from affecting the smoothness of the instruction and adaptation to the exercise movements, safety was also affected as they struggled for balance while attempting to follow the movements of the high intensity training. Thus, it was decided that during recruitment of voluntary participation for the main research, subjects will be asked about their music inclinations and group exercise experience.

3.7 Music composition to music inclination

Responding to the feedback received from the pilot study and emphasising the principal benefits of music – improved mood, arousal control, reduced perceived exertion, enhanced work output, improved skill acquisition, flow states, dissociation from feelings of pain and fatigue – are determined by the four factors of rhythm response, musicality, cultural impact, and extra-musical associations, as per Terry & Karageorghis (2006), a special original orchestra arrangement was composed by the Cultural Centre of University of Malaya integrating popular and culturally-sensitive music.

A special original orchestra arrangement namely "Symphony No 5', "Bujang Dara", "Jangan Tinggal Daku" and "Sing, Sing, Sing" was especially composed for the main research study. The above was assembled, as per Costas I. Karageorghis & David-Lee Priest (2012) that rhythm response refers to the effects of musical rhythm, especially tempo (speed of music as measured in beats per min (bpm). Musicality refers to the pitch-related elements of music such as harmony (how the notes are combined when played together) and melody (the tune). Cultural impact concerns the pervasiveness of the music within society or a sub-cultural group. Association refers to the extra-musical associations that may be evoked. The music was chosen over more than 30 repertoire suggestions. The final songs chosen were the ones liked by the subjects and the songs were familiar to their age groups.

As well as rhythm, music is constructed from elements such as tempo, dynamics, articulation, expression, phrasing and so forth, which equally contribute to the synchronization of movements in a routine. A familiar Symphony Western classical popular song was used to trigger interest. In the twenty-first century, people looked to the western for musical influence. Thus a song based on the above, was designed for movement, to be used during the research's physical activity intervention. Up-tempo beat was injected.

To enhance ethnocentric and culture-centric experience, for these demographics – the Malays, the song entitled "Bujang Dara" reminiscence of the 1950's era brought back nostalgia using the current style. "Jangan Tinggal Daku" was sombre and soulful, with the singing style of cantabile dolce was used during the static stretches segment at the cooldown phase. "Sing Sing Sing" was a fast, swing style ballroom dancing to match the peak portion of the exercise prescription. These 4 songs are completely different in styles and was specially rearranged and recorded for this project by the Cultural Centre of University of Malaya.

In addition to the above, Karageorghis' (2017) guidelines in applying music in exercise and sport was adopted. Namely, that music selected as an accompaniment for exercise should be congruent with an individual's personal characteristics (e.g. age, personality, attentional style), the exercise task, the physical and social environment in which the activity takes place, and desired outcomes.

3.8 Statistical analysis

Data collected were analyzed using the Statistical Package for the Social Science version 22.0 (IBM SPSS Statistics, Armonk, NY, USA). All descriptive statistics are presented in means and standard deviations for pre and post-tests scores. A repeated measure (pre-post-tests) for the three groups was conducted to determine the changes before and after 12-week intervention. The level of significance used was $\alpha = 0.01$. Later, the split plot ANOVA (SPANOVA), also known as mixed design ANOVA, was carried out to explore the groups intervention (Group A = exercise with synchronous music; Group B = exercise with asynchronous music; Group C = exercise with no music) on body composition, blood lipid metabolic profiles and fitness at Time 1 (baseline, prior to intervention) and Time 2 (12-weeks after intervention), with a statistically significant level at both $p < 0.01$ and $p < 0.05$ (Spanova multivariate).

Split-plot ANOVA tests were performed to address the research questions of this study. The dependent outcome measures were analysed for Multivariate Pillai's Trace test to describe the changes reported in the scores between the participants in the two groups for their repeated measures. Comparison of the variability of scores between the two groups is conducted by calculating the *F* ratio. The greater the *F* ratio the greater difference between group variance with the assumption that it was the causal effect by an independent variable. In order to use SPANOVA, there are two assumptions need to be fulfilled, equality of variance and equality of covariance matrices. We use the Pillai's Trace test if at least one of two assumptions was violated and the Wilk's Lambda test if the two assumptions above were fulfilled. Data collected were analysed by using SPSS software. Multiple regression analysis was generated for the prediction formulae of this study.

CHAPTER 4: RESULTS

4.1 Introduction/Review: Music and Physical Activity on Body Composition, Fitness and Blood Lipid Parameters

This chapter presents the statistical analysis of data and results of the study (See Appendix G). The sections are organized and reported accordingly and presented in means and standard deviations for repeated pre and post-tests scores for the three groups, which was conducted to determine the changes before and after 12-week intervention. SPANOVA analysis was then conducted to explore the groups intervention (Group A = exercise with synchronous music; Group B = exercise with asynchronous music; Group C = exercise with no music) on for body composition, fitness evaluations and metabolic blood profile parameters.

The purpose of the current study was to examine the effects of two experimental conditions, namely synchronous music and asynchronous music and a no-music controlled condition and high intensity exercise on three relevantly grouped dependent measures: body composition (namely BMI, weight loss, body fat percentage, waist circumference and waist-to-hip ratio), fitness (namely push up, curl up, bodyweight squat tests and resting heart rate) and metabolic health (namely cholesterol, fasting blood glucose, triglycerides, blood pressure) parameters.

The results are presented to attend to the objectives of the study as follows:

- Investigate the effects of a twelve-week physical activity intervention programme with music as ergogenic factor, on body composition parameters (namely, BMI, weight loss, body fat percentage, waist circumference and waist-to-hip ratio); fitness parameters (namely, modified push up, modified curl up, bodyweight squats and resting heart rate) and blood lipid health parameters (fasting cholesterol (LDL & HDL), fasting blood glucose and triglycerides) of adult overweight and obese Malay women in Singapore;

- Propose prediction formulae for body weight and waist reduction through high intensity exercise with/without music.
- Ascertain if adherence to exercise is affected at the end of the study.
- Examine a follow up study on the subjects 2 years post-study for their adherence to exercise

With music in the exercise domain being an almost symbiotic relationship, hypothesis for this study was based on findings and theoretical predictions that addresses the antecedents, moderators and consequences of music use (Karageorghis, 2016), relevant models of information processing (Rejeski, 1985), attention (Tenenbaum, G., 2001) and the principles of rhythmic entrainment. It was hypothesised that at post intervention,

- Group A (synchronous music + physical activity) will augment the highest body composition, functional fitness and blood lipid health parameters;

- Second highest will be Group B (asynchronous music + physical activity) and
- Lowest is Group C (no-music physical activity intervention)

This research hypothesized that there will be a significant relationship between synchronous music to high intensity exercise resulting in reduction of BMI, increased weight loss and increased functional fitness as well as improved metabolic profile.

The null hypothesis H_0 is that there will be no significant relationship between synchronous music to high intensity exercise resulting in reduction of BMI, increased weight loss and increased functional fitness as well as improved metabolic profile. With the findings of this research, we do not reject the null hypothesis as there was no significant relationship between synchronous music to high intensity exercise resulting in reduction of BMI, increased weight loss, improved metabolic profile and increased functional fitness (except for Curl Up fitness). As for Curl Up Fitness we accept the alternate hypothesis that there was a significant relationship between synchronous music to high intensity exercise.

Answers to the following research questions will be presented in this chapter:

Can this physical activity intervention, with/without the accompaniment of specially choreographed music, impact body composition positively in terms of increased weight loss and decreased waist measurements in overweight and obese adult Malay women in Singapore?

- Is music effectual at high intensity exercises?
- Is high-intensity exercise detrimental to the obese in terms of adherence?
- List differences in exercise participation, pre-study, post 12 weeks study and after 2 years post study

4.2 Background of Respondents/ Data Description

Voluntary (N=92) subjects consisted of adult pre-menopausal, overweight and obese Singaporean Malay women aged between 25 and 55 years old, who were randomly divided into three groups, two treatment groups namely exercise with synchronous music (n=31), exercise to asynchronous music(n=31) and the controls (exercise with no music) (n=30). As given in Figure 4.1, the three groups underwent a twelve-week thrice weekly intervention of high intensity exercises training at 85–95 % peak heart rate (HR_{peak}).

- The dependent variables for Body composition were Weight Loss, BMI, Body Fat Percentage, Waist Circumference and Waist Circumference;

- The dependent variables for Fitness were Push-Ups, Curls-Ups, Bodyweight Squats, Resting Heart Rates and
- The dependent variables for Blood Lipid Metabolic parameters were Cholesterol (LDL and HDL), Fasting Blood Glucose, Triglycerides and Blood Pressure (systolic and diastolic).

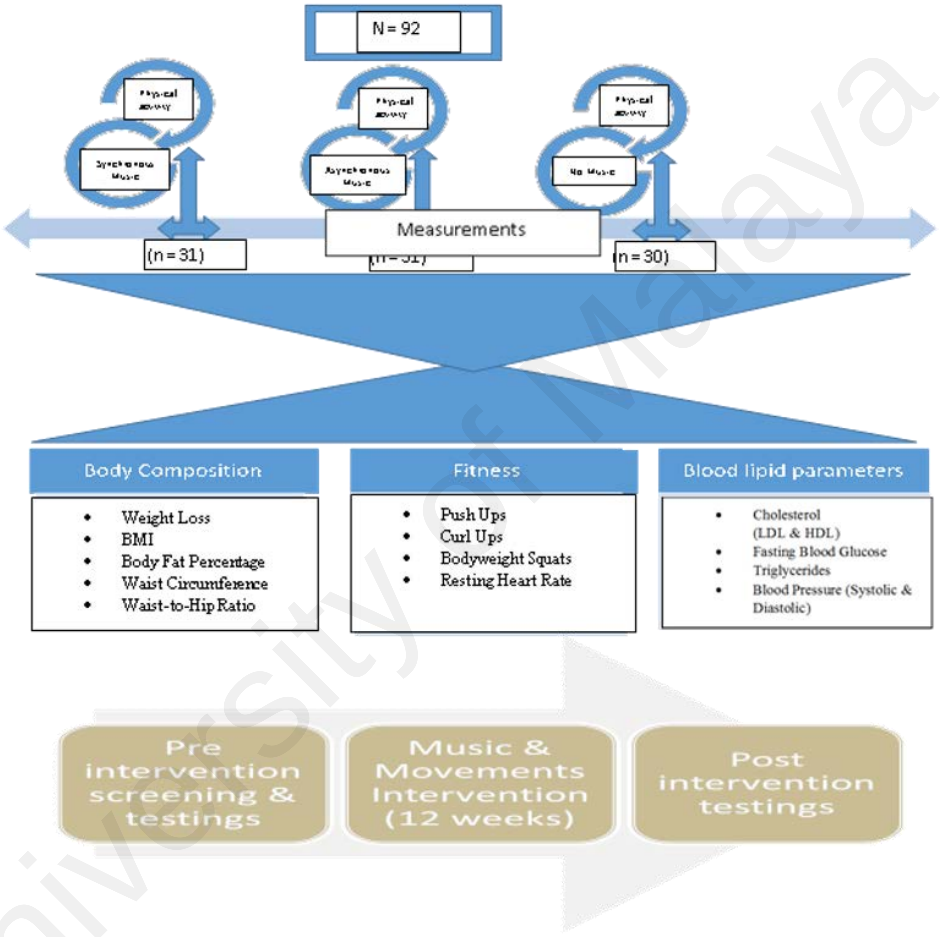


Figure 4.1: Music and High Intensity Exercise on Body Composition, Fitness and Blood Lipid parameters at 12 weeks Intervention (Pre & Post Tests)

4.3 Descriptive statistics of subjects in the study

Figure 4.2 and Table 4.1 showed the distribution of subjects in the study. The mean and standard deviation of age for the studied subjects were 43 ± 8.97 years old (Group A = exercise with synchronous music), 40 ± 10.66 years old (Group B = exercise with asynchronous music) and 40.07 ± 9.4 years old (Group C = exercise without music) respectively. About 29.3% of the subjects were ≤ 34 years old, 28.3% were in the range of 35 to 44 years old, while the rest were ≥ 45 years old (42.4%).

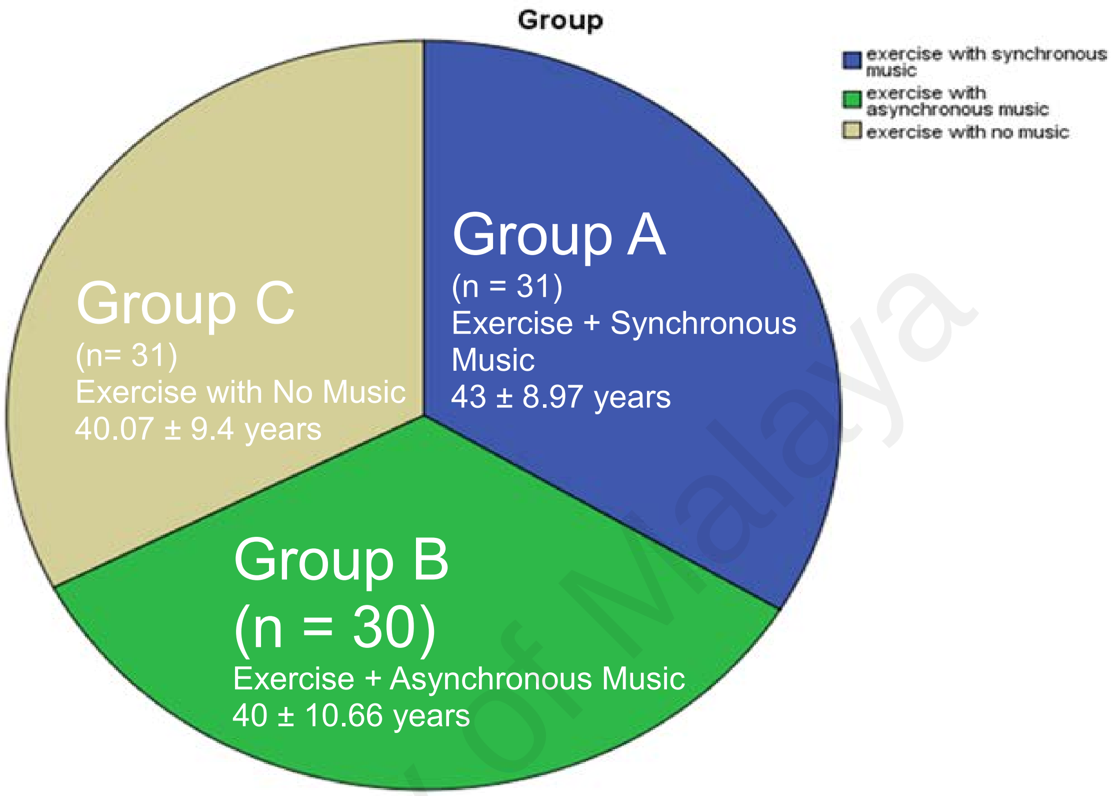


Figure 4.2: Distribution of subjects in the study

Table 4.1: Distributions of subjects according to age and groups (Displaying the means, standard deviations as well as the mean difference of the raw scores according to subjects' age and groups)

Groups	Exercise with synchronous music n (33.7%)	Exercise with asynchronous music n (33.7%)	Exercise with no music n (32.6%)
Age (Mean ±SD)	43.00 ± 8.97	40.03 ± 10.66	40.07 ± 9.40
≤ 34	6 (19.35)	13 (41.94)	8 (26.67)
35-44	10 (32.26)	4 (12.90)	12 (40.00)
≥45 Total (N=92)	15 (48.39) n=31	14 (45.16) n=31	10 (33.33) n=30

4.4 Correlations of the Music and Physical Activity on Body Composition, Fitness and Metabolic Parameters

In this section, we are examining the correlations of the music and physical activity on Body Composition, Fitness and Metabolic Parameters. Correlation is a statistical measure that indicates the extent to which two or more variables fluctuate together. A positive correlation indicates the extent to which those variables increase or decrease in parallel. On the other hand, a negative correlation indicates the extent to which one variable increases as the other decreases. We used Spearman’s rho as it states the relationship between variables when the distribution of data is not normal and where both of the variables are in ordinal scale which are arranged according to rank (Chua, 2013). So, we divided into four subsections, as follows:

4.4.1 Correlations between Groups and Body Composition (Weight Loss, BMI, Fat Percentage, Waist Circumference and Waist to Hip Ratio).

In this subsection, we investigate the correlations between Treatment Group A (Synchronous + Exercise) and Treatment Group B (Asynchronous Music + Exercise) and Control Group C (No Music + Exercise) and Body Composition (Weight Loss, BMI, Fat Percentage, Waist Circumference and Waist to Hip Ratio).

Table 4.2: The correlation coefficient between Groups and Body Composition

			Group	Weight. Difference	BMI .Diff	BodyFat .Diff	Waist .Diff	Waist.Hip .Diff
Spearman's rho	Group	Correlation Coefficient	1.000	.325**	.310**	.117	.158	.065
		Sig. (2-tailed)	.	.002	.003	.268	.132	.538
		N	92	92	92	92	92	92

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Based on Table 4.2, the results of Spearman’s rho cumulative analysis indicated that there is a moderate strength (r=.325, p<0.01) between groups and weight difference. It means there is a difference of the three groups on their weight.

Between groups and BMI difference, we also found the results of the Spearman's rho cumulative analysis to indicate that there is a moderate strength (r=.310, p<0.01) as reflected in Table 4.2. It means there is a difference of the three groups on their BMI.

For both, looking at correlation results between groups and weight and between groups and BMI, there is a significant correlations at the 0.01. Using Spearman's rho correlation, we found that group has moderate (0.3 - 0.7) significant correlation with reduced weight (p-value = 0.002) and reduced BMI (p-value = 0.003). To see whether the treatments given to these groups has effects on their weight and BMI, we use SPANOVA. SPANOVA is a statistical test for experimental studies, which is able to identify the effect of treatments (between-subjects comparison) on repeated measures (within-subjects comparison). In this case between-subjects comparison is the three groups comparisons (namely Treatment Group A -Synchronous + Exercise and Treatment Group B - Asynchronous Music + Exercise and Control Group C using No Music + Exercise) and the within-subjects comparison is the time of 12 weeks intervention.

4.4.2 Correlation between Groups and Fitness (Push Up, Curl Up and Body weight Squat and Resting Heart Rate)

In this subsection, we investigate the correlations between Treatment Group A (Synchronous + Exercise) and Treatment Group B (Asynchronous Music + Exercise) and Control Group C (No Music + Exercise) and Fitness (Push Up, Curl Up and Body weight Squat and Resting Heart Rate).

Table 4.3: The correlation coefficient between Groups and Fitness

			Group	PushUp.Diff	CurlUp.Diff	Bodyweight Squat.Diff	HR.Diff
Spearman's rho	Group	Correlation Coefficient	1.000	-.280**	-.353**	-.452**	.108
		Sig. (2-tailed)	.	.007	.001	.000	.304
		N	92	92	92	92	92

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Based on Table 4.3, using Spearman's rho correlation, we found that Group has no significant correlation with heart rate. However, the results of Spearman's rho correlation analysis indicated that Groups have significant correlation with several fitness parameters, namely Push Up difference (r=-.280, p<.01), Curl Up difference (r=-.353, p<.01) and Bodyweight Squat difference (r=-.452, p<.01). All correlations are significant at the 0.01 level. Using Spearman's rho correlation, we found that group significant correlation with Push Up, Curl Up and Bodyweight Squat (Sig. (2-tailed): .001) respectively. The result indicates that the groups have a negative linear relationship on their Push Up, Curl Up and Bodyweight Squats.

This means that there are differences of the three groups on their Push Up, Curl Up and Bodyweight Squats. Further analysis is needed to see whether the treatments given to the three groups has effects on Push Up, Curl Up and Bodyweight Squats. The analysis is done by using SPANOVA because it is a statistical test for experimental studies, which is able to identify the effect of treatments (between-subjects comparison) on repeated measures (within-subjects comparison). In this case between-subjects comparison (namely Treatment Group A -Synchronous + Exercise and Treatment Group B - Asynchronous Music + Exercise and Control Group C using No Music + Exercise) is the three groups' comparisons and the within-subjects comparison is the time of 12 weeks intervention.

4.4.3 Correlations between Groups and Metabolic Profile (Cholesterol (HDL, LDL, Total Cholesterol, Triglycerides, Blood Glucose and Blood Pressure).

In this subsection, we investigate the correlations between Treatment Group A (Synchronous + Exercise) and Treatment Group B (Asynchronous Music + Exercise) and Control Group C (No Music + Exercise) and Metabolic Profile (Cholesterol (HDL, LDL, Total Cholesterol, Triglycerides), Blood Glucose and Blood Pressure).

Table 4.4: The correlation coefficient between Groups and Metabolic Lipid Profile

			Group	Total.Chol.Diff	Total. HDL.Diff	LDL. Chol.Diff	Triglyceride.Diff	Blood.Glucose. Diff
Spearman's rho	group	Correlation Coefficient	1.000	.107	.069	.126	.019	.073
		Sig. (2-tailed)	.	.309	.512	.232	.859	.491
		N	92	92	92	92	92	92

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Based on Table 4.4, the results of Spearman's rho correlation analysis indicates that groups do not have significant correlation with all metabolic lipid parameters, namely Total Cholesterol difference (r=.107, p>.01), Total HDL difference (r=.069, p>0.1), LDL Cholesterol Difference (r=.126, p>.01), Triglycerides (r=.019, p>0.01) and Blood Glucose difference (r=.073, p>.01).

Table 4.5: The Correlations Coefficient between Groups and Blood Pressure

			Group	BP.Cat.Diff
Spearman's rho	Group	Correlation Coefficient	1.000	-.090
		Sig. (2-tailed)	.	.391
		N	92	92
	BP.Cat.Diff	Correlation Coefficient	-.090	1.000
		Sig. (2-tailed)	.391	.
		N	92	92

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Based on Table 4.5, the results of Spearman's rho correlation analysis indicated that groups do not have significant correlation with blood pressure parameters.

4.4.4 Body Composition, Fitness and Metabolic Parameters - Significant Correlations

We tabulated a comprehensive table of Body Composition, Fitness and Metabolic Parameters - Significant Correlations in Table 4.6. The highlighted variables might influence the analysis. Based on this table, we need further analysis to identify whether the treatments given to the three groups have effects on their BMI, weight loss, Push Up, Curl Up and Bodyweight Squats.

Table 4.6: Body Composition, Fitness and Metabolic Parameters - Significant Correlations

		Group	Correlation
Body Composition	BMI	1	$.310^{**}$
	Weight Loss	1	$.325^{**}$
	Body Fat	0	0.005
	Waist	0	0.158
	Waist to hip	0	0.065
Fitness	Push up	1	$-.280^{**}$
	Curl up	1	$-.353^{**}$
	Bodyweight Squats	1	$-.452^{**}$
Blood Lipid	Cholesterol	0	0.107
	LDL	0	0.045
	HDL	0	0.069
	Triglyceride	0	0.019
	Fasting blood glucose	0	0.073
	Heart Rate	0	0.108

Significant Correlation (1:Yes, 0:No) **p=<.01

4.4.5 Summary of SPANOVA analysis (multivariate) for pre post difference after 12 weeks intervention

Referring to the Table 4.6 on Body Composition, Fitness and Blood Lipid parameters, significant correlations between group and the highlighted variables might influence the two experimental conditions, namely synchronous and asynchronous music. The highlighted variables here were BMI, Weight Loss, Push up, Curl up and Bodyweight Squats. Thus, SPANOVA needs to be used. The SPANOVA (Split-Plot ANOVA) is a statistical test for experimental studies, which is able to identify the effect of treatments (between-subjects comparison) on repeated measures (within-subjects comparison). In this case between-subjects comparison is the three groups' comparisons and the within-subjects comparison is the time of 12 weeks intervention. In order to use SPANOVA, there are two assumptions need to be fulfilled, equality of variance and equality of covariance matrices. We use the Pillai's Trace test if at least one of two assumptions violated and the Wilk's Lambda test if the two assumptions above is fulfilled. The analysis is done by using SPSS software.

For BMI, we use Pillai's Trace test to test whether there are differences of BMI between the means of identified groups of subjects on a combination of times (before and after 12-week fitness management) since one of two assumptions above violated. Based on the Multivariate Tests table, the significance value (p.value=0.003) is < 0.05, so we conclude that the mean scores of three groups, synchronous music, asynchronous music and no music, are significantly different in BMI across 12 weeks of obesity fitness management simultaneously.

For Weight Loss, we use the Wilk's Lambda test (since two assumptions above were fulfilled) to test whether there are differences of weight loss between the means of identified groups of subjects on a combination of times (before and after 12 weeks fitness management). Since the significance value (p.value =0.002) is < 0.05, we conclude that the mean score of three groups, synchronous music, asynchronous music and no music, are significantly different in weight loss across 12 weeks of obesity fitness management simultaneously.

For Body Fat, we use the Wilks' Lambda test (since one of two assumptions above violated) to test whether there are differences of body fat between the means of identified groups of subjects on a combination of times (before and after 12 weeks fitness management). Since the significance value (p.value =0.256) is > 0.05, we conclude that the mean score of three groups, synchronous music, asynchronous music and no music, is not significantly different in body fat across 12 weeks of obesity fitness management simultaneously.

For waist, we use the Wilk's Lambda test (since two assumptions above fulfilled) to test whether there are differences of waist between the means of identified groups of subjects on a combination of times (before and after 12 weeks fitness management). Since the significance value (p.value =0.381) is greater than 0.05, we conclude that the mean score of three groups, synchronous music, asynchronous music and no music, is not significantly different of waist across 12 weeks of obesity fitness management simultaneously.

For waist to hip, we use the Wilk's Lambda test (since two assumptions above fulfilled) to test whether there are differences of waist to hip between the means of identified groups of subjects on a combination of times (before and after 12 weeks fitness management). Since the significance value (p.value =0.280) is > 0.05, we conclude that the mean score of three groups, synchronous music, asynchronous music and no music, is not significantly different in waist to hip across 12 weeks of obesity fitness management simultaneously.

For push-up, we use the Wilk's Lambda test (since two assumptions above fulfilled) to test whether there are differences of push up between the means of identified groups of subjects on a combination of times (before and after 12 weeks fitness management). Since the significance value (p.value =0.870) is > 0.05, we conclude that the mean score of three groups, synchronous music, asynchronous music and no music, is not significantly different in push up across 12 weeks of obesity fitness management simultaneously.

For curl-up, we use the Wilk's Lambda test (since two assumptions above fulfilled) to test whether there are differences of curl up between the means of identified groups of subjects on a combination of times (before and after 12 weeks fitness management). Since the significance value (p.value =0.000) is < 0.05, we conclude that the mean score of three groups, synchronous music, asynchronous music and no music, is significantly different in curl up across 12 weeks of obesity fitness management simultaneously.

For bodyweight squats, we use the Wilk's Lambda test (since two assumptions above fulfilled) to test whether there are differences of bodyweight squats between the means of identified groups of subjects on a combination of times (before and after 12 weeks fitness management). Since the significance value (p.value=0.003) is < 0.05, we conclude that the mean score of three groups, synchronous music, asynchronous music and no music, is significantly different in bodyweight squats across 12 weeks of obesity fitness management simultaneously.

For heart rate, we use the Wilks' Lambda test (since one of two assumptions above violated) to test whether there are differences between the means of identified groups of subjects on a combination of times (before and after 12 weeks fitness management). Since the significance value (p.value=0.307) is > 0.05, we conclude that the mean score of three groups, synchronous music, asynchronous music and no music, is not significantly different in heart rate across 12 weeks of obesity fitness management simultaneously.

For Cholesterol, we use the Wilk's Lambda test (since two assumptions above fulfilled) to test whether there are differences of total cholesterol between the means of identified groups of subjects on a combination of times (before and after 12 weeks fitness management). Since the significance value (p.value=0.071) is > 0.05, we conclude that the mean score of three groups, synchronous music, asynchronous music and no music, is not significantly different in total cholesterol across 12 weeks of obesity fitness management simultaneously.

For LDL, we use the Wilk's Lambda test (since two assumptions above fulfilled) to test whether there are differences of LDL between the means of identified groups of subjects on a combination of times (before and after 12 weeks fitness management). Since the significance value (p.value=0.066) is > 0.05, we conclude that the mean score of three groups, synchronous music, asynchronous music and no music, is not significantly different in LDL across 12 weeks of obesity fitness management simultaneously.

For HDL, we use the Wilk's Lambda test (since two assumptions above fulfilled) to test whether there are differences of HDL between the means of identified groups of subjects on a combination of times (before and after 12 weeks fitness management). Since the significance value (p.value=0.287) is > 0.05, we conclude that the mean score of three groups, synchronous music, asynchronous music and no music, is not significantly different in HDL across 12 weeks of obesity fitness management simultaneously.

For Triglyceride, we use the Pillai's test (since two assumptions above violated) to test whether there are differences of Triglyceride between the means of identified groups of subjects on a combination of times (before and after 12 weeks fitness management). Since the significance value (p.value =0.563) is > 0.05, we conclude that the mean score of three groups, synchronous music, asynchronous music and no music, is not significantly different in Triglyceride across 12 weeks of obesity fitness management simultaneously.

For Blood Glucose, we use the Pillai's test (since one of two assumptions above violated) to test whether there are differences of Blood Glucose between the means of identified groups of subjects on a combination of times (before and after 12 weeks fitness management). Since the significance value (p.value.=0.676) is > 0.05, we conclude that the mean score of three groups, synchronous music, asynchronous music and no music, is not significantly different in Blood Glucose across 12 weeks of obesity fitness management simultaneously.

Table 4.7: SPANOVA Summary

		Group*time	Group	Time
Body Composition	BMI	1 (p=0.003)	0 (p=0.314)	1 (p=0.000)
	Weight Loss	1 (p=0.002)	0 (p=0.273)	1 (p=0.000)
	Body Fat	0 (p=0.256)	0 (p=0.604)	1 (p=0.000)
	Waist	0 (p=0.381)	0 (p=0.434)	1 (p=0.000)
	Waist to hip	0 (p=0.280)	0 (p=0.394)	0 (p=0.056)
Fitness	Push up	0 (p=0.870)	0 (p=0.635)	1 (p=0.000)
	Curl up	1 (p=0.000)	1 (G1& G3, p=0.02)	1 (p=0.000)
	Bodyweight Squats	1 (p=0.003)	0 (p=0.065)	1 (p=0.000)
Blood Lipid	Cholesterol	0 (p=0.071)	0 (p=0.479)	1 (p=0.000)
	LDL	0 (p=0.066)	0 (p=0.506)	1 (p=0.000)
	HDL	0 (p=0.287)	0 (p=0.059)	1 (p=0.000)
	Triglyceride	0 (p=0.563)	0 (p=0.308)	1 (p=0.004)
	Fasting blood glucose	0 (p=0.676)	0 (p=0.165)	1 (p=0.037)
	Heart Rate	0 (p=0.307)	0 (p=0.074)	1 (p=0.000)

Significant Difference (1:Yes, 0:No)

**p=<.05

As shown in Table 4.7, after SPANOVA was conducted, it was reported that for body composition, for p=<0.05, BMI and Weight Loss have significant interaction of groups and time simultaneously. Note that the main effect of Time was significant but the main effect of group was not significant. For fitness, Curl up and Bodyweight squat have significant interaction of groups and time. The main effect of Group and the main effect of Time were significant for Curl up. On the other hand, only the main effect of Time was significant for Bodyweight Squat. In contrast, there is no significant effect between Group and Time for Blood Lipid.

The procedures of analysis for Body Composition, Fitness and Metabolic Profile parameters of this study are presented in length in Appendix K.

CHAPTER 5: SUMMARY, DISCUSSIONS, IMPLICATIONS, RECOMMENDATIONS, FUTURE DIRECTIONS, CONCLUSIONS AND CONTRIBUTIONS

5.1 Summary of Findings

The obese has limitations in terms of their exercise capacity and this affects their performance at submaximal, peak intensity and during recovery. Furthermore, they tend to end their effort due to musculoskeletal pain and not true leg fatigue (Hulens et al., 2001) when performing exercise. Addressing this issue, this research attempted to use music as an ergogenic aid to physical activity. The physical activity selected in this research, is of high intensity, noting that a dose-response relationship exist between the amount of physical activity and health outcomes and that higher heart rated physical activity will lead to generally greater benefits (Miller et al., 2014), high intensity training was chosen due to its time efficiency (Gillen & Gibala, 2014) and its perception of enjoyability (Bartlett et al. (2011). Music used in this study was synchronous and asynchronous.

For this 12 weeks research intervention, 92 overweight and obese adult Singapore women (25 – 55 years of age) were voluntarily recruited and randomly put into two treatment groups (using synchronous and asynchronous music) and a control group (using no music). The high intensity exercises were the same for all three groups. The dependent variables researched in this study were body composition (namely BMI, weight loss, body fat percentage, waist circumference and waist-to-hip ratio, fitness parameters (namely, modified push up, modified curl up, bodyweight squats and resting heart rate) and blood lipid health parameters (namely fasting cholesterol (LDL & HDL), fasting blood glucose, triglycerides) and blood pressure. Pre and post tests were conducted with 12 weeks of intervention.

Significant correlations were found in BMI, Weight Loss, Push Up, Curl Up and Bodyweight Squats. After SPANOVA analysis, for body composition, BMI and Weight Loss have significant interaction of groups and time simultaneously. Note that the main effect of Time was significant but the main effect of group was not significant. For fitness, Curl up and Bodyweight squat have significant interaction of groups and time. The main effect of Group and the main effect of Time were significant for Curl up. Curl Up reported significant differences in the Treatment A Group using synchronous music and the Control C group using no music. On the other hand, only the main effect of Time was significant for Bodyweight Squat. In contrast, there is no significant effect between Group and Time for Blood Lipid. This study reported that music (synchronous and asynchronous) as well as no music does not impact on all the groups with the exception of Curl Up Fitness where Synchronous music and No-Music are significant.

To summarise results in body composition, fitness and metabolic health, all results are tabulated in Table 5.1 below:

Table 5.1: Summary of findings in body composition, fitness and metabolic health

		Group*time	Group	Time
Body Composition	BMI	1 (p=0.003)	0 (p=0.314)	1 (p=0.000)
	Weight Loss	1 (p=0.002)	0 (p=0.273)	1 (p=0.000)
	Body Fat	0 (p=0.256)	0 (p=0.604)	1 (p=0.000)
	Waist	0 (p=0.381)	0 (p=0.434)	1 (p=0.000)
	Waist to hip	0 (p=0.280)	0 (p=0.394)	0 (p=0.056)
Fitness	Push up	0 (p=0.870)	0 (p=0.635)	1 (p=0.000)
	Curl up	1 (p=0.000)	1 (G1& G3, p=0.02)	1 (p=0.000)
	Bodyweight Squats	1 (p=0.003)	0 (p=0.065)	1 (p=0.000)
Blood Lipid	Cholesterol	0 (p=0.071)	0 (p=0.479)	1 (p=0.000)
	LDL	0 (p=0.066)	0 (p=0.506)	1 (p=0.000)

	HDL	0 (p=0.287)	0 (p=0.059)	1 (p=0.000)
	Triglyceride	0 (p=0.563)	0 (p=0.308)	1 (p=0.004)
	Fasting blood glucose	0 (p=0.676)	0 (p=0.165)	1 (p=0.037)
	Heart Rate	0 (p=0.307)	0 (p=0.074)	1 (p=0.000)

Significant Difference (1:Yes, 0:No)

**p=<.05

Results showed significant differences in all parameters in within-subjects-comparisons Time 1 to Time 2 of intervention.

- BMI: pre = 32.62 ± 0.85, post = 30.75 ± 0.83, p = 0.00<0.05;
- Weight Loss: pre = 78.50 ± 1.25, post = 73.92 ± 1.13, p = 0.00<0.05;
- Body Fat: pre = 34.72 ± 0.32, post = 31.69 ± 0.29, p = 0.00 < 0.05;
- Waist: pre = 36.52 ± 0.37, post = 34.34 ± 0.30, p = 0.00 < 0.05;
- Push-Up: pre = 8.37 ± 0.55, post = 18.70 ± 0.68, p = 0.00 < 0.05;
- Curl-Up: pre = 9.46 ± 0.59, post = 21.82 ± 0.84, p = 0.00 < 0.05;
- Squat: pre = 11.39 ± 1.18, post = 31.16 ± 1.50, p = 0.00 < 0.05;
- Cholesterol: pre = 205.46 ± 3.69, post = 188.95 ± 2.88, p = 0.00 < 0.05;
- LDL: pre = 125.39 ± 3.14, post = 116.79 ± 2.67, p = 0.00 < 0.05;
- HDL: pre = 57.22 ± 1.11, post = 52.91 ± 0.82, p = 0.00 < 0.05;
- Triglycerides: pre = 120.23 ± 9.42, post = 95.76 ± 3.24, p = 0.004 < 0.05;
- Blood Glucose: pre = 98.95 ± 4.72, post = 92.64 ± 2.58, p = 0.037 < 0.05.

For between-subjects-comparison, Curl-Up reported significant difference. Treatment Group A Synchronous Music vs. Control Group C (pre = 9.48 ± 7.22, post = 26.32 ± 10.37 vs. Pre = 8.73 ± 5.09, post = 18.67 ± 5.98, p = 0.023 < 0.05).

BMI ($p<0.05$) and Weight Loss ($p<0.05$) have significant interaction of groups and time simultaneously. Note that the main effect of Time was significant but the main effect of group was not significant.

For fitness, Curl up and Bodyweight squat have significant interaction of groups and time. The main effect of Group and the main effect of Time were significant for Curl up. On the other hand, only the main effect of Time was significant for Bodyweight Squat. In contrast, there is no significant effect between Group and Time for Metabolic Blood Lipids.

Results proved positively for obesity reduction, fitness and metabolic health. Physical activity proved effective in all groups, notwithstanding music or non-music. Non-music and synchronous music are ergogenically effective for Curl-Up fitness. This research contributes trans-disciplinary and Asia-Pacific-centric new body of knowledge. Original orchestra arrangement and prediction formulae (weight loss and waist circumference) are novel findings generated from study.

5.2 Overall Summary of Body Composition

The mean value and standard deviation for anthropometric measurements pre and post intervention are presented in Table 5.2. The three groups showed improvements from pre to post intervention shown in Figures 4.5.1 and 4.5.2 respectively. This is positive for health as for every 1-inch (2.5-cm) increase in waist circumference, the following associated health risks were found, namely, blood pressure increases by 10%, blood cholesterol level increases by 8%, high-density lipoprotein (HDL) decreases by 15%, triglycerides increase by 18% and metabolic syndrome risk increases by 18% (Bray, 2004).

Table 5.2: Baseline and post intervention of body composition of the exercise with synchronous music (Group A), exercise with asynchronous music (Group B) and exercise without music (Group C)

Body composition	Group A		Group B		Group C	
	Pre	Post	Pre	Post	Pre	Post
Weight (kg)	78.1±14.6	71.5±11.7	76.7±10.4	73.2±10.7	80.8±10.5	77.1±9.9
BMI (kg/m^2)	31.3±5.1	28.7±4.2	31.1±4.0	29.7±4.1	32.5±4.4	31.0±4.1
Abdomen girth (in)	38.2±4.3	35.1±3.2	38.8±3.7	36.2±3.7	39.8±3.5	37.5±3.5
Waist girth (in)	36.0±4.2	33.6±3.0	36.6±3.6	34.5±3.2	37.0±2.6	35.0±2.4
Hip girth (in)	43.3±3.6	40.0±3.6	43.4±3.5	40.6±2.9	45.1±3.2	42.5±4.0
Waist-to-hip ratio	0.83±0.06	0.84±0.07	0.84±0.05	0.85±0.06	0.82±0.05	0.83±0.05
Triceps fat (%)	28.0±8.0	21.2±3.6	29.1±5.9	24.3±4.6	30.6±5.4	26.4±5.9
Thigh fat (%)	41.7±12.1	29.8±8.8	43.5±8.6	33.8±8.8	44.0±11.7	36.8±12.3
Suprailium fat (%)	25.9±10.4	18.0±6.5	27.7±7.7	21.2±6.1	28.7±10.1	23.5±8.6
Body fat sum	95.6±27.1	69.0±16.4	100.3±18.2	79.3±17.5	103.3±25.4	86.7±25.0

Data were presented as the mean value ± standard deviation

The mean value and standard deviation for anthropometric measurements pre and post intervention are presented in Table 5.2, while the paired sample t-test of the body composition is shown in Table 5.3. Paired sample t-test was conducted to evaluate the impact of exercise with different intervention of music (synchronous, asynchronous or no music) on body composition in the 3-months interval. There were very significant decreases ($p<0.01$) in all the variables except for waist-to-hip ratio, where the changes were not significant ($t = -1.15$, $t = -1.00$ and $t = -0.55$ for Group A, Group B and Group C, respectively, as shown in Table 5.3). The number of subjects having more than 32% of fat at triceps, thigh and suprailiac has decreased significantly. Group A (exercise with synchronous music) showed largest paired difference in their body composition, while

Group B (exercise with asynchronous music) and Group C (exercise with no music) revealed similar changes for the variables tested.

Table 5.3: Paired sample t-test results of body composition pre and post-training for high intensity exercise with synchronous, asynchronous and without music

Body composition	Group A (exercise with synchronous music)				Group B (exercise with asynchronous music)				Group C (exercise without music)			
	Pre (Mean ±SD)	Post (Mean ±SD)	Paired Diff	t	Pre (Mean ±SD)	Post (Mean ±SD)	Paired Diff	t	Pre (Mean ±SD)	Post (Mean ±SD)	Paired diff	t
Weight (kg)	78.1 ±14.6	71.5 ±11.7	6.64 ±4.49	8.23 **	76.7 ±10.4	73.2 ±10.7	3.55 ±3.57	5.54 **	80.8 ±10.5	77.1 ±9.9	3.69 ±2.71	7.45 **
BMI (kg/m^2)	31.3 ±5.1	28.7 ±4.2	2.63 ±1.66	8.84 **	31.1 ±4.0	29.7 ±4.1	1.44 ±1.47	5.48 **	32.5 ±4.4	31.0 ±4.1	1.48 ±1.10	7.39 **
Chest girth (in)	38.7 ±3.0	36.3 ±2.9	2.44 ±2.11	6.42 **	39.1 ±3.3	37.1 ±3.0	1.98 ±2.01	5.50 **	39.4 ±3.3	37.4 ±3.6	1.92 ±1.82	5.78 **
Abdomen girth (in)	38.2 ±4.3	35.1 ±3.2	3.11 ±2.97	5.84 **	38.8 ±3.7	36.2 ±3.7	2.61 ±3.13	4.65 **	39.8 ±3.5	37.5 ±3.5	2.31 ±2.21	5.73 **
Waist girth (in)	36.0 ±4.2	33.6 ±3.0	2.42 ±2.18	6.17 **	36.6 ±3.6	34.5 ±3.2	2.11 ±2.21	5.34 **	37.0 ±2.6	35.0 ±2.4	2.02 ±2.02	5.47 **
Hip girth (in)	43.3 ±3.6	40.0 ±3.6	3.26 ±3.01	6.04 **	43.4 ±3.5	40.6 ±2.9	2.81 ±2.72	5.75 **	45.1 ±3.2	42.5 ±4.0	2.60 ±2.16	6.60 **
Waist-to-hip ratio	0.83 ±0.06	0.84 ±0.07	-0.01 ±0.05	-1.15 n.s.	0.84 ±0.05	0.85 ±0.06	-0.01 ±0.04	-1.00 n.s.	0.82 ±0.05	0.83 ±0.05	-0.05 ±0.05	-0.55 n.s.
Triceps fat (%)	28.0 ±8.0	21.2 ±3.6	6.77 ±7.47	5.05 **	29.1 ±5.9	24.3 ±4.6	4.76 ±4.85	5.46 **	30.6 ±5.4	26.4 ±5.9	4.22 ±3.88	5.95 **
Thigh fat (%)	41.7 ±12.1	29.8 ±8.8	11.92 ±11.42	5.81 **	43.5 ±8.6	33.8 ±8.8	9.69 ±9.86	5.48 **	44.0 ±11.7	36.8 ±12.3	7.22 ±7.19	5.50 **
Suprailium fat (%)	25.9 ±10.4	18.0 ±6.5	7.89 ±10.07	4.36 **	27.7 ±7.7	21.2 ±6.1	6.53 ±7.47	4.87 **	28.7 ±10.1	23.5 ±8.6	5.15 ±5.77	4.89 **
Body fat sum	95.6 ±27.1	69.0 ±16.4	26.58 ±25.75	5.75 **	100.3 ±18.2	79.3 ±17.5	20.98 ±18.55	6.30 **	103.3 ±25.4	86.7 ±25.0	16.59 ±15.19	5.98 **

Note: Data are presented as the mean value ± standard deviation; ** significant at $p < 0.01$, n.s. non-significant

A split-plot ANOVA (SPANOVA) was conducted to explore the group intervention (A = exercise with synchronous music; B = exercise with asynchronous music; C = exercise with no music) on body composition at Time 1 (baseline, prior to intervention) and Time 2 (12-weeks after intervention). The interaction effect is statistically significant [the sig. level for Wilk's lambda is 0.003 and 0.002 correspondingly, which is smaller than alpha level of 0.05] for BMI and Weight Loss, thus there are interactions between time and group for these two variables/factors. There was a significant main effect for time [Wilk's lambda, both sig values smaller than 0.05]. This suggested that there was a change in body composition from baseline to 12 weeks after intervention. The partial eta squared for time in this study is 0.723, and using the guidelines proposed by Cohen (1988) (0.01 = small effect; 0.06 = moderate effect; 0.14 = large effect), this result suggests very large effect size. The sig. value for group is 0.314 and 0.273 correspondingly which are greater than alpha = 0.05, so we conclude that the main effect for group is not significant. There was significant difference in the body composition for the three groups (those who were exercising with synchronous music, those who exercise with asynchronous music and those who exercise without music). The effect size for group is 0.029, thus it did not reach statistical significance. It is suffice to say that there is some changes in body composition from pre intervention to post intervention ($p<0.05$). Our results were in agreement with that of Slentz et al. (2004), who also reported that physical activity is associated with significant reductions in body weight and fat mass in overweight and obese middle aged men and women in a dose-response manner.

Table 5.1.1.3: SPANOVA Analysis for Body Composition

Table 5.4: SPANOVA Analysis for Body Composition

		Group*time	Group	Time
Body Composition	BMI	1 (p=0.003)	0 (p=0.314)	1 (p=0.000)
	Weight Loss	1 (p=0.002)	0 (p=0.273)	1 (p=0.000)
	Body Fat	0 (p=0.256)	0 (p=0.604)	1 (p=0.000)
	Waist	0 (p=0.381)	0 (p=0.434)	1 (p=0.000)
	Waist to hip	0 (p=0.280)	0 (p=0.394)	0 (p=0.056)

Table 5.5: Multivariate Tests^a

Effect BMI		Value	F	Hypothesis df	Error df	Sig.	Noncent. Parameter	Observed Power^c
pre.post * Group	Pillai's Trace	.122	6.201^b	2.000	89.000	.003	12.402	.883
	Wilks' ambda	.878	6.201^b	2.000	89.000	.003	12.402	.883
	Hotelling's Trace	.139	6.201^b	2.000	89.000	.003	12.402	.883
	Roy's Largest Root	.139	6.201^b	2.000	89.000	.003	12.402	.883

Table 5.6: Effect of weight loss

Effect Weight Loss		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
pre.post.program * Group	Pillai's Trace	.135	6.949^b	2.000	89.000	.002	.135
	Wilks' Lambda	.865	6.949^b	2.000	89.000	.002	.135
	Hotelling's Trace	.156	6.949^b	2.000	89.000	.002	.135
	Roy's Largest Root	.156	6.949^b	2.000	89.000	.002	.135

Table 5.7: Measure of BMI

Measure: MEASURE_1							
Transformed Variable: Average							
BMI							
Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Noncent. Parameter	Observed Power^a
Intercept	184642.566	1	184642.566	1429.061	.000	1429.061	1.000
Group	303.425	2	151.712	1.174	.314	2.348	.251
Error	11499.289	89	129.205				
Weight Loss							

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	1068895.051	1	1068895.051	4203.670	.000	.979
Group	669.120	2	334.560	1.316	.273	.029
Error	22630.619	89	254.277			

Table 5.8: Pairwise comparison

Measure: BMI

(I) pre.post	(J) pre.post	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
1	2	1.873*	.155	.000	1.565	2.181
2	1	-1.873*	.155	.000	-2.181	-1.565

Measure: Weight Loss

(I) pre.post.program	(J) pre.post.program	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
1	2	4.625*	.383	.000	3.864	5.386
2	1	-4.625*	.383	.000	-5.386	-3.864

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

As reflected in Table 5.4, 5.5, 5.6, 5.7 and 5.8, all the subjects were overweight (46.7%) and obese (53.3%) before the intervention, with 5.4% of the subjects in Grade III obesity (BMI > 40.0) (Table 4.7). The percentage of obese dropped after the 12-weeks intervention. However, subjects were still in increased risk and high risk according to the Asian cut-offs BMI points. Physical activity is inversely associated with body weight, thus associated with lower BMI in adults (Brien & Katzmarzyk, 2006). Increasing physical activities showed clinically significant weight loss of more than 5% even without caloric restriction (Ross et al., 2004) as is evidenced in this study.

Table 5.9: BMI analysis based on the International BMI reference chart cut-offs (WHO)

International BMI cut-off	Pre		Post
	Frequency (Percentage)		Frequency (Percentage)
Underweight (BMI < 18.5)	0 (0%)		0 (0%)
Normal weight (BMI 18.5 – 24.9)	0 (0%)		10 (10.9%)
Overweight (BMI 25.0 – 29.9)	43 (46.7%)		46 (50.0%)
Grade I obesity (BMI 30.0 – 34.9)	27 (29.4%)		22 (23.9%)
Grade II obesity (BMI 35.0 – 39.9)	17 (18.5%)		13 (14.1%)
Grade III obesity (BMI > 40.0)	5 (5.4%)		1 (1.1%)
Total	92 (100%)		92 (100%)

Based on the BMI classifications Table 5.9 above, Figure 5.1 and Figure 5.2 show the three groups' pre and post intervention's BMI (International Classifications) levels, respectively. Initially at baseline, all subjects were either overweight or obese. However, at post intervention, a healthy demographic resulted. The healthy range reported as Group A (Synchronous music+HIT) 19.35%, Group B (Asynchronous music+HIT) 9.67% and Group C (No music+HIT) 3.33%. Body Mass Index Classification for Adults - International & Asian cut offs (WHO, 2011) is given in Table 5.10.

Table 5.10: Body Mass Index Classification for Adults - International & Asian cut offs (WHO, 2011)

International Classification Group	Classification	International BMI (kg/m^2)	Asian BMI Cut-Offs for interpretation of health risks (kg/m^2	Asian Classification Group
1	Underweight	Below 18.5	Below 18.5	1
2	Healthy weight	18.5 to 24.9	18.5 to 22.9 (Low Risk)	2
3	Overweight	25 to 29.9	23.0 to 7.4 (Moderate Risk)	3
4	Obesity (Mild / Class I)	30 to 34.9	Equal or >27.5 (High Risk)	4
5	Obesity (Moderate/ Class II)	35 to 39.9		
6	Obesity (Severe/ClassIII)	40 or more		

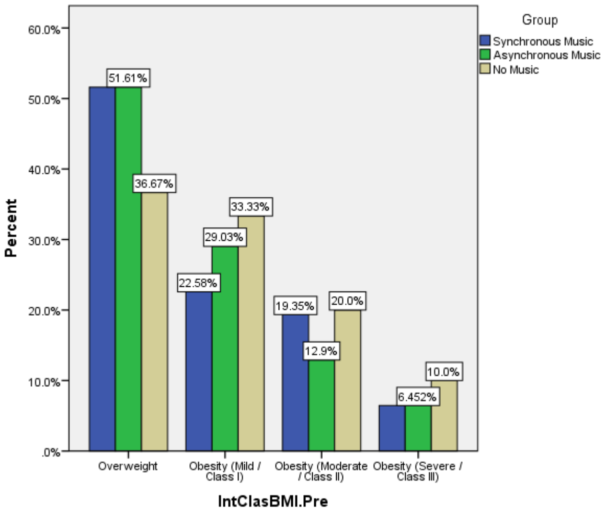


Figure 5.1: International BMI Pre Intervention

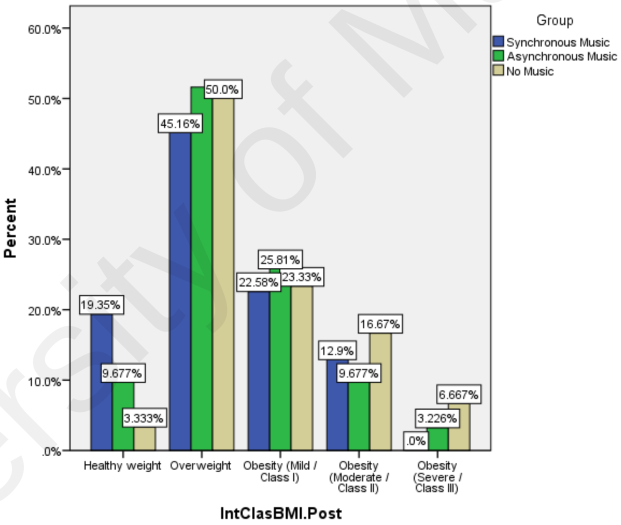


Figure 5.2: International BMI Post Intervention

5.2.1.1 Summary of Comparisons of target heart rate and RPE in all groups

The tables below present the target heart rate achieved which were iso-volumetric. In ascertaining whether fitness (curl ups, push ups and squats) were affected by significant differences between groups in RPE and target heart rate, it was found that there were no significant differences and trends were similar in all as reflected in Table

5.11 (Curl up), Table 5.12 (Push up), and Table 5.13 (Squats) and Figure 5.3 (Curl up), Figure 5.4 (Push up) and Figure 5.5 (Squat), respectively.

Table 5.11: Curl Up – Target Heart Rate & RPE Means

	Pre		Post	
Group	Target heart rate (%)	RPE	Target heart rate (%)	RPE
Treatment A	85.84	15.84	87.94	16.00
Treatment B	85.77	16.00	88.52	16.29
Control	85.97	16.03	88.33	16.27

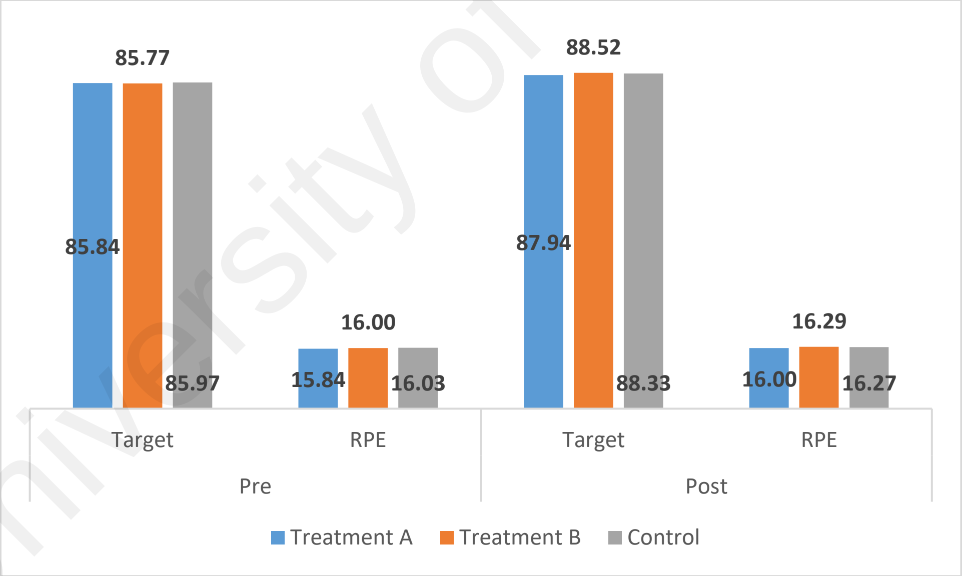


Figure 5.3: Curl Up – Target Heart Rate & RPE Comparison

Table 5.12: Push Up – Target Heart Rate & RPE Means

	Pre		Post	
Group	Target	RPE	Target	RPE
Treatment A	85.71	15.81	87.87	15.87
Treatment B	85.87	16.00	87.90	16.23
Control	85.87	16.03	88.23	16.20

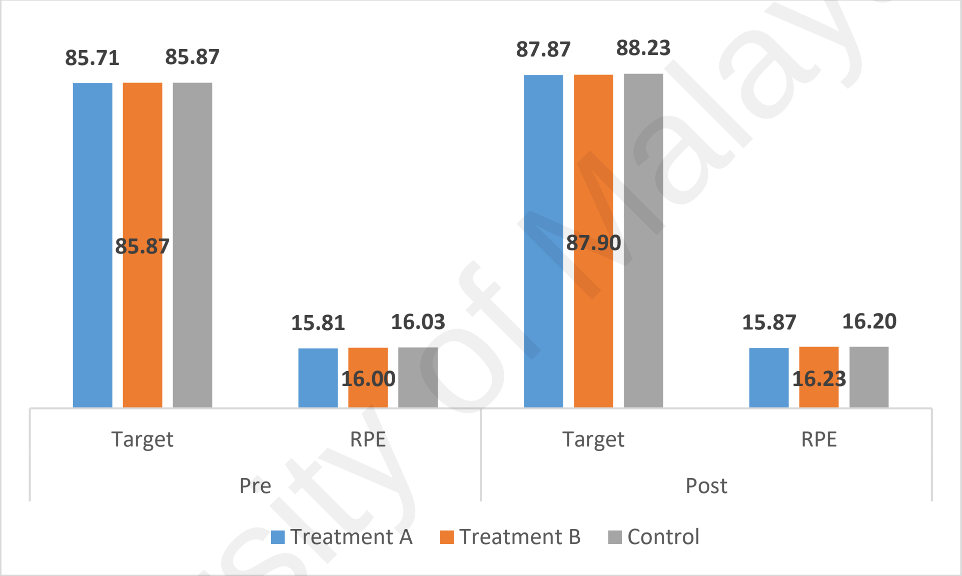


Figure 5.4: Push Up – Target Heart Rate & RPE Comparison

Table 5.13: Squat - Target Heart Rate & RPE Means

	Pre		Post	
Group	Target	RPE	Target	RPE
Treatment A	85.97	15.90	88.06	16.03
Treatment B	85.90	16.00	87.81	16.16
Control	85.83	16.00	88.27	16.27

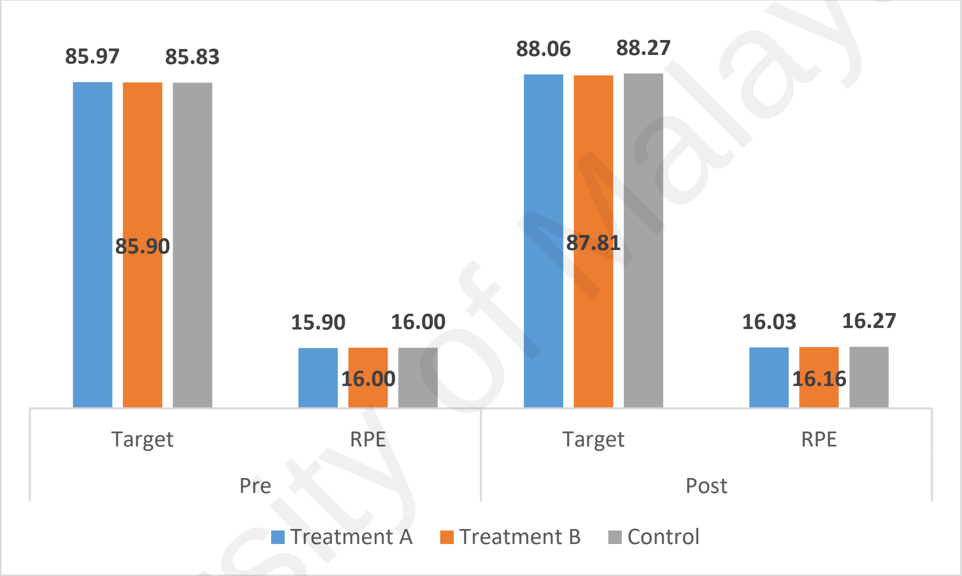


Figure 5.5: Squat – Target Heart Rate & RPE Comparison

Table 5.14: Fitness evaluation for exercise with synchronous music (group A), exercise with asynchronous music (group B) and exercise with no music (group C) groups pre and post intervention

Fitness evaluation	Group A		Group B		Group C	
	Pre	Post	Pre	Post	Pre	Post
Push up	7.6 ± 5.2	20.5 ± 6.5	8.8 ± 5.5	18.7 ± 6.1	8.8 ± 5.0	16.9 ± 6.9
Curl up	9.4 ± 6.3	26.5±10.3	10.2 ± 5.5	20.4 ± 7.2	8.7 ± 5.1	18.7 ± 6.0
Squat	10.7 ± 8.8	37.3±13.5	12.0±14.7	32.1±18.7	11.5 ± 9.3	24.1 ± 9.3

Data were presented as the mean value ± standard deviation

The findings for fitness evaluation were presented in Table 5.14 for pre and post intervention, while Table 5.15 shows the t-test results. The curl up test and the maximum number of push up that can be performed without rest are used to evaluate the endurance of the abdominal muscle groups and upper body muscles respectively. From Table 5.14, we can see that Group A has a largest number of push up, curl up and squat compare to other groups. The changes in push up, curl up and bodyweight squat fitness tests are statistically significant, with $p < 0.01$ (see Table 5.15). The percentage of subjects fall in very poor norm category has reduced drastically (16.3% to 1.1%, 90.2% to 29.3% and 33.7% to 3.3% for push up, curl up and bodyweight squat, respectively.

Table 5.15: Changes in physical fitness pre and post-training

Fitness tests	Paired differences			t			Sig.		
	Group A	Group B	Group C	Group A	Group B	Group C	Group A	Group B	Group C
Push up	-12.94±7.13	-9.90±5.46	-8.13±5.93	-10.11	-10.11	-7.51	**	**	**
Curl up	-17.03±7.71	-10.13±7.17	-9.93±6.98	-12.31	-7.86	-7.33	**	**	**
Bodyweight squat	-26.55±11.83	-20.13±22.66	-12.63±9.46	-12.49	-4.95	-7.32	**	**	**

Data were presented as the mean value ± standard deviation
** :$p < 0.01$

A split-plot ANOVA (SPANOVA) was conducted to explore the group intervention (A = exercise with synchronous music; B = exercise with asynchronous music; C = exercise with no music) on physical fitness at Time 1 (baseline) and Time 2 (12-weeks after intervention). The interaction effect is statistically significant [Wilk's lambda = 0.839 and Pillai's Trace=0.12, F = 8.565 and 6.075, p = 0.000 and 0.0003 < 0.05 correspondingly] for curl up and squats, therefore these two variables/factors had interactions between time and group. There was a significant effect for time [$p < 0.05$]. This suggested that there was a change in physical fitness from baseline to 12 weeks after intervention. The partial eta squared for time in this study is 0.832, and using the guidelines proposed by Cohen (1988) (0.01 = small effect; 0.06 = moderate effect; 0.14 = large effect), this result suggests very large effect size. The main effect between subjects (group) has p = 0.023 < 0.05 for curl up. We conclude that group effect is significant only for curl up. There was no significant difference in the push up and bodyweight squat for the three groups (those who were exercising with synchronous music, those who exercise with asynchronous music and those who exercise without music). The partial eta squared is 0.059; as such it has small effect size, which is the reason why it did not reach statistical significance. The results of SPANOVA are given in Tables 5.16, 5.17, 5.18, 5.19, and 5.20.

Table 5.16: SPANOVA Analysis for Fitness

		Group*time	Group	time
Fitness	Push up	0 (p=0.870)	0 (p=0.635)	1 (p=0.000)
	Curl up	1 (p=0.000)	1 (G1& G3, p=0.023)	1 (p=0.000)
	Bodyweight Squats	1 (p=0.003)	0 (p=0.065)	1 (p=0.000)
	Heart Rate	0 (p=0.307)	0 (p=0.074)	1 (p=0.000)

Significant Difference (1:Yes, 0:No)
**p=<.05

Table 5.17: Multivariate Tests[a]

Effect Curl-up		Value	F	Hypothesis df	Error df	Sig.	Noncent. Parameter	Observed Power[c]
pre.post * Group	Pillai's Trace	.161	8.565[b]	2.000	89.000	.000	17.130	.963
	Wilks' Lambda	.839	8.565[b]	2.000	89.000	.000	17.130	.963
	Hotelling's Trace	.192	8.565[b]	2.000	89.000	.000	17.130	.963
	Roy's Largest Root	.192	8.565[b]	2.000	89.000	.000	17.130	.963
Effect Squat		Value	F	Hypothesis df	Error df	Sig.	Noncent. Parameter	Observed Power[c]
pre.post * Group	Pillai's Trace	.120	6.075[b]	2.000	89.000	.003	12.149	.876
	Wilks' Lambda	.880	6.075[b]	2.000	89.000	.003	12.149	.876
	Hotelling's Trace	.137	6.075[b]	2.000	89.000	.003	12.149	.876
	Roy's Largest Root	.137	6.075[b]	2.000	89.000	.003	12.149	.876

a. Design: Intercept + Group
Within Subjects Design: pre.post
b. Exact statistic
c. Computed using alpha = .05

Table 5.18: Tests of Between-Subjects Effects

Measure: MEASURE_1							
Transformed Variable: Average							
Curl-up							
Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Noncent. Parameter	Observed Power[a]
Intercept	45008.552	1	45008.552	642.921	.000	642.921	1.000
Group	549.541	2	274.770	3.925	.023	7.850	.693
Error	6230.568	89	70.006				
Squats							
Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Noncent. Parameter	Observed Power[a]
Intercept	83283.560	1	83283.560	396.151	.000	396.151	1.000
Group	1182.073	2	591.036	2.811	.065	5.623	.540
Error	18710.645	89	210.232				
a. Computed using alpha = .05							

Table 5.19: Comparison of the different tests

					95% Confidence Interval for Difference[b]	
(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.[b]	Lower Bound	Upper Bound
Synchronous Music	Asynchronous Music	2.581	1.503	.268	-1.086	6.247
	No Music	4.203*	1.515	.020	.506	7.900
Asynchronous Music	Synchronous Music	-2.581	1.503	.268	-6.247	1.086
	No Music	1.623	1.515	.861	-2.075	5.320
No Music	Synchronous Music	-4.203*	1.515	.020	-7.900	-.506
	Asynchronous Music	-1.623	1.515	.861	-5.320	2.075
Based on estimated marginal means						
*. The mean difference is significant at the .05 level.						
b. Adjustment for multiple comparisons: Bonferroni.						

Table 5.20: Pairwise Comparisons

Measure: MEASURE_1 Curl-up						
					95% Confidence Interval for Difference[b]	
(I) pre.post	(J) pre.post	Mean Difference (I-J)	Std. Error	Sig.[b]	Lower Bound	Upper Bound
1	2	-12.365*	.767	.000	-13.889	-10.841
2	1	12.365*	.767	.000	10.841	13.889
Measure: MEASURE_1 Squat						
					95% Confidence Interval for Difference[b]	
(I) pre.post	(J) pre.post	Mean Difference (I-J)	Std. Error	Sig.[b]	Lower Bound	Upper Bound
1	2	-19.770*	1.644	.000	-23.038	-16.503
2	1	19.770*	1.644	.000	16.503	23.038
Based on estimated marginal means						
*. The mean difference is significant at the .05 level.						
b. Adjustment for multiple comparisons: Bonferroni.						

5.2.2 Overall Summary of Blood Metabolic Profiles

Table 5.21: Blood chemistry and hemodynamic data of the intervention groups (A = exercise with synchronous music and B = exercise with asynchronous music) and the control group (C = exercise with no music) at baseline and at the end of intervention (Data were presented as the mean value ± standard deviation)

Metabolic profiles	Group A		Group B		Group C	
	Pre-	Post-	Pre-	Post-	Pre-	Post-
BP systolic	116.39±13.74	111.14±13.63	113.18±14.20	107.94±13.35	104.09±21.07	104.55±12.14
BP diastolic	76.04±12.09	67.36±7.51	73.53±8.54	65.59±8.64	70.27±11.47	68.36±9.87
Heart rate	74.96±8.44	70.21±6.36	70.59±6.36	68.94±5.17	80.20±14.34	72.70±7.54
Total cholesterol	210.71±31.36	184.89±28.55	205.29±43.57	195.71±38.43	212.90±40.33	200.50±33.80
HDL	59.61±11.57	53.61±9.88	54.59±8.16	50.41±6.86	58.10±9.13	57.70±12.64
Total cholesterol/HDL	3.62±0.68	3.56±0.89	3.84±0.98	3.94±0.89	3.74±0.80	3.61±0.97
LDL	127.61±27.81	112.39±25.84	125.76±41.08	123.94±34.17	131.70±37.68	124.80±34.45
Triglyceride	118.36±47.56	94.57±34.18	124.06±79.14	106.65±43.35	121.50±44.00	90.60±35.97
Blood glucose	88.41±10.78	85.04±9.19	97.35±32.82	97.47±29.20	116.90±82.53	108.50±57.44

In assessing the post test results according to the AHA and the National Heart, Lung and Blood Institute (AHA/NHLBI, 2005) with three of more of the following denotes metabolic syndrome:

- Elevated waist circumference (Women: > or equal to 35 inches 0r 88cm)
- Elevated triglycerides (150 mg/dL)
- Reduced HDL cholesterol (Women: < 50 mg/dL)
- Elevated blood pressure (> or equal to 130/85 mm/Hg
- Elevated fasting blood glucose (> or equal to 100 mg/dL)

As shown in Table 5.21 above, all blood lipids variable fell within the clinical specified normal ranges, except for total cholesterol (High total cholesterol levels: 240 mg/dL or higher, Borderline: 200 to 239 mg/dL) that was slightly higher than the healthy normal range during pre-intervention. There was no change in total cholesterol / HDL ratio and blood glucose level during pre- and post-testing. However, there were significant drop in all other variables (systolic blood pressure, diastolic blood pressure, resting heart rate, total cholesterol, HDL-cholesterol, LDL-cholesterol and triglyceride) during the post-intervention.

Table 5.22 show the effects of intervention groups on blood lipid metabolic profiles. The subjects' turn-up percentage for post intervention was only 60%. All blood lipid variables fell within the clinical specified normal ranges, except for total cholesterol that was slightly higher than the healthy normal range during pre-intervention.

Table 5.22: Effect of intervention on blood chemistry and hemodynamic variables

Metabolic profiles	Paired differences			t			Sig.		
	Group A	Group B	Group C	Group A	Group B	Group C	Group A	Group B	Group C
Systolic BP	5.25±10.23	5.24±10.92	-0.46±16.80	2.716	1.977	-0.090	**	n.s.	n.s.
Diastolic BP	8.68±10.85	7.94±9.91	1.91±11.27	4.234	3.304	0.562	**	**	n.s.
Resting heart rate	4.75±6.36	1.65±3.97	7.50±8.71	3.954	1.712	2.724	**	n.s.	*
Total cholesterol	25.82±29.46	9.59±23.62	12.40±15.72	4.638	1.674	2.494	**	n.s.	*
HDL-cholesterol	6.00±7.59	4.18±6.87	0.40±9.51	4.182	2.508	0.133	**	*	n.s.
Total cholesterol / HDL ratio	0.64±0.53	-0.10±0.60	0.13±0.60	0.644	-0.690	0.683	n.s.	n.s.	n.s.
LDL-cholesterol	15.21±25.65	1.82±19.75	6.90±20.80	3.138	0.381	1.049	**	n.s.	n.s.
Triglyceride	23.79±35.06	17.41±66.23	30.90±17.03	3.590	1.084	5.737	**	n.s.	**
Blood glucose	3.37±13.09	-0.12±11.67	8.40±27.06	1.338	-0.042	0.982	n.s.	n.s.	n.s.

Data were presented as the mean value ± standard deviation
** $p < 0.01$
* $p < 0.05$
n.s. non-significant

SPANOVA analysis showed that the interaction effect is statistically not significant for all metabolic profiles. There was significant effect for time [all p-values >0.05] for all metabolic profiles. This suggested that there was a changes in metabolic profiles from baseline to 12 weeks after intervention. The main effect between subjects (group) has p-values > 0.05 for all metabolic profiles. Therefore, we conclude that group effect is not significant for metabolic profiles. There was no significant difference in the metabolic profiles for the three groups (those who were exercising with synchronous music, those who exercise with asynchronous music and those who exercise without music). SPANOVA results are given in Table 5.23.

Table 5.23: SPANOVA Analysis for Metabolic Profile

		Group*time	Group	time
Blood Lipid	Cholesterol	0 (p=0.071)	0 (p=0.479)	1 (p=0.000)
	LDL	0 (p=0.066)	0 (p=0.506)	1 (p=0.000)
	HDL	0 (p=0.287)	0 (p=0.059)	1 (p=0.000)
	Triglyceride	0 (p=0.563)	0 (p=0.308)	1 (p=0.004)
	Fasting blood glucose	0 (p=0.676)	0 (p=0.165)	1 (p=0.037)
	Heart Rate	0 (p=0.307)	0 (p=0.074)	1 (p=0.000)

5.3 Linear Regression for Prediction Formulae for weight and waist reduction

The following research questions was phrased at the beginning of the study:

- Can this physical activity intervention, with/without the accompaniment of specially choreographed music, impact body composition positively in terms of increased weight loss and waist girth measurements decrease in overweight and obese adult Malay women in Singapore?

The study has shown reduction in weight and waist measurements in all three groups. As shown by the results in this study, high intensity exercise, with and without the accompaniment of specially choreographed music, has impacted body composition positively in terms of increased weight loss and waist girth measurements decrease in overweight and obese adult Malay women in Singapore. Prediction formulae using linear regression for waist reduction and weight loss is the product of this research, as follows:

Linear regression is a statistical approach for modeling the relationship between a scalar dependent variable y and one or more explanatory variables (or independent variables) denoted X (Freedman, 2009). The case of one explanatory variable (independent variable) is called simple linear regression.

A simple linear regression was used in this study to predict weight measurement based on time (week). Notice that, our sample size is small $n = 12$ (weeks) due to limitations in time, costs and subjects. This simple linear regression studies the prediction of waist based on time (weeks).

A linear regression line has an equation of Y = a + bX, where X is the explanatory variable and Y is the dependent variable. The slope of the line is b, and a is the intercept (the value of y when x = 0).

5.3.1 Linear Regression – Waist Reduction

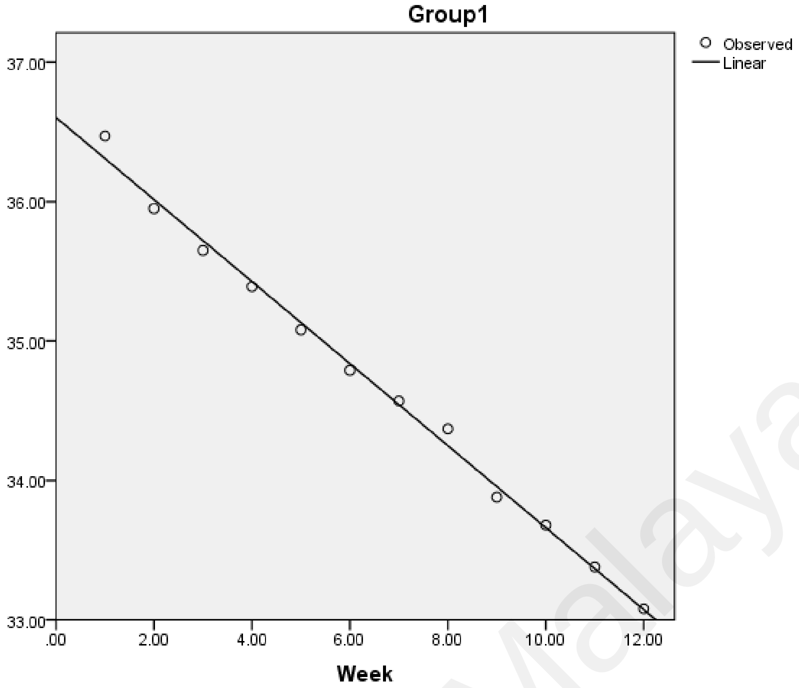


Figure 5.6: Waist Reduction using Regression Equation for Group A: Synchronous Music + Exercise

For group 1, a significant regression equation was found $F(1,10) = 1966.342$, $p = 0.000 < 0.05$, with an R^2 of 0.995. Participants' predicted waist is equal to 36.602 + (-0.294) (time) (unit of waist) when time is measured in week. Participants' waist decreased -0.294 for each week of time.

The Prediction Formula for the first treatment of Synchronous music and exercise is

y_G1 = - 0.2941x + 36.602

$R^2 = 0.995$

This means that 99.49% of the variance y_G1 is predicted by the formula. This finding can be used as a benchmark for predicting waist circumference improvements in obese adult Singapore Malay women when they exercise with synchrnous music.

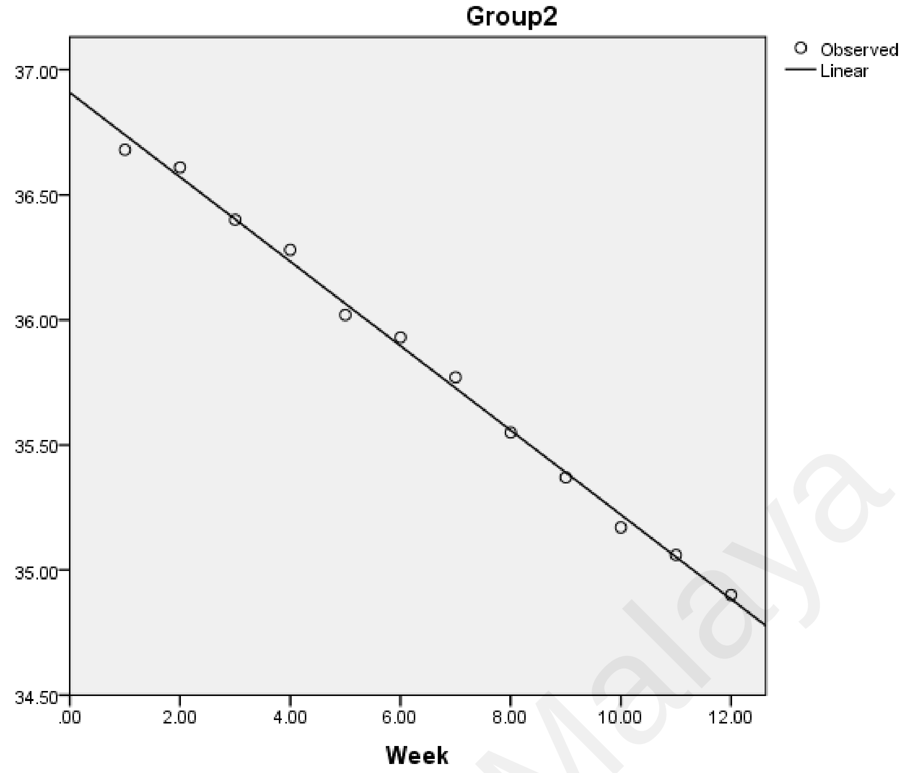


Figure 5.7: Waist Reduction using Regression Equation for Group B: Asynchronous Music + Exercise

For group 2, a significant regression equation was found $F(1,10) = 2603.390$, $p = 0.000 < 0.05$, with an R^2 of 0.998. Participants' predicted waist is equal to 36.908 + (-0.169) (time) (unit of waist) when time is measured in week. Participants' waist decreased -0.169 for each week of time.

The Prediction Formula for the second treatment of Asynchronous music and exercise is
y_G2 = - 0.169x + 36.908
$R^2 = 0.998$

This means that 99.8% of the variance y_G1 is predicted by the formula. This finding can be used as a benchmark for predicting waist circumference improvements in obese adult Singapore Malay women when they exercise with Asynchronous music.

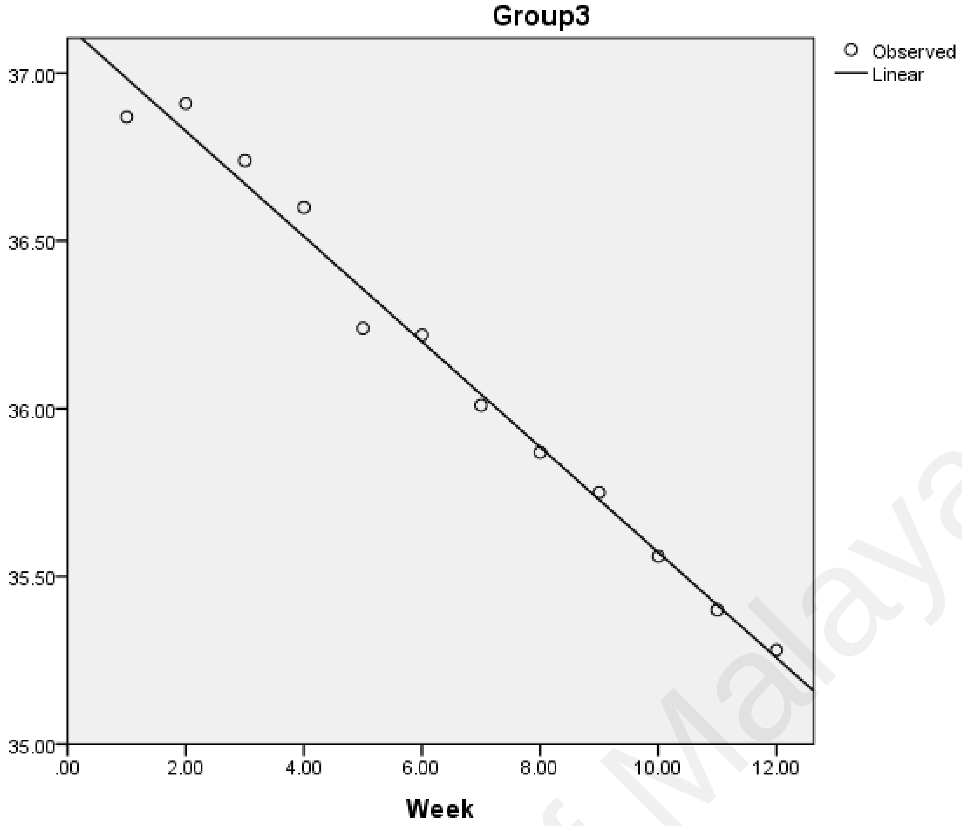


Figure 5.8: Waist Reduction using Regression Equation for Group C: No Music + Exercise

For group 3, a significant regression equation was found $F(1,10) = 722.131$, $p = 0.000 < 0.05$, with an R^2 of 0.986. Participants' predicted waist is equal to 37.142 + (-0.157) (time) (unit of waist) when time is measured in week. Participants' waist decreased -0.157 for each week of time.

The Prediction Formula for the third treatment of exercise to no music

y_G3 = - 0.157x + 37.142

R^2 = 0.986

This means that 98.63% of the variance y_G1 is predicted by the formula. This finding can be used as a benchmark for predicting waist circumference improvements in obese adult Singapore Malay women when they exercise to no music.

5.3.2 Linear Regression – Weight Reduction

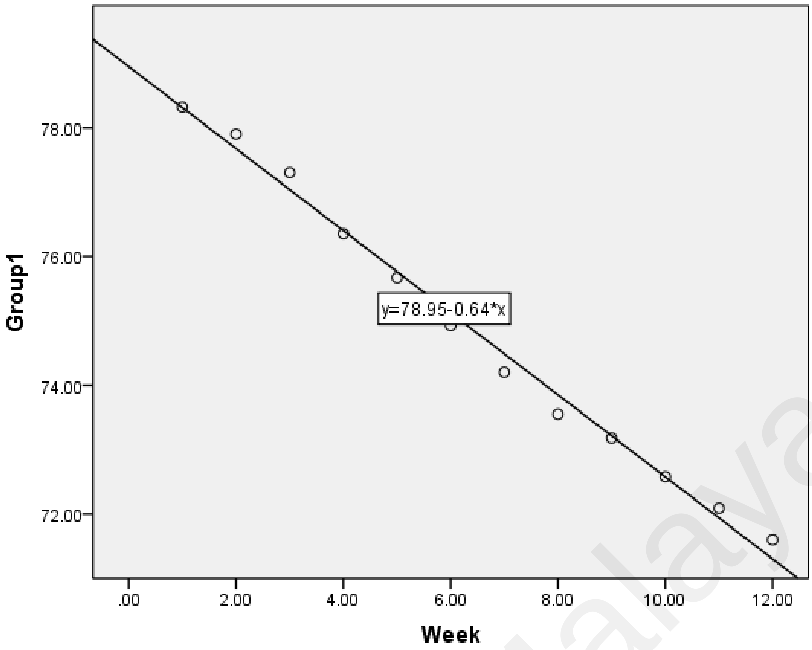


Figure 5.9: Weight Reduction using Regression Equation for Group A: Synchronous Music + Exercise

For group 1, a significant regression equation was found $F(1,10) = 1273.627$, $p = 0.000 < 0.05$, with an R^2 of 0.992. Participants' predicted weight is equal to 78.947 + (-0.637) (time) (unit of weight) when time is measured in week. Participants' waist decreased -0.637 for each week of time.

The Prediction Formula for weight loss in the first treatment of Synchronous music to exercise:

y_G1 = -0.637x + 78.947

$R^2 = 0.992$

This means that 99.2% of the variance y_G1 is predicted by the formula. This finding can be used as a benchmark for predicting weight reduction improvements in obese adult. Singapore Malay women when they exercise to synchronous music.

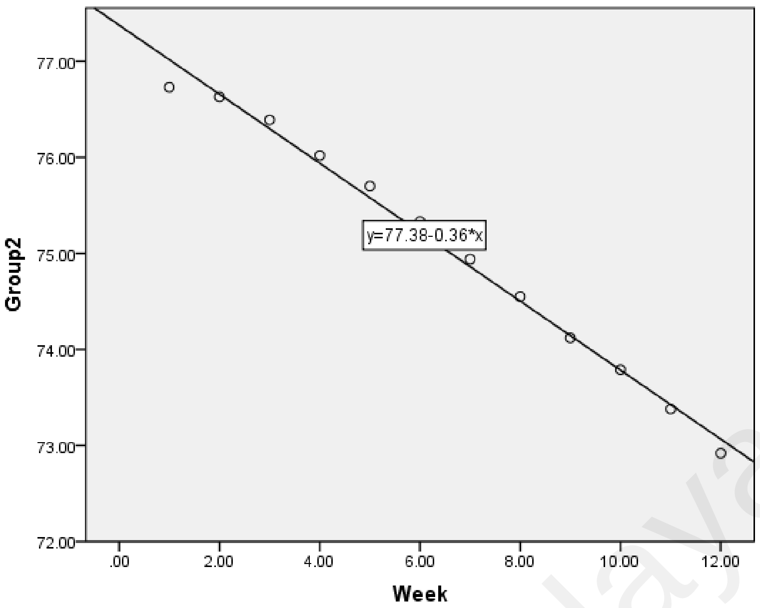


Figure 5.10: Weight Reduction using Regression Equation for Group B: Asynchronous Music + Exercise

For group 2, a significant regression equation was found $F(1,10) = 1178.619$, $p = 0.000 < 0.05$, with an R^2 of 0.992. Participants' predicted weight is equal to 77.376 + (-0.359) (time) (unit of weight) when time is measured in week. Participants' weight decreased -0.359 for each week of time.

The Prediction Formula for weight loss in the second treatment group of Asynchronous music to exercise:

y_G1 = -0.359x + 77.376

$R^2 = 0.992$

This means that 99.2% of the variance y_G1 is predicted by the formula. This finding can be used as a benchmark for predicting weight reduction improvements in obese adult Singapore Malay women when they exercise to asynchronous music.

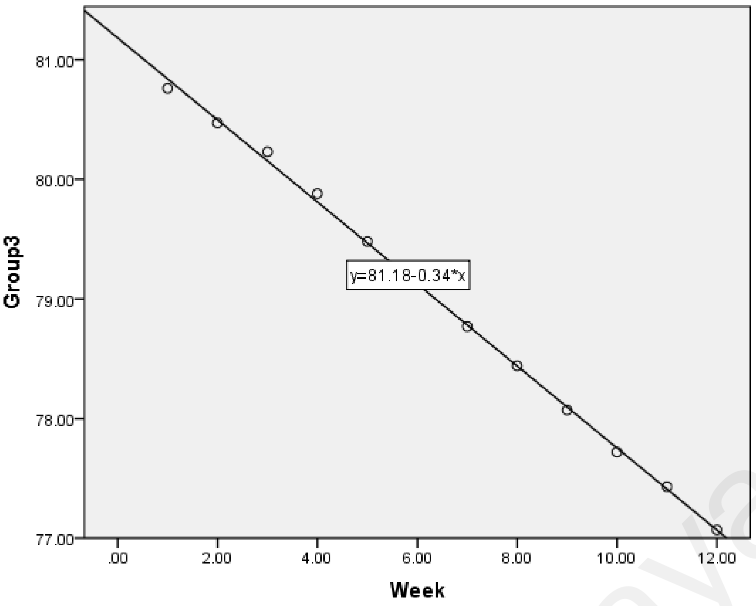


Figure 5.11: Weight Reduction using Regression Equation for Group C: No Music + Exercise

For group 3, a significant regression equation was found $F(1,10) = 8340.330$, $p = 0.000 < 0.05$ with an R^2 of 0.999. Participants' predicted weight is equal to 81.182 + (-0.343) (time) (unit of weight) when time is measured in week. Participants' waist decreased -0.343 for each week of time.

The Prediction Formula for weight loss in the control group of no music to exercise:

y_G1 = -0.343x + 81.182

$R^2 = 0.999$

This means that 99.9% of the variance y_G1 is predicted by the formula. This finding can be used as a benchmark for predicting weight loss in obese adult Singapore Malay women when they exercise to no music.

5.4 Hypotheses Answered

It was hypothesised that at post intervention, Group A (synchronous music + physical activity) will augment the highest body composition, functional fitness and blood lipid health parameters. Second highest will be Group B (asynchronous music + physical activity) and lowest is Group C (no-music + physical activity).

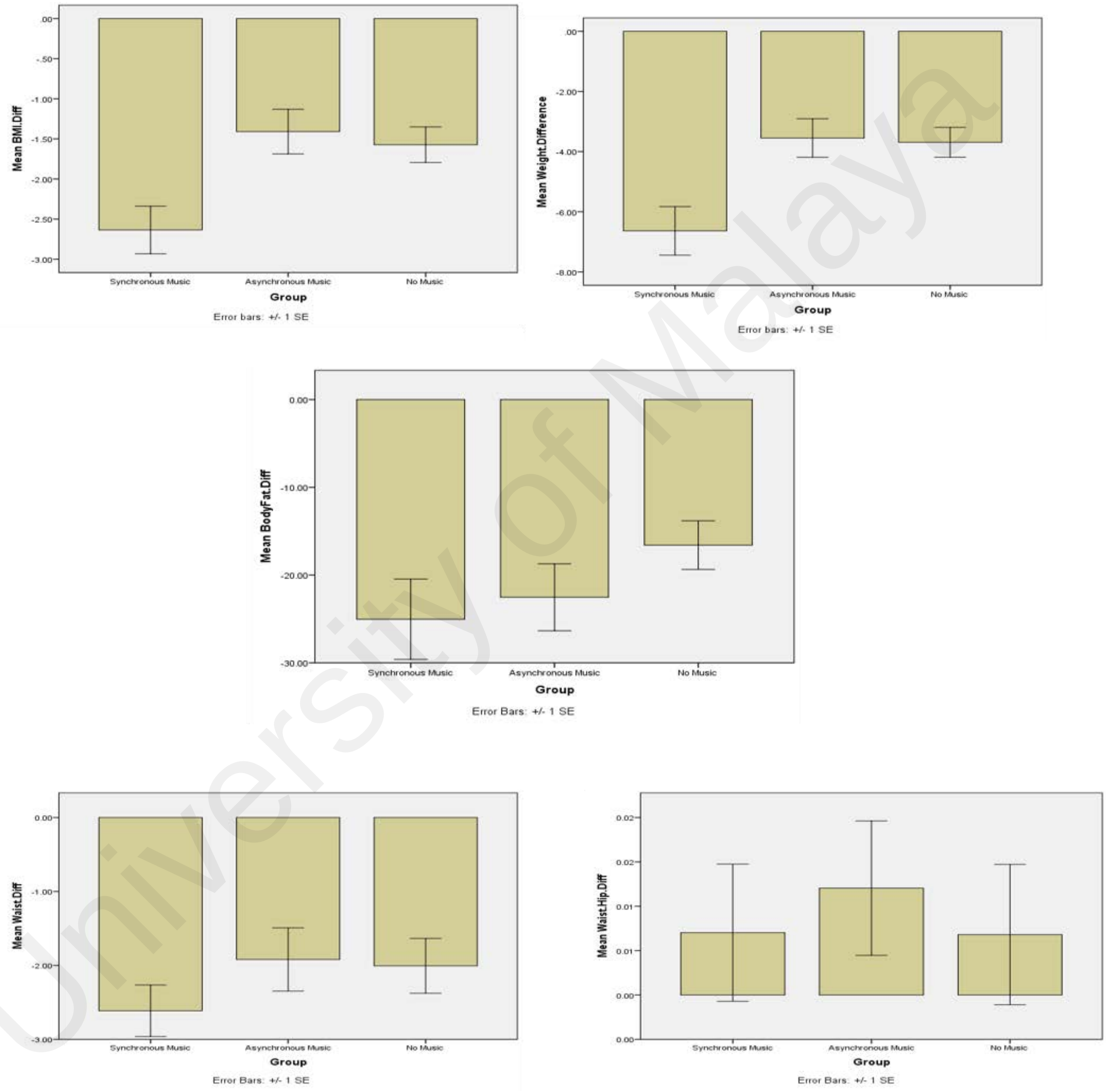


Figure 5.12: Differences between Pre and Post for all Body Composition variables

Based on the descriptive statistics Figure 5.12, all of the groups have improvements in body composition for all variables during the interval of before (BMI.pre) and after (BMI.post) 12 weeks fitness management program. There were very significant decreases ($p<0.01$) in all the variables except for waist-to-hip ratio, where the changes were not significant ($t = -1.15$, $t = -1.00$ and $t = -0.55$ for Group A, Group B and Group C, respectively). However, SPANOVA analysis showed that the group as main effect is not statistically significant, indicating there was no significance in the body composition for the three groups. Notice that, Synchronous Music group shows the largest of difference of body compositions compared to the other groups for these samples. Most of the cases, Group A (exercise with synchronous music) showed largest paired difference in their body composition, while Group B (exercise with asynchronous music) and Group C (exercise with no music) revealed similar changes for the variables tested.

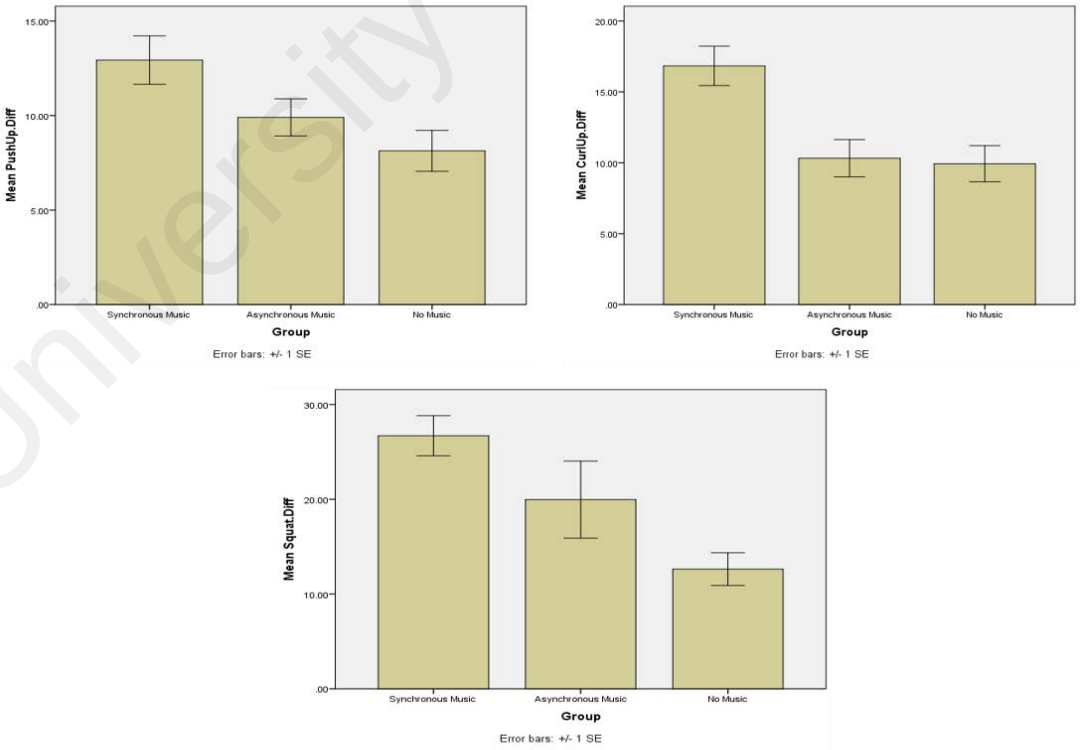


Figure 5.13: Differences between Pre and Post for all Fitness variables

Based on the descriptive statistics Tables 5.13, all of the groups have improvements in fitness activities for all variables during the interval of before (BMI.pre) and after (BMI.post) 12 weeks fitness management program. The changes in push up, curl up and bodyweight squat fitness tests are statistically significant, with $p < 0.01$. There was no significant difference in the push up and bodyweight squat for the three groups (those who were exercising with synchronous music, those who exercise with asynchronous music and those who exercise without music). On the other hand, there is a significant difference for group as main effect in curl up. That is, group of synchronous music is significantly difference at 0.05 significant level with those who exercise without music (p-value=0.02) by using pairwise comparison. Notice that, Synchronous Music group shows the largest improvement compared to the other groups. Most of the cases, Group A (exercise with synchronous music) showed largest paired difference in their fitness, while Group B (exercise with asynchronous music) and Group C (exercise with no music) revealed almost similar changes for the variables tested as given in Figure 4.8.

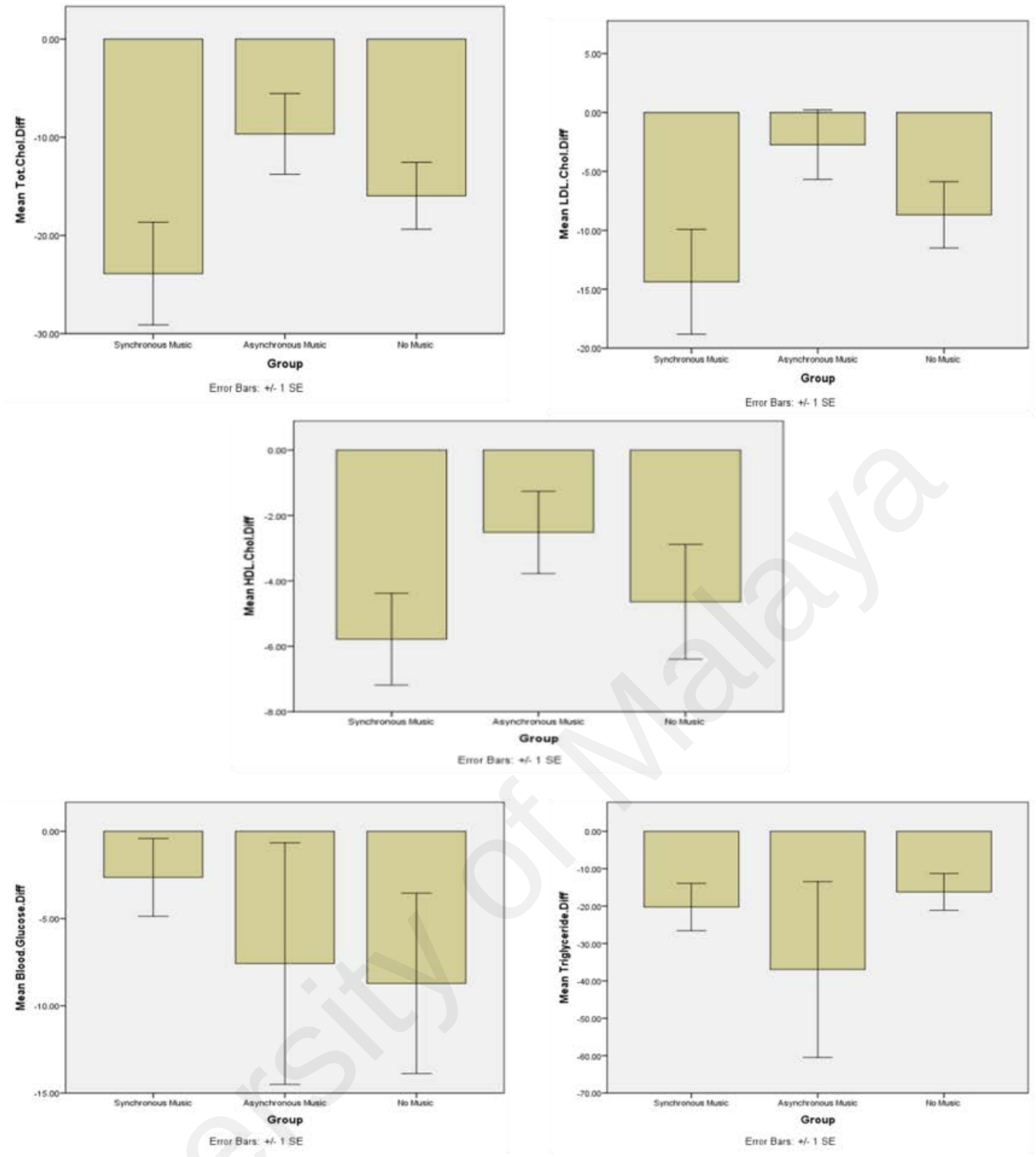


Figure 5.14: Differences between Pre and Post for all metabolic lipid variables

All of the groups have changes in metabolic lipid for all variables during the interval of before (BMI.pre) and after (BMI.post) 12 weeks fitness management program (Figure 5.14). Unlike body composition and fitness, metabolic lipid variables show inconsistent pattern for all metabolic variables. There was no change in total cholesterol / HDL ratio and blood glucose level during pre and post intervention. However, there were significant drop in all other variables (systolic blood pressure, diastolic blood pressure, resting heart rate, total cholesterol, HDL-cholesterol, LDL-cholesterol and triglyceride) for the post-intervention. Note that, Group A (exercise with synchronous music) showed largest paired difference in their fitness, (exercise with asynchronous music) and Group C (exercise with no music) are not statistically significant in all metabolic lipid variables. Tjonna et al. (2008) reported that HIT was superior compared to continuous moderate exercise in the reduction in blood glucose and lipogenesis in adipose tissues but no difference in weight reduction. Our study reported significant drop in systolic blood pressure, diastolic blood pressure, resting heart rate, total cholesterol, HDL-cholesterol, LDL-cholesterol and triglyceride for the post-intervention.

5.5 In answering if music is effectual at high intensity exercises?

Rejeski (1985) posited that at higher intensities of exercise the response to an affective stimulus such as music is attenuated by the internal feedback with which it competes. Although fatigue-related symptoms predominate attentional processing at high intensities of exercise, appropriate music can make the interpretations of such fatigue-related symptoms more positive (Karageorghis, Jones et al., 2006). Added on to this, thoughts were that music may promote in terms of enhanced exercise adherence by dint of improvements in positive affect as reported by Boutcher & Trenske (1990) and Elliot et al. (2004). However, this study proved otherwise. Music or no music across the three groups did not have significant effects (with the exception of Curl Up fitness where Synchronous and Non-music were effective). With the exception of Curl Up fitness, music was not effective ergogenically at high intensity exercise. The physiological stress of high intensity exercises overcame the ergogenic effects of music. For all variables apart from Curl Up fitness, this research findings support Rejeski (1985).

5.6 Upon examining, whether high-intensity exercise is detrimental to the obese in terms of adherence?

Vandoni et al. (2016) in his study examining whether the intensity of exercise matters in group exercise training sessions when it comes to psychophysiological responses. The findings reported that their responses were intensity dependent. Their affective responses to vigorous session were less pleasant than those during moderate session. Thus adherence-wise, we are encouraged to emphasize group exercise training sessions at a moderate intensity to maximize affective responses and to minimize exertional responses, which in turn may positively affect exercise behavior.

It is not the case however for our study. Of the total 92 obese women who volunteered for this study, only one subject dropped out of the study from the Control Group. The subject decided to opt out and was absent for the pre and post intervention testing. The inability to commit to the program due to time commitment was the reason given. All subjects adhered to the high intensity exercise sessions and attendance was 92% overall, with the occasional non-attendance across the three groups, due to family and work commitment. Comparing our study to our literature review's 18 studies (Appendix I), Lunt et al. (2013), Nicklas et al. (2009) and Keating et al. (2015) developed injuries in the group related to training. There was no adverse events during the study related to the intensity of the exercise. Thus, our study proves that high-intensity exercise is not detrimental to the obese in terms of adherence.

5.7 Post intervention- 2-years follow up was conducted to track weight and waist reductions in the subjects.

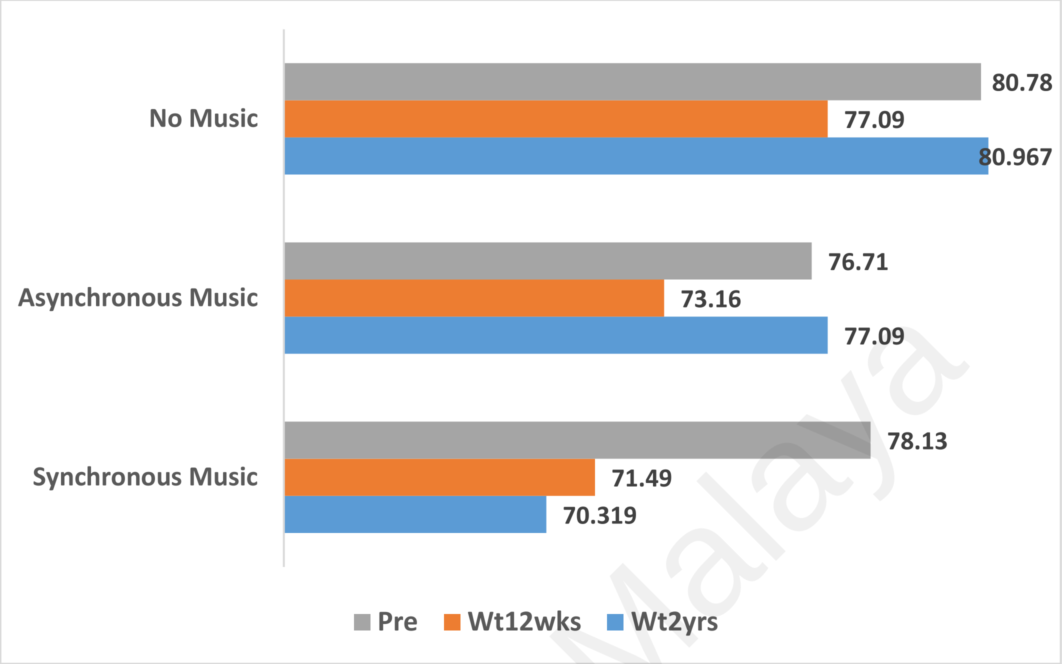


Figure 5.15: Post 2-year follow up on Weight Reduction Trends

The groups have almost similar trend in the changes of weight before (Pre), after twelve weeks (Wt12wks) and after two years fitness management program excluding Syhchronous Music which is shown in Figure 5.15. If we consider weight before and after twelve weeks fitness management program, the synchronous music group showed the most reduction of weight, meanwhile the other two groups have almost similar trend in reduction of weight. However, it is an interesting fact that the synchronous group is the only group showing gradually reduction in weight even after two years of fitness management program. On the other hand, no music and asynchronous music groups shown an increasing trend of weight after two years of fitness management program.

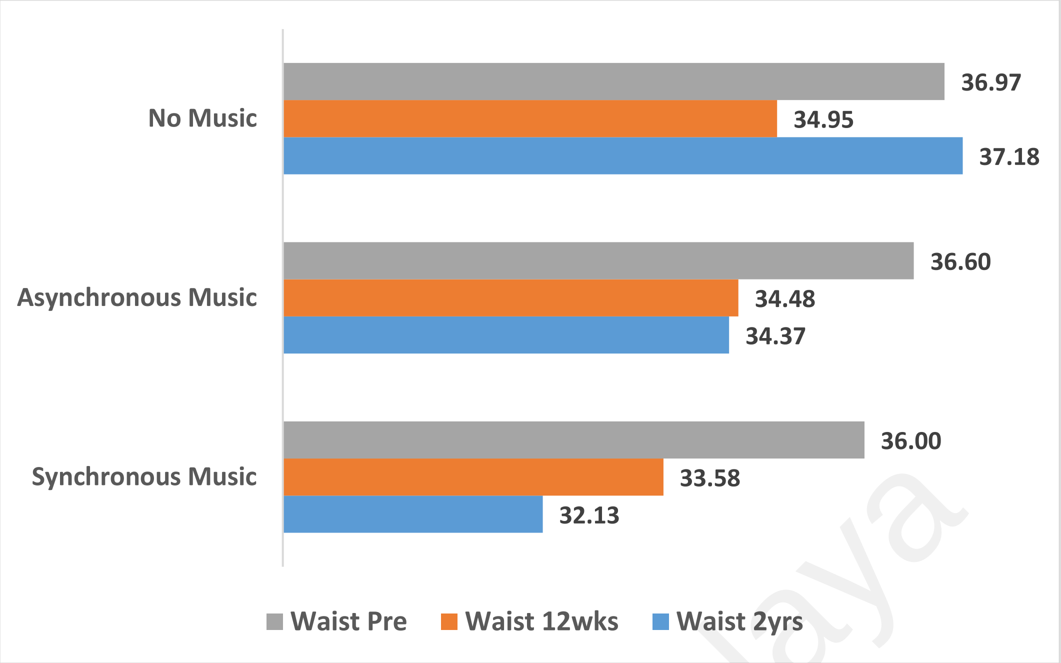


Figure 5.16: Post 2-year follow up on Waist Reduction Trends

From Figure 5.16, the synchronous music group shows a consistent decreasing trend in the changes of waist before (Waist Pre), after twelve weeks (Waist 12wks) and after two years fitness management program. The asynchronous music group shows a significant decrease only after 12 weeks, but after two years the reduction of waist is not significant. The No-music group is the only group that showed an increase trend in waist after two years post intervention.

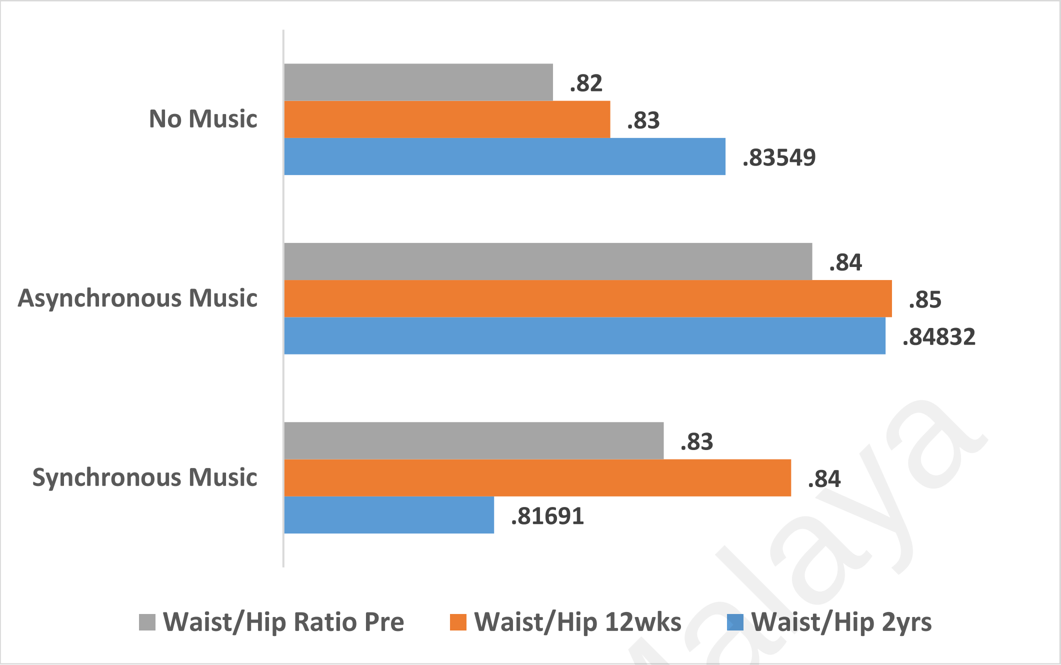


Figure 5.17: Post 2-year follow up on Waist-to-Hip Ratio Trends

Figure 5.17 above is according to the following gradings:

Health Risk: Low for 0.80 or lower

Moderate for 0.81-0.85

High 0.86 or higher

The synchronous music group shows a dramatic trend in the changes of waist/hip ratio from twelve weeks (Waist 12wks) to two years fitness management program. The asynchronous music group shows only a slight decrease only after 12 weeks to two years. However, the no music group showed increase trend in waist/hip ratio from pre until after two years of fitness management program.

5.8 DISCUSSIONS, IMPLICATIONS, RECOMMENDATIONS, FUTURE DIRECTIONS, CONCLUSIONS AND CONTRIBUTIONS

High intensity training to music was the intervention used in this study. As the obese has limitations in terms of their exercise capacity and this affects their performance at submaximal, peak intensity and during recovery, they tend to end their effort due to musculoskeletal pain and not true leg fatigue (Hulens et al., 2001) when performing exercise. Addressing this issue, this research attempted to use music as an ergogenic aid to physical activity. The physical activity selected in this research, is of high intensity, noting that a dose-response relationship exist between the amount of physical activity and health outcomes and that higher heart rated physical activity will lead to generally greater benefits (Miller et al., 2014), high intensity training was chosen due to its time efficiency (Gillen & Gibala, 2014) and its perception of enjoyability (Bartlett et al. (2011).

For this, 12 weeks research intervention, 92 overweight and obese adult Singapore women (25 – 55 years of age) were voluntarily recruited and randomly put into two treatment groups (using synchronous and asynchronous music) and a control group (using no music). The high intensity exercises were the same for all three groups. The dependent variables researched in this study were body composition (namely BMI, weight loss, body fat percentage, waist circumference and waist-to-hip ratio, fitness parameters (namely, modified push up, modified curl up, bodyweight squats and resting heart rate) and blood lipid health parameters (namely fasting cholesterol (LDL & HDL), fasting blood glucose, triglycerides) and blood pressure. Pre and post tests were conducted with 12 weeks of intervention.

Significant correlations were found in BMI, Weight Loss, Push Up, Curl Up and Bodyweight Squats. After SPANOVA analysis, for body composition, BMI and Weight Loss have significant interaction of groups and time simultaneously. Note that the main effect of Time was significant, but the main effect of group was not significant. For fitness, Curl up and Bodyweight squat have significant interaction of groups and time. The main effect of Group and the main effect of Time were significant for Curl up. Curl Up reported significant differences in the Treatment A Group using synchronous music and the Control C group using no music. On the other hand, only the main effect of Time was significant for Bodyweight Squat. In contrast, there is no significant effect between Group and Time for Blood Lipid. This study reported that music (synchronous and asynchronous) as well as no music does not impact on all the groups with the exception of Curl Up Fitness where Synchronous music and No-Music are significant.

A follow up study on the subjects was conducted on the subjects post 2 years after the completion of the 12 weeks study and it was discovered that there is a consistent decreasing trend in weight and waist for the synchronous group, With the No-Music group on the other end of the spectrum, with an increasing trend in weight gain and waist girth measurements. All the subjects in the Synchronous Group reported exercising regularly at least 3 times per week and the Asynchronous Group subjects once or twice per week. 50% of the No-Music Group reported sedentarism. The Synchronous and Asynchronous Music groups reported exercising to music in Zumba classes regularly at least once to thrice per week. 14 subjects from the Asynchronous Group volunteered and participated in the post-2-year walking football research researched by this author, a study characterizing the metabolic intensity and cardiovascular demands of walking football. According to Heil, Newton and Salle (2018), the results of the study supported that competitive walking football is of sufficient intensity to promote positive changes in both metabolic and cardiovascular fitness (Appendix J). From the follow up tracking of all the subjects as well as from the results of this Walking Football Study, it has been shown that subjects in Synchronous and Asynchronous have been physically active and exercising regularly 2 years post-research whereas all subjects were sedentary (an inclusion criteria) when they volunteered to be subjects of the first initial high intensity training and music study. Short IPAQ questionnaire was used for the follow up 2-years post research study.

A follow up study on the subjects was conducted post-2 years after the completion of the 12 weeks study and it was discovered that there is a consistent decreasing trend in weight and waist for the Synchronous Group and the No-Music group on the other end of the spectrum, with an increasing trend in weight gain and waist girth measurements. All the subjects in the Synchronous Group reported exercising regularly at least 3 times per week and the Asynchronous Group subjects once or twice per week. 50% of the No-Music Group reported sedentarism. The Synchronous and Asynchronous Music groups reported exercising to music in Zumba classes regularly at least once to thrice per week. 14 subjects from the Asynchronous Group volunteered and participated in the post-2-year walking football research researched by this author, a study characterizing the metabolic intensity and cardiovascular demands of walking football. According to Heil, Newton and Salle (2018), the results of the study supported that competitive walking football is of sufficient intensity to promote positive changes in both metabolic and cardiovascular fitness (Appendix J). From the follow up tracking of all the subjects as well as from the results of this Walking Football Study, it has been shown that the subjects in Synchronous and Asynchronous groups have been physically active and exercising regularly 2 years after their first research intervention. It is reiterated that all the subjects in all the 3 groups were sedentary. This was an inclusion criteria when they first volunteered to be subjects of this study pre intervention. Short IPAQ questionnaire was used for the follow up 2-years post research study.

5.8.1 Novel findings - Prediction Formulae

There are several novel findings generated from this research. Six prediction formulae for waist and weight reduction resulted from this study. Three formulae were predicted for each as follows:

In terms of Waist Reduction for Group A exercise with synchronous music, a significant regression equation was found $F(1,10)=1966.342$, $p = 0.000 < 0.05$, with an R^2 of 0.995. Participants' predicted waist is equal to 36.602 + (-0.294) (time) (unit of waist) when time is measured in week. Participants' waist decreased -0.294 for each week of time.

The Prediction Formula for the first treatment of Synchronous music and exercise is

y_G1 = - 0.2941x + 36.602

$R^2 = 0.995$

This means that 99.49% of the variance y_G1 is predicted by the formula. This finding can be used as a benchmark for predicting waist circumference improvements in obese adult Singapore Malay women when they exercise with synchronous music.

For Group B exercise with asynchronous music, a significant regression equation was found $F(1,10)=2603.390$, $p = 0.000 < 0.05$, with an R^2 of 0.998. Participants' predicted waist is equal to 36.908 + (-0.169) (time) (unit of waist) when time is measured in week. Participants' waist decreased -0.169 for each week of time.

The Prediction Formula for the second treatment of Asynchronous music and exercise is

y_G2 = - 0.169x + 36.908

$R^2 = 0.998$

This means that 99.8% of the variance y_G1 is predicted by the formula. This finding can be used as a benchmark for predicting waist circumference improvements in obese adult Singapore Malay women when they exercise with Asynchronous music.

For Control Group C exercise with no music, a significant regression equation was found $F(1,10) = 722.131$, $p = 0.000 < 0.05$, with an R^2 of 0.986. Participants' predicted waist is equal to 37.142 + (-0.157) (time) (unit of waist) when time is measured in week. Participants' waist decreased -0.157 for each week of time.

The Prediction Formula for the third treatment of exercise to no music

y_G3 = - 0.157x + 37.142

$R^2 = 0.986$

This means that 98.63% of the variance y_G1 is predicted by the formula. This finding can be used as a benchmark for predicting waist circumference improvements in obese adult Singapore Malay women when they exercise to no music.

With regards to Weight Reduction, for Group A exercise with synchronous music, a significant regression equation was found $F(1,10) = 1273.627$, $p = 0.000 < 0.05$, with an R^2 of 0.992. Participants' predicted weight is equal to 78.947 + (-0.637) (time) (unit of weight) when time is measured in week. Participants' waist decreased -0.637 for each week of time.

The Prediction Formula for weight loss in the first treatment of Synchronous music to exercise:

y_G1 = -0.637x + 78.947

$R^2 = 0.992$

This means that 99.2% of the variance y_G1 is predicted by the formula. This finding can be used as a benchmark for predicting weight reduction improvements in obese adult.

For Group B exercise with asynchronous music, a significant regression equation was found $F(1,10) = 1178.619$, $p = 0.000 < 0.05$, with an R^2 of 0.992. Participants' predicted weight is equal to 77.376 + (-0.359) (time) (unit of weight) when time is measured in week. Participants' weight decreased -0.359 for each week of time.

The Prediction Formula for weight loss in the second treatment group of Asynchronous music to exercise:

y_G1 = -0.359x + 77.376

$R^2 = 0.992$

This means that 99.2% of the variance y_G1 is predicted by the formula. This finding can be used as a benchmark for predicting weight reduction improvements in obese adult Singapore Malay women when they exercise to asynchronous music.

For Group C exercise with no music, a significant regression equation was found $F(1,10) = 8340.330$, $p = 0.000 < 0.05$ with an R^2 of 0.999. Participants' predicted weight is equal to 81.182 + (-0.343) (time) (unit of weight) when time is measured in week. Participants' waist decreased -0.343 for each week of time.

The Prediction Formula for weight loss in the control group of no music to exercise:

y_G1 = -0.343x + 81.182

$R^2 = 0.999$

This means that 99.9% of the variance y_G1 is predicted by the formula. This finding can be used as a benchmark for predicting weight loss in obese adult Singapore Malay women when they exercise to no music.

Comparing the prediction formulae to the post 2 year follow-up results of all 3 groups, only the Synchronous and Asynchronous groups continued regularly exercising twice to thrice per week to music, 14 subjects of the Asynchronous Group played modified sport – walking football, training regularly every week. It is a point to note that only the subjects in the Synchronous Group reported regularly practiced their high intensity exercises once per week. Following from the prediction formula, as long as they continuously trained with the high intensity exercises taught in the study, weight and waist reduction is predicted. Their post 2 year follow-up study reflected this decrease in weight and waist. However, only the Synchronous Group reported once weekly training of the high intensity exercises of the initial study. Further post study can be conducted on these subjects to assess their psychological motivation to adherence, when practicing the exercises taught in the initial study longitudinally.

5.8.2 Novel music arrangement copyright

As for music, the original contribution was special original orchestra arrangement composed by the Cultural Centre of University of Malaya. A copyright application was filed under filing number from MYIPO (LY2016001444) on 6 June 2016.

According to Martiniz et al (1999), obesity in the general population is the result of sedentary lifestyle and substantial reduction in everyday physical activity. Sedentary behavior in extended doses has been reported to be associated with metabolic syndrome as is evident in this study. At the end of this study, the subjects' metabolic profile improved as compared to pre intervention, where they were relatively sedentary. This research echoes the report by Kessler, Sisson, & Short (2012). It provides robust evidence on improvements in body composition, fitness and notably blood lipid parameters in terms of physical activity. It implies that high intensity physical activity has a major role in improving obesity levels, notwithstanding music accompaniment or non-music for that matter.

This research reported improved obesity levels, fitness and metabolic health, even in those yet-to-be in their ideal weight group. According to the Maastricht Study (Rooji et al., 2016), on the overall, the metabolically healthy groups were less sedentary and more physically active than the metabolically unhealthy groups. Physical activity and sedentary time may partly explain the presence of the metabolic syndrome in obese as well as non-obese individuals. This study echoes this, noting their post metabolic profile and their increase in exercise involvement in this study versus their sedentary lifestyle pre intervention. As one of the criteria for inclusion in this study was that subjects were relatively sedentary as defined by the Model of Sedentarism by Ricciardi (2005), however, at the end of this research study, on the average, each subject had completed approximately 92% in exercise session attendance. This meant that the subjects in this study had exercised about 33 times in 12 weeks. The subjects had increased their dosage and volume of exercises from pre intervention when they were relatively sedentary. Their post intervention metabolic profile improved from their exercise involvement in this study.

Post 2 years after the first exercise intervention, the Synchronous and Asynchronous group showed modest weight lost of between 5% -10%. The goal of sustained weight loss of about 5% - 10% of baseline body weight has also been recommended by the 2013 AHA/ACC/TOS Guideline for the Management of Overweight and Obesity in Adults (Jensen et al., 2014). Furthermore, from a clinical point of view, this amount of weight loss significantly eliminates most of the other risks associated with obesity.

Wing and Hill (2001) put forward that successful weight loss maintenance should be defined as “individuals who have intentionally lost at least 10% of their body weight and kept it off at least 1 year”. An important indicator of weight maintenance is that weight loss should be intentional (French et al., 1995). This applies even better in this study post 2 years.

A systematic review quoted in Wing (2002) on the outcome of weight loss lifestyle modification programs reported that at 1 year, about 30% of participants had a weight loss ≥10%, 25% between 5% and 9.9%, and 40% ≤4.9%. Weight loss peaked within 6 months of the commencement of treatment, and in the absence of a weight maintenance program, the trend begins to reverse after that with 50% of patients returning to their original weight after about 5 years.

It would be interesting to see what longitudinal studies on physical activity maintenance post-study reveals, with regards to exercise maintenance long term. On this note, it would be valuable to track these subjects at 5 years, 10 years and thereafter, to examine their adherence to physical activity post-study as well as their post-study health status. Maintenance of healthy lifestyle - in particular, adherence to regular physical activity, pose much challenges as reported in the behavioral treatment for weight gain prevention among black women (Bennett et al., 2013). It is encouraging to see health benefits reported in long term weight maintenance subjects at 10 years (Montesi et al., 2016 and Diabetes Prevention Program Research Group et al, 2009). The term "successful", obviously, would require a much longer period of weight maintenance, ideally life-long and thus a longitudinal study on this research subjects is recommended.

It would be interesting to see what longitudinal studies on physical activity maintenance post study reveals with regards to exercise maintenance long term. On this note, it would be valuable to track these subjects at 5 years, 10 years and thereafter, to examine their adherence to physical activity post study as well as their post-study health status. Maintenance of healthy lifestyle, in particular, adherence to regular physical activity, pose much challenges as reported in the behavioral treatment for weight gain prevention among black women (Bennett et al., 2013). Obviously, the term "successful" would require a much longer period of weight maintenance, ideally life-long. It is encouraging to see health benefits reported in long term weight maintenance subjects at 10 years (Montesi et al., 2016 and Diabetes Prevention Program Research Group et al, 2009).

With regards to future studies on music genre, from the results obtained in this study, future studies are needed to examine specific music genre's ergogenic properties on high intensity physical activity and its results on obesity, fitness and health parameters as Yamasaki et al (2012) proved positively the impact of music on metabolism.

The use of music is safe and inexpensive. It can be easily incorporated into any physical activity routine and becomes an ergogenic aid for the obese and overweight particularly, if music has congruent accompaniment. This study takes into consideration Loo & Loo's (2014) recommendations that the preference for the new accompaniment reflects the possibility that music could be composed based on the existing choreography of a routine. This is contrary to the conventional method in which a routine is choreographed based on an existing music, which most often causes limitations for the choreographers.

In the current study, however synchronous or asynchronous or even non-music for that matter, does not impact body composition, fitness (except for curl up) and blood lipid parameters when it comes to high intensity exercises. The three groups of synchronising movements to composed music, asynchronized movements to same music and with non-music on exercise, seems to provide across the board significant drop in all other variables (systolic blood pressure, diastolic blood pressure, resting heart rate, total cholesterol, HDL-cholesterol, LDL-cholesterol and triglyceride) during the post-intervention. However, there was no change in total cholesterol / HDL ratio and blood glucose level during pre- and post-testing. This might bring to fore the issue of inadequate time span on this study to produce significant changes in blood glucose and cholesterol parameters.

There have been negative results between adiposity and ability to optimization during high intensity exercise because it is interrupted by pain or fatigue. This study supports that the association is independent and that the role of pain and fatigue in the relationship may have previously been over-emphasised. Intensity of physical activity was proven to be a moderating variable, as opposed to low and moderate intensity physical activity, as in Curan & Karageorghis (2014). This study mirrors that. Music is less effective as a disassociation tool at high exercise intensities owing to the pre-eminence of physiological cues (Boutcher & trenske, 1990; Tenenbaum et al., 2004; Tenenbaum 2001; Rad & Hafezi, 2013).

Overweight and obesity lead to adverse metabolic effects on blood pressure, cholesterol, triglycerides and insulin resistance. Risks of coronary heart disease, ischemic stroke and type 2 diabetes mellitus increase steadily with increasing body mass index (BMI), a measure of weight relative to height. Raised body mass index also increases the risk of cancer of the breast, colon, prostate, endometrium, kidney and gall bladder. Mortality rates increase with increasing degrees of overweight, as measured by body mass index. To achieve optimum health, the median body mass index for an adult population should be in the range of 21 to 23 kg/m2, while the goal for individuals should be to maintain body mass index in the range 18.5 to 24.9 kg/m2. There is increased risk of co-morbidities for body mass index 25.0 to 29.9, and moderate to severe risk of co-morbidities for body mass index 30 or greater.

In a study by Czernichow et al. (2011) on BMI, WC and WHR to ascertain the better discriminator of cardiovascular disease mortality risk researching from evidence from an indi-parti meta-analysis of 82,864 participants from 9 cohort studies, it was reported that the risk of cardiovascular disease mortality increased linearly for WC and WHR with a 66% increased risk in highest quantile of WHR. Measures of abdominal adiposity, but not BMI, were related to an increased risk of cardiovascular disease mortality. There was improvements in both BMI and waist circumference and prediction formulae resulted for both for all three groups in this study.

Adiposity is strongly associated with cardiovascular disease (CVD) risk factors such as hypertension, diabetes mellitus and dyslipidemia (Cornier et al., 2011, InterAct Consortium et al., 2012). BMI which does not consider body fat distribution highlights its limitations that the metabolic complications of obesity are more closely related to visceral adiposity than overall adiposity (Cornier et al., 2011). Hence, other measures of adiposity, which consider body fat distribution, like waist circumference (WC), waist-to-hip ratio (WHR) are used at the same time for overall evaluations. WC has been reported to be the best amongst these measures, with excellent correlation with abdominal imaging and high association with CVD risk factors, especially diabetes (InterAct Consortium et al., 2012). Abdominal fatness as in WC (≥80 cm for females, ≥90 cm for males) and (WHR) of more than 1.0 for males and more than 0.85 for females (NHS, 2010) had better sensitivities compared to BMI. Hence, using a combination of measures, which includes a measure of general adiposity and a measure of central adiposity, would be more appropriate in the identifying obesity and even CVD risk factors (Lam et al., 2015). A waist circumference cut-off at 99.5cm in men and 91 cm in women was the best predictor of METS in Qatar and is being supported in this study.

The findings of the present study demonstrated that physical activity is a valid factor in BMI reduction impacting weight loss and fat percentage reduction. Fitness capacity research is rather limited in the samples of overweight and obese individuals in Asia entering duo obesity-fitness management programme, particularly using music as ergogenic aid. Whilst much of the research investigating the complex association between adiposity and functional capacity has only incorporated individuals across the spectrum of overweight and obesity consisting of Westerns, African-Americans, Asians consisting of the Japanese, Chinese, the present study is of particular importance as it focuses on the Malays in Singapore, of which there is no study on this demographic group till date on exercise and music in obesity and fitness management.

Notwithstanding the types of music used or non-music for that matter in this study, it showed physical activity augmented changes in all parameters, namely body composition, fitness and metabolic profile (although negligible in blood glucose and cholesterol). A 12-week study by Racil et al. (2013) has reported that high intensity interval training positively changes blood lipids and adiponectin resulting in improved insulin sensitivity in obese young females. It is not the case in this study although it used similar time span and high intensity training. Thus time span to augment significant changes in blood glucose and cholesterol needs to be examined further in this population.

Visceral adiposity has been shown to be an important link between cardiorespiratory fitness and markers of the metabolic syndrome. Metabolic syndrome is defined as having 3 or more of the following: insulin insensitivity, hypercholesterolemia and high triglycerides. As reflected in this study, improved insulin sensitivity following weight loss has been particularly associated with the loss of visceral abdominal fat (Goodpaster et al., 1999) Physical activity, be it with or without diet-induced weight loss has been shown to induce greater reductions in visceral abdominal fat relative to general body fat (Ross et al., 2000). This was echoed in this study with an exception in the resting heart rate results. Compared to those who were in the asynchronous and controlled groups, those who were in the synchronous music group had a significantly greater decrease in SBP before and after ($P < 0.001$) but the asynchronous and no music registered non-significant. There is a significantly greater decrease in DBP for both synchronous and asynchronous groups ($P < 0.001$) but no significance in the control group. There is significantly greatest decrease in HR in synchronous group ($P < 0.001$), significant change in the control group ($P < 0.005$) but no significant changes in the group with asynchronous music.

Loomba and Arora (2012) reported on the effects of music on systolic blood pressure, diastolic blood pressure, and heart rate. Investigating the effect of music on various vital signs, namely systolic blood pressure (SBP), diastolic blood pressure (DBP), and heart rate (HR), many studies have also assessed effects of music on self-reported anxiety level, attributing some degree of music-induced anxiety relief to the beneficial impacts of music on vital signs. A meta-analysis conducted reported that compared to those who did not receive music therapy, those who did receive music therapy had a significantly greater decrease in SBP before and after (difference in means, −2.629, confidence interval (CI), −3.914 to −1.344, $P < 0.001$), a significantly greater decrease in DBP (difference in means, −1.112, CI, −1.692 to −0.532, $P < 0.001$), and a significantly greater decrease in HR (difference in means, −3.422, CI, −5.032 to −1.812, $P < 0.001$). This was reflected in this study.

Although a special original orchestra arrangement was composed by the Cultural Centre of University of Malaya for this study, ethnocentric and culturally sensitive for the subjects, the results of this study, was not significantly impacted with regards to synchronous music, asynchronous music or no music used, pointing that the physiological stress of high intensity exercise overcame any music effect on the subjects. Recommendations on ways to improve this in future study is to examine the effects of self-selected versus researcher-selected music on psychological, physiological and performance outcomes of high intensity exercise. Current study on the effects of using self-selected versus researcher-selected music used running task and subjects reported favourably in intrinsic motivation, greater rating of rate of perceived exertion and distance run results (Jermel & Kimberley, 2016).

De Feo (2013) on discussing whether high intensity exercise is better than moderate intensity exercise for weight loss, reported that although the attraction of executing exercises in shorter time and that high intensity training appears to induce superior improvements in aerobic fitness, on the other hand, prescribing a higher-intensity exercise for obese individuals decreases adherence and results in the completion of less exercise. He further argued that a successful exercise program should be proposed at a moderate intensity and a low perceived effort because obese subjects who have low self-efficacy, poor mood status, and are not familiar with high-intensity workouts could easily drop out. It has been shown otherwise in this study. Only one subject dropped out of this study due to her inability to commit due to time commitment factor. Thus this subject did not have the chance to perform the prescribed exercise regime. While expecting these obese subjects to have negative adherence to the exercise because of its high intensity level, on the contrary, adherence to their exercise participation was high. This might be accrued to the fact that high intensity training in this instance, countered their most quoted barrier to exercise, namely boredom. The findings in this study points towards Heinrich et al. (2014) high intensity functional training among physically inactive overweight and obese adults which was compared to moderate-intensity training for exercise initiation, enjoyment, adherence, and intentions. They reported that high intensity functional training participants spent significantly less time exercising per week, yet were able to maintain exercise enjoyment and were more likely to intend to continue. Even with pre-diabetes adults, high intensity interval training is reported to be an efficacious alternative to moderate intensity continuous training. Individuals in high intensity interval training adhered to their prescribed protocol to a greater extent than individuals in moderate intensity continuous training (Jung et al., 2015).

In BMI and weight versus body fat, Padwal et al. (2016) in a Canadian study of more than 50,000 people mostly of women over age 40, looking at BMI and body fat obtained from scans, reported that people with the most body fat, specifically 38% fat for women, were the most likely to die within a few years, regardless of weight and BMI. According to Barry et al. (2014) in their Fitness vs. Fatness on All-Cause Mortality: A Meta-Analysis, compared to normal weight-fit individuals, unfit individuals had twice the risk of mortality regardless of BMI. Overweight-fit and obese-fit individuals had similar mortality risks as normal weight-fit individuals. Implications from this study is how physical activity has an impact on all the groups, particularly in health by improving body composition, fitness and metabolic parameters. Researchers, clinicians, and public health officials should focus on physical activity and fitness-based interventions rather than on BMI reduction and weight loss per se. After all, the emphasis should be on quality of life and disability-free life expectancy rather than on life expectancy per se.

5.9 Recommendations

In discussing this research against the backdrop of the obesity paradox (Lavie, 2009) where it has been documented in several trials where overweight and obese individuals with established cardiovascular disease, which includes cardiac heart disease, heart failure, hypertension and peripheral arterial disease, have a better prognosis compared to non-overweight/non-obese patients, where fitness in fatness becomes a protective quality. The fitness of fat as being in the obesity paradox might be applicable here. For subjects in this study with pre-cursors to metabolic diseases, by propagating fitness in fatness and fitness against fatness in this obesity fitness management programme, the end result will be a reduction of weight loss but more applicably fat loss, as well as disease pre-cursors' prevention, management and treatment. Thus BMI might not be the most desirable measuring mechanism.

Physical activity produces many beneficial health outcomes that are too often deemphasized in favour of weight-based end points, as also reiterated by Shaibi et al. (2015). Benefits of exercise training includes improving insulin resistance, beta cell function, glucose tolerance, dyslipidemia, vascular function, strength, fitness and functionality. More effort should be taken to educate to shift the emphasis on fitness management in obesity programme as has been embraced by this study's focus on obesity fitness and health management. It is also important to assess the health benefits from physical activity when improvements is measured relative to the individual's fitness and not as an absolute value.

The success of community-based interventions based on their efficacy in changing individual-level clinical indicators is encouraging in this study. Pre to post intervention results of this study showed success in improvements in body composition, fitness and metabolic health parameters after timeline of 12 weeks. While improvements in some clinical risk factors can be achieved through relatively diffuse and shorter-term community-level activity, improvements in others may require interventions of greater intensity and duration.

A more inclusive, social community initiative in terms of a holistic prevention and solution must be championed to target the disability-free quality driven lifestyle of a healthy weight. It is also proposed that obesity fitness management should be more group-centric than individual-centric. This study went a step further by making it ethno-centric, namely support via culture and group bonding. This study also made it culture-centric with the inclusion of culture-centric music. This entails the change of societal norms in terms of physical activity than to deal only with the individuals who suffer from the detrimental effects of inactivity. Population-based approaches seek to positively affect the determinants of physical activity on obesity and address them in the whole population. According to Wareham et al. (2005), by effecting a positive shift in societal norms with regards to physical activity, this offers the probability of large-scale returns in terms of a positive shift in the prevalence of overweight and obesity. On the other hand, a small shift in the percentage of the population accumulating sufficient levels of physical activity can result in notable reduction in levels of overweight and obesity.

In terms of public health implications, group exercise encourages and promotes social bonding. The synergy of "togetherness" in physical exertive movement in societal activity is significant not only for the individual's physical and mental health but for social well being too as reiterated by Davis, Taylor and Cohen (2015). Adherence-wise, exercising with others was superior to exercising alone. Burke et al. (2008) reported that motivation and pleasure in exercise settings is significantly predicted by group cohesion and intragroup similarity. Cohen et al. (2010) reported positive impact on performance reducing perceptions of pain.

Studies of rowers and runners reported that participants tolerate significantly greater pain following group synchronous workouts than after solo or group non-synchronous workouts of the same basic form, intensity and duration (Cohen et al., 2010; Sullivan et al., 2014). It will be interesting to find out in future studies whether exercising solo to synchronous or asynchronous music versus exercising synchronously in a group either using synchronous or asynchronous music will reveal difference in results and to what degree is the results significant. This might have significant implications to exercise adherence, thus its results on one's or the group's health and fitness results stemming from the adherence to exercise.

The incidence and prevalence of obesity globally and in Asia has a negative impact on Singapore's economic growth and sustainance. And so does obesity in Singapore, affecting its progress with the rest of the world in terms of productivity and economy. Thus it is imperative that ongoing research solutions affecting socioeconomic and behavioural factors combatting obesity be sought and practically implemented, particularly those that involves community-health interaction and integration, as was evident in this study on music and movements in obese Singapore Malay women. The impact of good health, of the country's population, on the economy is undeniable.

More population-based interventions on physical activity is needed to study the metabolic health responses to ethno and culture-centric music for the rest of the ethnic population in Singapore This study is imperative not only in Singapore's context but also in the other South East Asian countries riding the wave of globalization. This research is applicable as an obesity fitness management targeting the dynamics of a community intervention. As South-East Asia becomes progressively urbanized, noting the recommendations regarding GDP growth and the fact that, BMI of 23-25 kg/m^2 is needed to assist globalization, the results of this research is valuable, not only as a case study in a developed nation's fight against obesity, but can be used as translational to achieve the recommended BMI in the developing countries of South-East Asia. So far no country has overturned their obesity rate successfully. Asean will become more e-connected over time, but real action of connectivity will be in mainland S.E.A. A healthier community in one country, will translate positive benefits in terms of better quality of life, higher productivity and economy which permeates into the Asian and thereafter, the global community.

This research can also be used as a case study for Malaysia, which has a high population numbers of this ethnicity. According to the Department of Statistics Malaysia, Official Portal (2017), Malays is the predominant ethnic group in Peninsular Malaysia which constituted 63.1% according to the 2010 Population and Housing Consensus of Malaysia. Malaysia has been labelled as the fattest country in Asia. According to the National Health and Morbidity Survey of 2015, obese Malaysians make up 17.7 per cent of the population while those who are categorised as overweight make up 30 per cent. Diabetes was also affecting more people, with statistics showing an increase from 11.6 per cent of the population affected in 1996 to 17.5 per cent in 2015 and 47.7 per cent of adults in the country has high cholesterol.

A key strength of the present study is that it demonstrated that music whether it is synchronized, asynchronised or with no music, does not show significant difference ergogenically, when it comes to high intensity exercise. It does alter the negative impact on functional limitations of the obese when executing exercise movements thus impeding their performance translated into a less optimal weight loss. Previous studies have concluded that the association between adiposity and ability to optimization during high intensity exercise is mediated by health co-morbidities such as pain or fatigue; however the present study supports that the association is independent, and that the role of pain and fatigue in the relationship may have previously been over-estimated.

An additional strength of the present study is that it improves understanding of the characteristics of this less-researched obese ethnic population in Singapore. However, the present work has several limitations. The individuals characterized in the sample are those that had some prior exercise experience. Due to the needs of the study of executing high intensity exercises, it is deemed safer if the subjects had prior exercise experience versus those who had not exercised at all, to execute high intensity exercise. This is for safety as well as to eliminate unnecessary coordination problems when executing exercises. As they are required to move to music accompaniment during exercise (be it synchronous or asynchronous), it is imperative that they have some prior history of exercise to music experience. After all, Loo & Loo (2014) found that the intended congruence between a music and routine was evidently perceived visually in their study on the perception of dancers on the congruence between music and movement in a rhythmic gymnastics routine.

Another strength of this study is adherence to exercise. Exercise adherence is the voluntary and active involvement in an exercise program. Participation were good at attendance of 92% for all groups collectively. At the completion of the research, only one subject dropped out from the Control Group with the reason “unable to commit due to family commitments”. Personal attributes that influence a person’s decision to engage in exercise is past history. In supervised exercise programs, past program participation is the most reliable predictor of current participation. Thus the initial decision post-pilot study, to list “exercise to music experience” as a pre-requisite had a positive effect on attendance of the participants. Research has shown that obese individuals who are typically less active than normal-weight individuals are less likely to adhere to supervised exercise programs. However, it is not the case in this research. The subjects adhered well to the exercise programs until the end of the research.

With regards to physical activity factors, research has shown that dropout rates are high in vigorous intensity. It was also shown that more than 50% of people who started a new program will drop out within the first 6 months. Adherence, however, was good in this research. On the other hand, this however, might be due to the “mode of novelty” that this is a research programme and thus these participants will adhere to the research programme. Thus it will be good to have a follow up study on the adherence of these subjects post study, 6 months and beyond to examine their adherence and motivation to exercise. Motivation is the psychological drive that gives behavior direction and purpose. A separate study is recommended to study adherence and motivation to exercise post research.

For the correct reflection of obesity, even on a national or community level, the evaluation and assessment of obesity should not only be based on just BMI alone. It should take into consideration WC and WHR at the same time to provide accurate assessment. BMI, though a convenient population level measure, is not an accurate assessment of fatness on its own. BMI and WC is needed in tandem (Walls et al., 2011) as the adverse health consequences associated with obesity may be underestimated by trends in BMI alone. WC is closely related to adverse cardiovascular outcome, thus it is imperative to know the prevailing trends in both. According to Abbasi, Blasey & Reaven (2013), most individual with abnormal BMI also have abnormal WC. Both indexes of excess adiposity are positively associated with systolic blood pressure, FPG and triglycerides and inversely associated with HDL and cholesterol as confirmed by this study.

These findings have public health implications in that the high intensity interval trainings participants spent significantly less time exercising than current U.S. physical activity guidelines, yet they maintained exercise enjoyment reflected in the exercise adherence during the intervention. Apart from time economy, exercise variance and music are also motivating factors. The high intensity intervention training was economical in time and safely conducted for these previously inactive overweight and obese adults reflected from its injury-free experience of the subjects. Participants were able to improve their body composition during the exercise programs, with many losing over 3 kg. Ultimately, in order to promote community health adoption, public health researchers and practitioners would be well-served to include time-efficient high-intensity exercise options accompanied by music when promoting physical activity (Ekkekakis, Parfitt & Petruzzello, 2011).

For experimental studies, a recommendation of a minimum of 30 participants per experimental group was put forth by Fraenkel and Wallen (2003). The sample size for the present study met this criteria. The researchers further suggested that a sample size should be according to the researcher's "reasonable expenditure of time and energy". With more time and resources, it is recommended that future research use a larger sample size, which will increase accuracy in examining the effects of music on movements on obesity fitness management among these demographic profile.

CHAPTER 6: CONCLUSION AND FUTURE DIRECTIONS

6.1 Conclusion

Increased knowledge enhancements and health awareness promotions should be conducted at the community and national levels regarding fat-but-fit and metabolically healthy obese, to counteract the current common emphasis on thinness through caloric restriction through fad diets. This research supports Flegal (2005) in validating Andres (1980) U-shaped mortality curve that one's weight obviously factors one's health but also that one's health can also have a significant bearing on one's weight. In addition to this is the envelope effect that being physically active accords the individual. Metabolic benefits can only be achieved through exercise. As fitness in fatness trumps thinness with no fitness, thus parallel promotions of weight loss through fitness for health must be emphasized.

An urbanized Singapore's obesity threat to population health and economy presents its urgency of treatment. Alarming Important is the lack of national prevalence and epidemiological data in countries in the region coupled with a lack of uniformity in reference standards and cut-off points, particularly in the Asian BMI cut offs. Lifestyle behavioural modification needs to be continually integrated into strategies in a national and regional policy programme requiring collaboration between government and corporate sectors, the academics, the national governmental associations and the community, with the assistance of international aid agencies for development and implementation.

There need also to be a focus on physical activity promotion efforts via organizational and legislative changes rather than just on an individual level. There should also be a concerted effort on the emphasis that they do not see physical activity participation as an all or none behavior. They need to evaluate the efficacy of disseminations of these interventions with modern technology.

6.2 Future Directions

The timeline of this study was 12 weeks. The majority of high intensity training studies on various groups have utilized relatively short intervention periods (i.e. lasting up to several weeks). Future work should involve long-term interventions (i.e. months to years) in a variety of clinical cohorts (i.e. individuals at risk of metabolic disease, those with insulin resistance, obesity, type 2 diabetes and cardiovascular disease) are urgently needed to study in-depth and understand how manipulating the exercise stimulus impacts on health-related fitness re-modelling in these populations.

One aspect that remains unclear from the present literature is the precise intensity and minimal volume of training that is needed to potentiate the effect of the stimulus-adaptation on outcomes of relevant health markers. This needs to be exhaustively and extensively investigated.

Future studies need to provide evidence-based recommendations for novel exercise prescriptions which can be practically incorporated into the respective populations' daily living as a lifestyle. This progressively becomes an integral component in the development of prevention and treatment programme for chronic inactivity-related diseases.

Areas for future investigation should address behavioural strategies accompanying such music and movement studies to increase and maintain physical activity over a lifespan. In this case, a follow up research on whether the subjects maintain and sustain their physical activity and body composition, fitness and metabolic health profile needs to be conducted.

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Overall, this study contributes to the new body of knowledge in the area of music and movements on obesity fitness management of obese women in the Asia Pacific region. In terms of originality and contribution, this is the only research study with ethnically-centric synchronous and asynchronous music and movements on obesity, fitness and metabolic parameters in obese Singapore Malay women to date. The novel finding as a product of this research is the Prediction Formulae for Waist and Weight Reduction, original orchestra arrangement music composition, patents registered. This was also a multi-disciplinary, multi-measures and multi-time point research.

This research was honoured as the only Asian research selected and orally and poster presented at the President's Cup Award at the American College of Sports Medicine North West Chapter Annual Meeting in Tacoma Washington, on 15-16 April 2016.

The subjects who were involved in the music intervention group in this study volunteered as the subjects of the post 2-year study on "Characterising the metabolic intensity and cardiovascular demands of walking football in Southeast Asian women". The Oral Presentation (Population specific) was presented by the author at the 11th International Conference for Strength Training 2018 on 30 November – 3 December 2018, Perth Convention Centre, Australia. These findings were also presented at the 6th

Asia Football Confederation Medical Conference in Chengdu China on 4-8 March 2019. The journal article, the result of a collaborative study by this author (Salle) in Heil, D., Newton, R., & Salle, D. (2018) was published as the Highlighted Article in the International Journal of Physical Education, Fitness and Sports.

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List of Papers Presented & Publications

Oral Presentation

6th Asia Football Confederation Medical Conference 2019

4 – 8 March 2018, Chengdu, China

"Can Walking Football Cause Positive Changes in Cardiovascular Fitness in Southeast Asian Women?"

Oral Presentation - Population Specific

11th International Conference for Strength Training 2018

30 November – 3 December 2018, Perth, Australia

"Characterising the metabolic intensity and cardiovascular demands of walking football in Southeast Asian women"

Poster Presentation

American College of Sports Medicine North-West Chapter Annual Conference 2018

23 -24 February 2018, Riverhouse Convention Centre, Bend Oregon, USA

"Characterising heart rate responses in South-East Asian women walking soccer competitors during successive matches."

Oral & Poster Presentation in President's Cup Award

American College of Sports Medicine North-West Chapter & Alaska Annual Meeting 2016

15 – 16 April 2016, Tacoma, Washington, USA

"Physical activity and music on body composition, fitness and metabolic parameters among obese Singapore women."

Oral Presentation

9th International Conference on Economics and Social Sciences ICESS 2015

17 – 18 October 2015, Holiday Inn Istanbul City, Istanbul, Turkey

"Obesity Fitness Management: Effects of music on physical activity among obese women in Singapore."

Oral Presentation

9th ASEAN Conference Symposium on Primary Health Care

24 - 26 April 2015, Kinta Riverfront Hotel & Suites, Ipoh, Malaysia

"Lifestyle Management for Obesity: What works."

Oral Presentation

4th International Conference on Management, Finance & Entrepreneurship

11-12 April 2015, Garuda Plaza Hotel, Medan, Indonesia

"FAT to FIT – An Asian OBESITY MANAGEMENT PROGRAM and the Malaysian case study"

Oral Presentation

UMCares Exchange & Summit 2014

11-13 Nov 2014, Crystal Crown Hotel, Petaling Jaya, Malaysia

"Fat to Fit: The Obesogenic Factor."

Oral Presentation

World Leisure Congress

7-12 Sep 2014, Authur R Outlaw, Mobile Convention Centre, Mobile, Alabama, USA
"Algorithym of obesity fitness management in Singapore and Malaysia"

Oral Presentation

14th Annual International Conference on Sports: Economic, Management, Marketing &

Social Aspects, 19-22 May 2014, Athens, Greece

"Fat2Fit^R Reality TV: The Malaysian community perspective and the Singapore connection."

LIST OF PUBLICATIONS AND PAPERS PRESENTED

Salle, D.D., Aman, M.S., Hashim, M.N., & Loo, F.Y. (2019). *The Obesity Dilemma*. Malaysia: University of Malaya Press.

Salle, D.D., Aman, M.S., Hashim, M.N., Loo, F.Y., Chua, Y.P. & Tran, T. (2019). Using Music as an Impetus to Address Obesity and Metabolic Health During High Intensity Training. *International Journal of Exercise Science,* 12(5).

Heil, D., Newton, R., & Salle, D. (2018). Characterizing the Metabolic Intensity and Cardiovascular Demands of Walking Football in Southeast Asian Women. *International Journal of Physical Education, Fitness and Sports*, 7(3), 12-23. https://doi.org/10.26524/ijpefs1832.

Salle, D.D.A., Aman, M.S., Hashim, M.N., Loo, F.Y., & Tran, T. (2017). Effects of music and physical activity on body composition, fitness and metabolic parameters among obese Singapore women. *Journal of Sport & Health Science.*

Salle, D.D., Aman, M.S., Hashim, M.N. & Loo, F.Y. (2016) Physical activity and music on body composition, fitness and metabolic parameters among obese Singapore women. *International Journal of Exercise Science: Conference Proceedings*: 8(4),76.
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*Note: Dee Dee Ayra Salle (Salle, D.D.A. & Salle, D.D.) a.k.a. Dee Dee Mahmood (Mahmood, D.D.)

List of Intellectual Property Patent Information and Commercialisation

Malaysian Patent Application No: PI 2015701307 / Title: Artificial Intelligence for Behavioral Change on 23 April 2015

Trademark Registration No. 2015052709 / Title: Fat2Fit^{R} / Validity Date: 25 Feb 2015 to 25 Feb 2025

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Original orchestra arrangement & Original Choreography by Dee Dee Ayra Salle/A/P Dr Mohd Nasir Hashim

APPENDIX K

The procedures of analysis for Body Composition, Fitness and Metabolic Profile parameters of this study are presented in length below:

4.4 Post-Hoc test of main effect for Body Composition, Fitness and Metabolic Profile parameters

4.4.1 Body Composition – BMI

Table 4.4.1: Descriptive Statistics of BMI

	Group	Mean	Std. Deviation	N
BMI.Pre	Synchronous Music	31.3429	5.08832	31
	Asynchronous Music	32.5629	9.79497	31
	No Music	33.9482	8.79724	30
	Total	32.6036	8.12193	92
BMI.Post	Synchronous Music	28.7074	4.17611	31
	Asynchronous Music	31.1539	10.37653	31
	No Music	32.3750	8.18930	30
	Total	30.7277	8.06008	92

By looking at the descriptive statistics Table 4.4.1, all of the groups have a difference in BMI before (BMI.pre) and after (BMI.post) 12 weeks fitness management program. In addition, Synchronous Music group shows the largest of difference of BMI compared to the other groups as reflected in Figure 4.4.1 below:

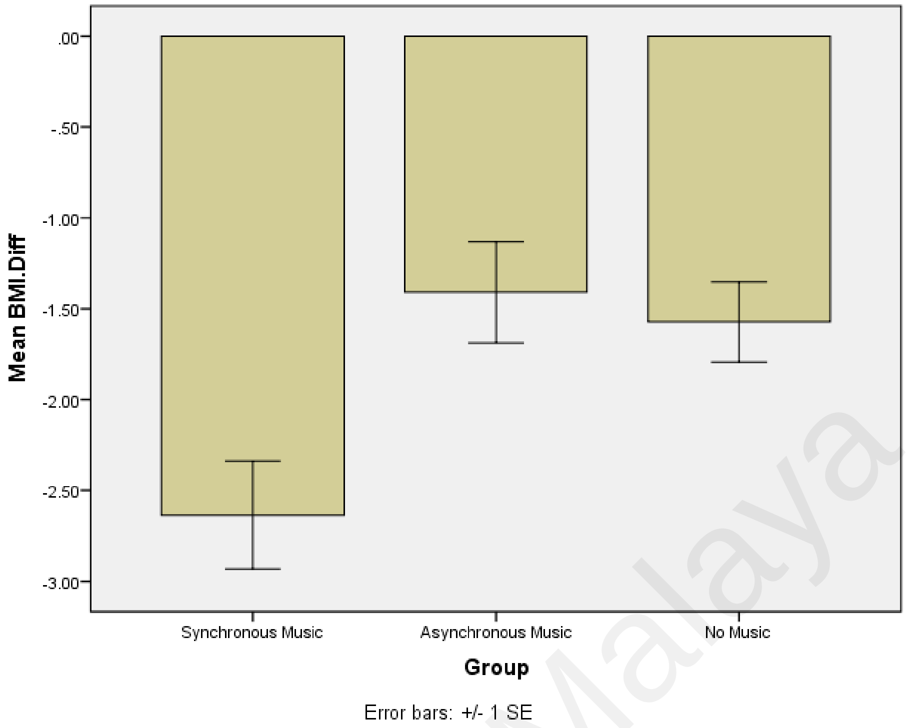

Figure 4.4.1: BMI Difference

SPANOVA was used to investigate the significant difference between groups by time. There are two assumption that needs to be fulfilled before using SPANOVA using the Levene's Test and Box's Test.

Table 4.4.1.1: Levene's Test of Equality of Error Variances[a]

	F	df1	df2	Sig.
BMI.Pre	.217	2	89	.805
BMI.Post	.606	2	89	.548
Tests the null hypothesis that the error variance of the dependent variable is equal across groups.				
a. Design: Intercept + Group Within Subjects Design: pre.post				

As shown in Table 4.4.1.1, since the significance value of both BMI.pre and BMI.post are > 0.01, we may use the Split-Plot ANOVA analysis because both of them have equal variance.

Table 4.4.1.2: Box’s Test of Equality of Covariance Matrices^a

Box's M	43.535
F	7.020
df1	6
df2	196116.265
Sig.	.000
Tests the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups.	
a. Design: Intercept + Group Within Subjects Design: pre.post	

As shown in Table 4.4.1.2, the significance value Box’s test of equality of covariance matrices is smaller than 0.01. The data meets the requirement of SPANOVA analysis. Thus Pillai’s Trace test may be used.

Table 4.4.1.3: SPANOVA Results

Table Multivariate Tests^a

Effect		Value	F	Hypothesis df	Error df	Sig.	Noncent. Parameter	Observed Power^c
pre.post	Pillai's Trace	.621	146.030^b	1.000	89.000	.000	146.030	1.000
	Wilks' Lambda	.379	146.030^b	1.000	89.000	000	146.030	1.000
	Hotelling's Trace	1.641	146.030^b	1.000	89.000	.000	146.030	1.000
	Roy's Largest Root	1.641	146.030^b	1.000	89.000	.000	146.030	1.000
pre.post * Group	Pillai's Trace	.122	6.201^b	2.000	89.000	.003	12.402	.883
	Wilks' Lambda	.878	6.201^b	2.000	89.000	.003	12.402	.883
	Hotelling's Trace	.139	6.201^b	2.000	89.000	.003	12.402	.883
	Roy's Largest Root	.139	6.201^b	2.000	89.000	.003	12.402	.883

a. Design: Intercept + Group

Within Subjects Design: pre.post

b. Exact statistic

c. Computed using alpha = .05

From the Multivariate Tests Table 4.4.1.3, from the usage of Pillai’s Trace test (since one of two assumptions above violated) to test whether there are differences of

BMI between the means of identified groups of subjects on a combination of times (before and after 12-week fitness management). Since the significance value (Sig.=0.003) is < 0.05, we concluded that the mean scores of three groups, synchronous music, asynchronous music and no music, are significantly different in BMI across 12 weeks of obesity fitness management simultaneously.

Table 4.4.1.4: Pairwise Comparisons between groups

Measure: MEASURE_1

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a]	
					Lower Bound	Upper Bound
Synchronous Music	Asynchronous Music	-1.833	2.042	1.000	-6.815	3.148
	No Music	-3.136	2.058	.393	-8.159	1.886
Asynchronous Music	Synchronous Music	1.833	2.042	1.000	-3.148	6.815
	No Music	-1.303	2.058	1.000	-6.326	3.720
No Music	Synchronous Music	3.136	2.058	.393	-1.886	8.159
	Asynchronous Music	1.303	2.058	1.000	-3.720	6.326

Based on estimated marginal means

a. Adjustment for multiple comparisons: Bonferroni.

As in Table 4.4.1.4, the three types of groups do not have a statistical significance difference between groups (Sig. = 0.314 > 0.05).

Table 4.4.1.5: Pairwise Comparisons between time

Measure: MEASURE_1

(I) pre.post	(J) pre.post	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
1	2	1.873*	.155	.000	1.565	2.181
2	1	-1.873*	.155	.000	-2.181	-1.565

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

As in Table 4.4.1.5, there is a significant change in BMI from time 1 (pre test/before 12 weeks fitness management) to time 2 (post-test/after 12 weeks fitness management) (Sig.=0.000 < 0.05). Therefore the main effect for BMI is time (pre-post).

The Body Composition – BMI: Profile plot for comparison between treatment & control groups in BMI is shown in Figure 4.4.1.6 below:

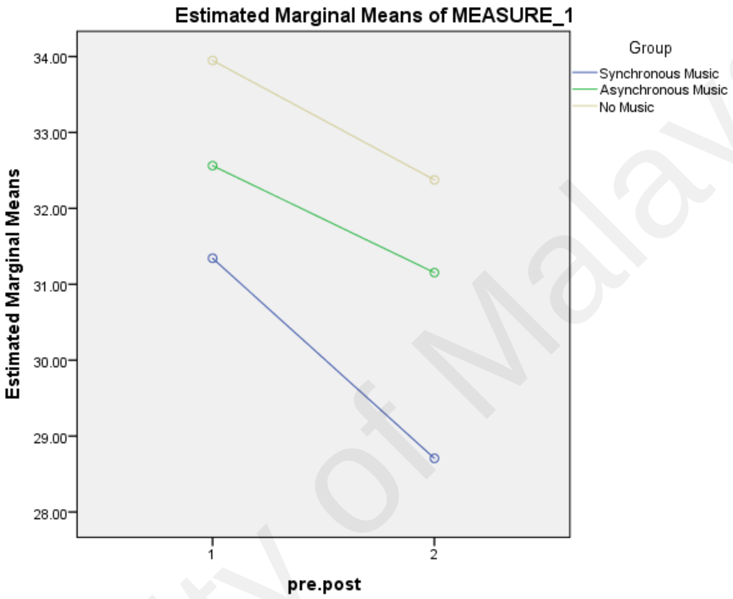

Figure 4.4.1.6: BMI: Profile plot for comparison between treatment & control groups in BMI

Next, we use SPANOVA (Split-Plot ANOVA) to investigate the significant difference of weight between groups by time. There are two assumptions that needs to be fulfilled before using SPANOVA;

Table 4.4.2.1: Levene's Test of Equality of Error Variances^a

	F	df1	df2	Sig.
Weight.Pre	2.163	2	89	.121
Weight.Post	.479	2	89	.621
Tests the null hypothesis that the error variance of the dependent variable is equal across groups.				
a. Design: Intercept + Group Within Subjects Design: pre.post.program				

As shown in Table 4.4.2.1, since the significance value of both weight.pre and weight.post are > 0.01, we may use the Split-Plot ANOVA analysis because both of them have equal variance.

Table 4.4.2.2: Box's Test of Equality of Covariance Matrices^a

Box's M	17.822
F	2.874
df1	6
df2	196116.265
Sig.	.011

Tests the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups.

Design: Intercept + Group

Within Subjects Design: pre.post.program

As shown in Table 4.4.2.2, similar result, the significance value Box's test of equality of covariance matrices is > 0.01, we may use the Wilk's Lambda test.

Table 4.4.2.3: SPANOVA

Multivariate Tests^a

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
pre.post.program	Pillai's Trace	.621	145.839^b	1.000	89.000	.000	.621
	Wilks' Lambda	.379	145.839^b	1.000	89.000	.000	.621
	Hotelling's Trace	1.639	145.839^b	1.000	89.000	.000	.621
	Roy's Largest Root	1.639	145.839^b	1.000	89.000	.000	.621
pre.post.program * Group	Pillai's Trace	.135	6.949^b	2.000	89.000	.002	.135
	Wilks' Lambda	.865	6.949^b	2.000	89.000	.002	.135
	Hotelling's Trace	.156	6.949^b	2.000	89.000	.002	.135
	Roy's Largest Root	.156	6.949^b	2.000	89.000	.002	.135

a. Design: Intercept + Group

Within Subjects Design: pre.post.program

b. Exact statistic

From the Multivariate Tests Table 4.4.2.3, we use the Wilk’s Lambda test (since two assumptions above were fulfilled) to test whether there are differences between the means of identified groups of subjects on a combination of times (before and after 12 weeks fitness management). Since the significance value (Sig.=0.002) is < 0.05, we conclude that the mean score of three groups, synchronous music, asynchronous music and no music, is significantly different across 12 weeks of obesity fitness management simultaneously.

Table 4.4.2.4: Tests of Between-Subjects Effects

Measure: MEASURE_1						
Transformed Variable: Average						
Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	1068895.051	1	1068895.051	4203.670	.000	.979
Group	669.120	2	334.560	1.316	.273	.029
Error	22630.619	89	254.277			

As in Table 4.4.2.4, the three types of groups do not have a statistical significance difference between groups (Sig. = 0.273 > 0.05).

Table 4.4.2.5: Pairwise Comparisons

Measure: MEASURE_1						
(I) pre.post.program	(J) pre.post.program	Mean Difference (I-J)	Std. Error	Sig.^{b}	95% Confidence Interval for Difference^b Lower Bound	95% Confidence Interval for Difference^b Upper Bound
1	2	4.625*	.383	.000	3.864	5.386
2	1	-4.625*	.383	.000	-5.386	-3.864
Based on estimated marginal means						
*. The mean difference is significant at the .05 level.						
b. Adjustment for multiple comparisons: Bonferroni.						

As in Table 4.4.2.5, there is a significant change from time 1 (pre- test/before 12 weeks fitness management) to time 2 (post-test/after 12 weeks fitness management) (Sig. = 0.00 < 0.05).

The profile plot for comparison between treatment & control groups in weight loss is shown in Figure 4.4.2.6 below:

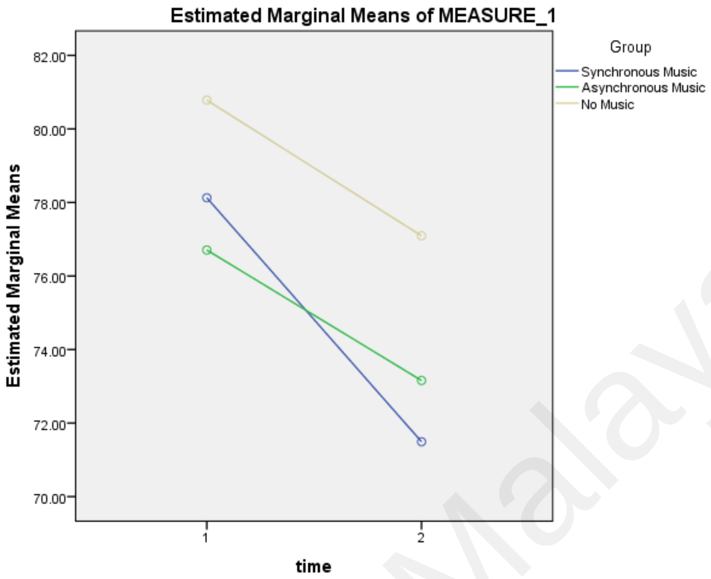

Figure 4.4.2.6: Weight Loss Profile plot for comparison between treatment & control groups in weight loss

4.4.3: Body Composition – Body Fat

Table 4.4.3: Descriptive Statistics of Body Fat

	Group	Mean	Std. Deviation	N
PerBodyfat.Pre	Synchronous Music	34.7681	3.23184	31
	Asynchronous Music	34.8329	3.47697	31
	No Music	34.5581	2.34741	30
	Total	34.7215	3.03292	92
PerBodyfat.Post	Synchronous Music	31.1895	2.96123	31
	Asynchronous Music	32.3464	3.32918	31
	No Music	31.5222	1.78889	30
	Total	31.6878	2.79391	92

By looking at the descriptive statistics table, all of the groups have a difference in body fat before (body fat.pre) and after (body fat.post) 12 weeks fitness management program. In addition, Synchronous Music group shows a larger difference of body fat compare to the other groups as shown in Figure 4.4.3 below:

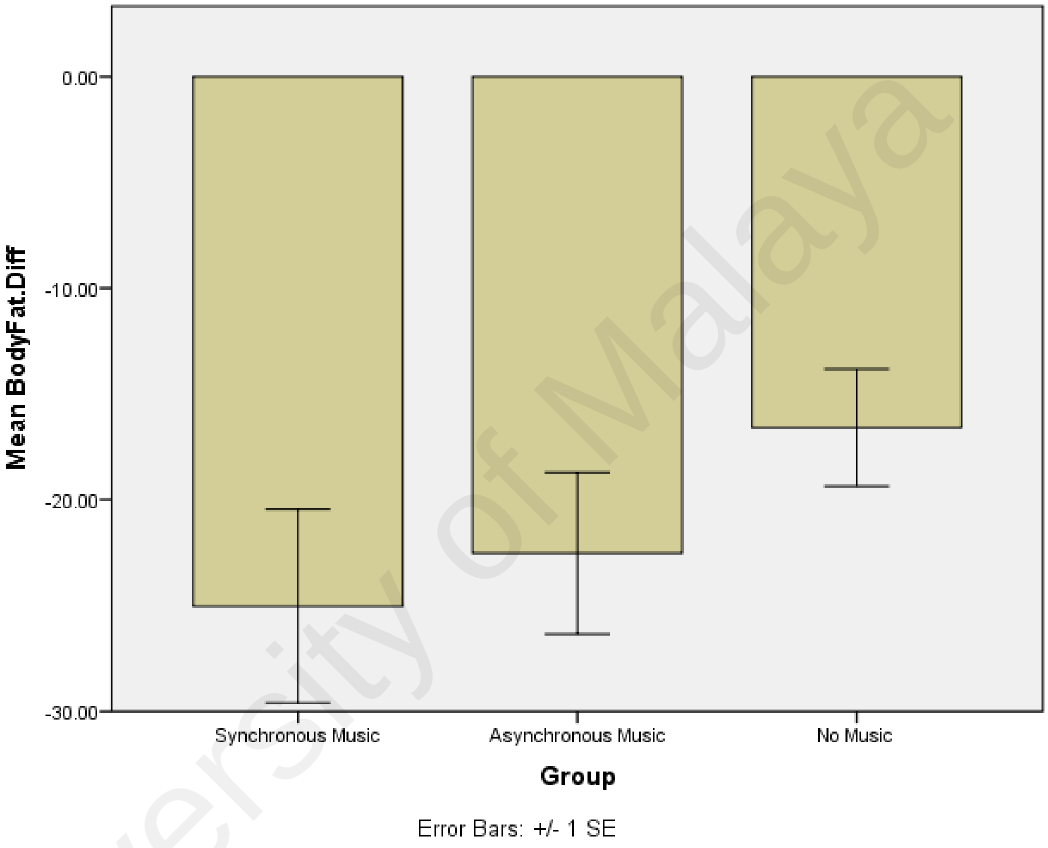

Figure 4.4.3: Body Fat Difference

Next, we use SPANOVA (Split-Plot ANOVA) to investigate the significant difference of body fat between groups by time. There are two assumption need to fulfil before using SPANOVA.

Table 4.4.3.1: Levene's Test of Equality of Error Variance^a

	F	df1	df2	Sig.
PerBodyfat.Pre	2.177	2	89	.119
PerBodyfat.Post	3.941	2	89	.023
Tests the null hypothesis that the error variance of the dependent variable is equal across groups.				
a. Design: Intercept + Group Within Subjects Design: pre.post				

Since the significance value of both body fat.pre and body fat.post are > 0.01, we may use the Split-Plot ANOVA analysis because both of them have equal variance.

Table 4.4.3.2: Box's Test of Equality of Covariance Matricesa

Box's M	14.951
F	2.411
df1	6
df2	196116.265
Sig.	.025
Tests the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups.	
a. Design: Intercept + Group Within Subjects Design: pre.post	

The significance value Box's test of equality of covariance matrices is > 0.01, we use the Wilks' Lambda test.

Table 4.4.3.3: SPANOVA: Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.
pre.post	Pillai's Trace	.588	126.852[b]	1.000	89.000	.000
	Wilks' Lambda	.412	126.852[b]	1.000	89.000	.000
	Hotelling's Trace	1.425	126.852[b]	1.000	89.000	.000
	Roy's Largest Root	1.425	126.852[b]	1.000	89.000	.000
pre.post * Group	Pillai's Trace	.030	1.385[b]	2.000	89.000	.256
	Wilks' Lambda	.970	1.385[b]	2.000	89.000	.256
	Hotelling's Trace	.031	1.385[b]	2.000	89.000	.256
	Roy's Largest Root	.031	1.385[b]	2.000	89.000	.256

a. Design: Intercept + Group

Within Subjects Design: pre.post

b. Exact statistic

From the Multivariate Tests table, we use the Wilks' Lambda test (since one of two assumptions above violated) to test whether there are differences between the means of identified groups of subjects on a combination of times (before and after 12 weeks fitness management). Since the significance value (Sig.=0.256) is > 0.05, we conclude that the mean score of three groups, synchronous music, asynchronous music and no music, is not significantly different in body fat across 12 weeks of obesity fitness management simultaneously.

Table 4.4.3.4: Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	202798.694	1	202798.694	14706.979	.000
Group	13.978	2	6.989	.507	.604
Error	1227.246	89	13.789		

Table 4.4.3.5: Pairwise Comparisons

Measure: MEASURE_1

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a]	
					Lower Bound	Upper Bound
Synchronous Music	Asynchronous Music	-.611	.667	1.000	-2.238	1.017
	No Music	-.061	.672	1.000	-1.702	1.580
Asynchronous Music	Synchronous Music	.611	.667	1.000	-1.017	2.238
	No Music	.550	.672	1.000	-1.091	2.190
No Music	Synchronous Music	.061	.672	1.000	-1.580	1.702
	Asynchronous Music	-.550	.672	1.000	-2.190	1.091

Based on estimated marginal means

a. Adjustment for multiple comparisons: Bonferroni.

The three types of groups do not have a significance difference of body fat between groups (Sig.=0.604 > 0.05).

Table 4.4.3.7: Pairwise Comparisons

(I) pre.post	(J) pre.post	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
1	2	3.034*	.269	.000	2.498	3.569
2	1	-3.034*	.269	.000	-3.569	-2.498

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

There is a significant change from time 1 (pre test/before 12 weeks fitness management) to time 2 (post test/after 12 weeks fitness management) (Sig.=0.00 < 0.05). Therefore, the main effect for Weight Loss is time (pre-post).

The Profile plot for comparison between treatment & control groups in body fat is shown in Figure 4.4.3.8

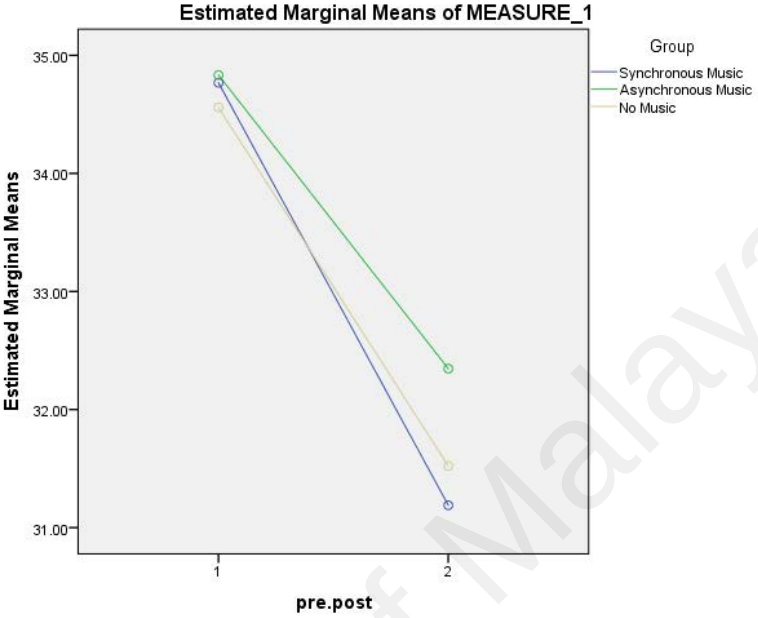

Figure 4.4.3.8: Profile plot for comparison between treatment & control groups in body fat

4.4.4: Body Composition – Waist

Table 4.4.4: Waist - Descriptive Statistics

	Group	Mean	Std. Deviation	N
Waist.Pre	Synchronous Music	36.2581	3.88345	31
	Asynchronous Music	36.3387	3.91235	31
	No Music	36.9667	2.60283	30
	Total	36.5163	3.50388	92
Waist.Post	Synchronous Music	33.6452	2.96983	31
	Asynchronous Music	34.4194	3.29165	31
	No Music	34.9610	2.39117	30
	Total	34.3351	2.93180	92

By looking at the descriptive statistics Table 4.4.4, all of the groups have a difference in waist before (waist.pre) and after (waist.post) 12 weeks fitness management program.

In addition, Synchronous Music group shows a larger difference of waist compared to the other groups as shown in Figures 4.4.4.

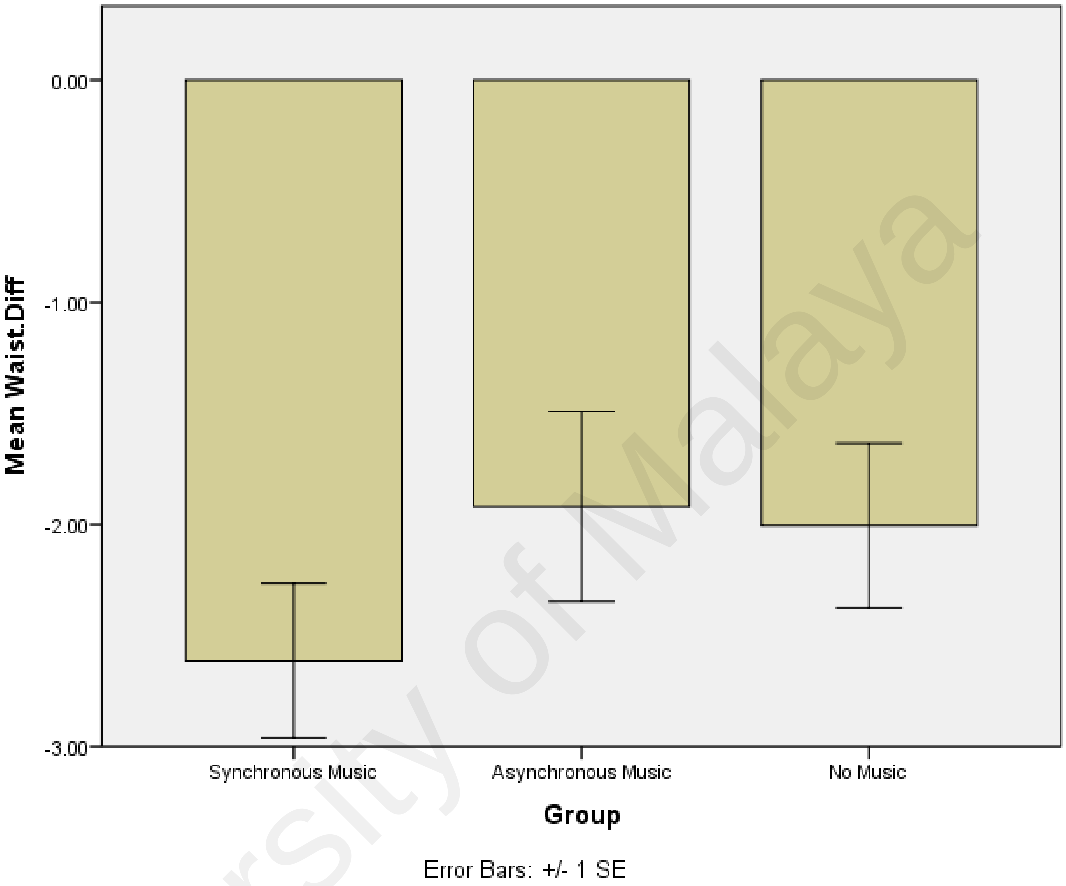

Figure 4.4.4: Waist Reduction

Next, we use SPANOVA (Split-Plot ANOVA) to investigate the significant difference of waist between groups by time. There are two assumption that needs to be fulfilled before using SPANOVA.

Table 4.4.4.1: Levene's Test of Equality of Error Variances^{a}

	F	df1	df2	Sig.
Waist.Pre	.807	2	89	.449
Waist.Post	.941	2	89	.394

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + Group

Within Subjects Design: pre.post

As shown in Table 4.4.4.1, since the significance value of both waist.pre and waist.post are > 0.01, we may use the Split-Plot ANOVA analysis because both of them have equal variance.

Table 4.4.4.2: Box's Test of Equality of Covariance Matricesa

Box's M	8.899
F	1.435
df1	6
df2	196116.265
Sig.	.197

Tests the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups.

a. Design: Intercept + Group

Within Subjects Design: pre.post

As per Table 4.4.4.2, similar result, the significance value Box’s test of equality of covariance matrices is > 0.01, we may use the Wilk’s Lambda test.

Table 4.4.4.3: SPANOVA: Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.	Noncent. Parameter	Observed Power[c]
pre.post	Pillai's Trace	.520	96.573[b]	1.000	89.000	.000	96.573	1.000
	Wilks' Lambda	.480	96.573[b]	1.000	89.000	.000	96.573	1.000
	Hotelling's Trace	1.085	96.573[b]	1.000	89.000	.000	96.573	1.000
	Roy's Largest Root	1.085	96.573[b]	1.000	89.000	.000	96.573	1.000
pre.post * Group	Pillai's Trace	.021	.976[b]	2.000	89.000	.381	1.951	.215
	Wilks' Lambda	.979	.976[b]	2.000	89.000	.381	1.951	.215
	Hotelling's Trace	.022	.976[b]	2.000	89.000	.381	1.951	.215
	Roy's Largest Root	.022	.976[b]	2.000	89.000	.381	1.951	.215

a. Design: Intercept + Group

Within Subjects Design: pre.post

b. Exact statistic

c. Computed using alpha = .05

From the Multivariate Tests Table 4.4.4.3, we use the Wilk's Lambda test (since two assumptions above fulfilled) to test whether there are differences of waist between the means of identified groups of subjects on a combination of times (before and after 12 weeks fitness management). Since the significance value (Sig.=0.381) is greater than 0.05, we conclude that the mean score of three groups, synchronous music, asynchronous music and no music, is not significantly different of waist across 12 weeks of obesity fitness management simultaneously.

Table 4.4.4.4: Table Tests of Between-Subjects Effects

Measure: MEASURE_1							
Transformed Variable: Average							
Source	Type III Sum of Squares	f	Mean Square	F	Sig.	Noncent. Parameter	Observed Power[a]
Intercept	230936.704		230936.704	12364.686	.000	12364.686	1.000
Group	31.445		15.723	.842	.434	1.684	.190
Error	1662.264	9	18.677				

a. Computed using alpha = .05

Table 4.4.4.5: Table Pairwise Comparisons

Measure: MEASURE_1						
					95% Confidence Interval for Difference[a]	
(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.[a]	Lower Bound	Upper Bound
Synchronous Music	Asynchronous Music	-.427	.776	1.000	-2.321	1.467
	No Music	-1.012	.783	.598	-2.922	.897
Asynchronous Music	Synchronous Music	.427	.776	1.000	-1.467	2.321
	No Music	-.585	.783	1.000	-2.495	1.325
No Music	Synchronous Music	1.012	.783	.598	-.897	2.922
	Asynchronous Music	.585	.783	1.000	-1.325	2.495

Based on estimated marginal means

a. Adjustment for multiple comparisons: Bonferroni.

The three types of groups do not have a statistical significance difference of waist between groups (Sig. = 0.434 >0.05).

Table 4.4.4.6: Pairwise Comparisons

Measure: MEASURE_1

(I) pre.post	(J) pre.post	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
1	2	2.179*	.222	.000	1.739	2.620
2	1	-2.179*	.222	.000	-2.620	-1.739

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

There is a significant change from time 1 (pre-test/before 12 weeks fitness management) to time 2 (post-test/after 12 weeks fitness management) (Sig. = 0.00 < 0.05).

The profile plot for comparison between treatment & control groups in Body composition – Waist is shown in Figure 4.4.4.7 below:

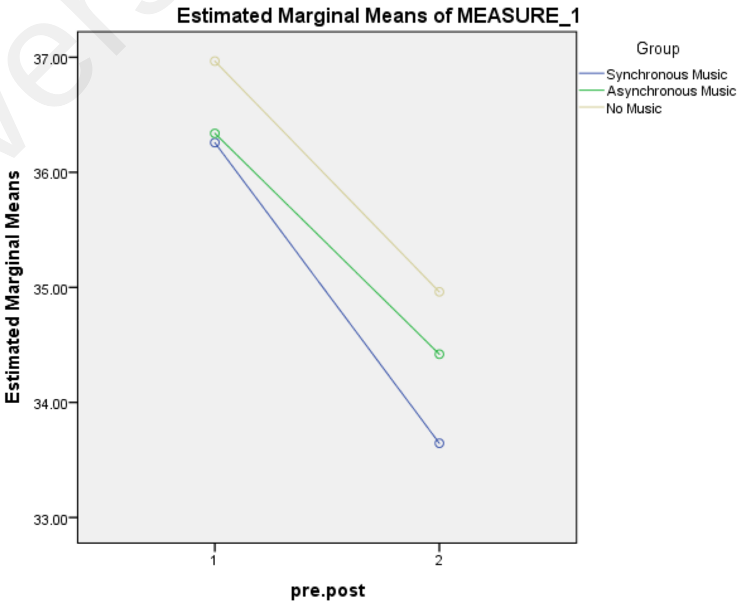

Figure 4.4.4.7: Waist: Profile plot for comparison between treatment & control groups in Waist

4.4.5: Body Composition - Waist-to-Hip

Table 4.4.5: Descriptive Statistics

	Group	Mean	Std. Deviation	N
Waist.Hip.Pre	Synchronous Music	.8376	.05370	31
	Asynchronous Music	.8363	.05769	31
	No Music	.8221	.05155	30
	Total	.8321	.05425	92
Waist.Hip.Post	Synchronous Music	.8446	.06803	31
	Asynchronous Music	.8483	.05598	31
	No Music	.8292	.05195	30
	Total	.8408	.05905	92

By looking at the descriptive statistics table 4.4.5, all of the groups have a difference in waist to hip before (Waist.Hip.pre) and after (Waist.Hip.post) 12 weeks fitness management program. In addition, Asynchronous Music group shows a larger difference of waist-to-hip compared to the other groups as shown in Figures 4.4.5.

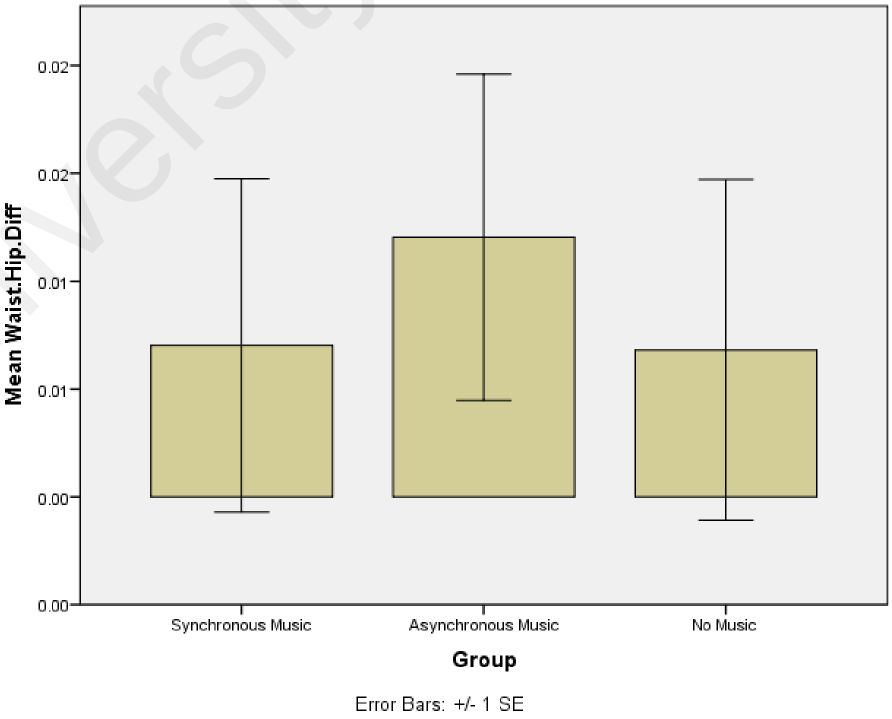

Figure 4.4.5: Waist-to-Hip Difference

Next, we use SPANOVA (Split-Plot ANOVA) to investigate the significant difference of waist to hip between groups by time. There are two assumption need to fulfil before using SPANOVA.

Table 4.4.5.1: Levene's Test of Equality of Error Variances[a]

	F	df1	df2	Sig.
Waist.Hip.Pre	.054	2	89	.947
Waist.Hip.Post	.142	2	89	.868

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + Group

Within Subjects Design: pre.post

As per Table 4.4.5.1, since the significance value of both Waist.Hip.pre and Waist.Hip.post are > 0.01, we may use the Split-Plot ANOVA analysis because both of them have equal variance.

Table 4.4.5.2: Box's Test of Equality of Covariance Matricesa

Box's M	4.032
F	.650
df1	6
df2	196116.265
Sig.	.690

Tests the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups.

a. Design: Intercept + Group

Within Subjects Design: pre.post

As shown in Table 4.4.5.2, similar result, the significance value Box’s test of equality of covariance matrices is > 0.01, we may use the Wilk’s Lambda test.

Table 4.4.5.3: SPANOVA:Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.	Noncent. Parameter	Observed Power[c]
pre.post	Pillai's Trace	041	3.764[b]	1.000	89.000	.056	3.764	.484
	Wilks' Lambda	.959	3.764[b]	1.000	89.000	.056	3.764	.484
	Hotelling's Trace	.042	3.764[b]	1.000	89.000	.056	3.764	.484
	Roy's Largest Root	.042	3.764[b]	1.000	89.000	.056	3.764	.484
pre.post * Group	Pillai's Trace	.003	.140[b]	2.000	89.000	.870	.280	.071
	Wilks' Lambda	.997	.140[b]	2.000	89.000	.870	.280	.071
	Hotelling's Trace	.003	.140[b]	2.000	89.000	.870	.280	.071
	Roy's Largest Root	.003	.140[b]	2.000	89.000	.870	.280	.071

a. Design: Intercept + Group

Within Subjects Design: pre.post

b. Exact statistic

c. Computed using alpha = .05

From the Multivariate Tests Table 4.4.5.3, we use the Wilk's Lambda test (since two assumptions above fulfilled) to test whether there are differences of waist to hip between the means of identified groups of subjects on a combination of times (before and after 12 weeks fitness management). Since the significance value (Sig.=0.280) is > 0.05, we conclude that the mean score of three groups, synchronous music, asynchronous music and no music, is not significantly different in waist to hip across 12 weeks of obesity fitness management simultaneously.

Table 4.4.5.4: Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	f	Mean Square	F	Sig.	Noncent. Parameter	Observed Power[a]
Intercept	128.671		128.671	23263.460	.000	23263.460	1.000
Group	.010		.005	.942	.394	1.884	.209
Error	.492	9	.006				

a. Computed using alpha = .05

Table 4.4.5.5: Pairwise Comparisons

Measure: MEASURE_1

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a]	
					Lower Bound	Upper Bound
Synchronous Music	Asynchronous Music	-.001	.013	1.000	-.034	.031
	No Music	.015	.013	.767	-.017	.048
Asynchronous Music	Synchronous Music	.001	.013	1.000	-.031	.034
	No Music	.017	.013	.661	-.016	.049
No Music	Synchronous Music	-.015	.013	.767	-.048	.017
	Asynchronous Music	-.017	.013	.661	-.049	.016

Based on estimated marginal means

a. Adjustment for multiple comparisons: Bonferroni.

The three types of groups do not have a statistical significance difference of waist to hip between groups (Sig. = 0.394 >0.05).

Table 4.4.5.6: Pairwise Comparisons

Measure: MEASURE_1						
					95% Confidence Interval for Difference[a]	
(I) pre.post	(J) pre.post	Mean Difference (I-J)	Std. Error	Sig.[a]	Lower Bound	Upper Bound
1	2	-.009	.004	.056	-.018	.000
2	1	.009	.004	.056	.000	.018

Based on estimated marginal means

a. Adjustment for multiple comparisons: Bonferroni.

As shown in Table 4.4.5.6, there is no significant change from time 1 (pre-test/before 12 weeks fitness management) to time 2 (post-test/after 12 weeks fitness management) (Sig.=0.056 > 0.05).

The profile plot for body composition – waist to hip ratio is shown below in Table 4.4.5.7.

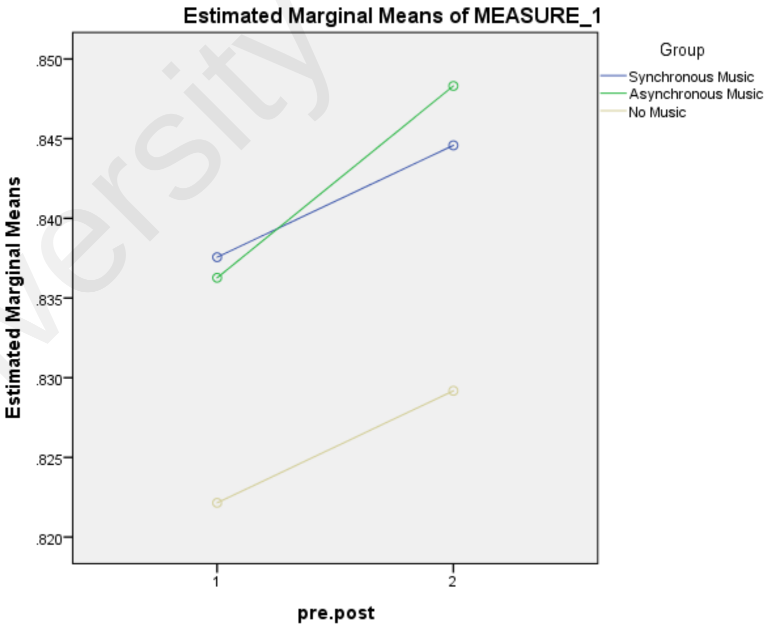

Figure 4.4.5.7: Waist-to-Hip: Profile plot for comparison between treatment & control groups in Waist-to-Hip

4.4.6: Fitness - Push Up

Table 4.4.6: Descriptive Statistics

	Group	Mean	Std. Deviation	N
PushUp.Pre	Synchronous Music	7.5161	5.25909	31
	Asynchronous Music	8.8387	5.48390	31
	No Music	8.7667	4.97361	30
	Total	8.3696	5.22403	92
PushUp.Post	Synchronous Music	20.4516	6.64750	31
	Asynchronous Music	18.7419	5.99982	31
	No Music	16.9000	6.84987	30
	Total	18.7174	6.59558	92

By looking at the descriptive statistics Table 4.4.6, all of the groups have a difference in push up before (push up.pre) and after (push up.post) 12 weeks fitness management program. In addition, Synchronous Music group shows a larger difference of push up compare to the other groups as shown in Figure 4.4.6a.

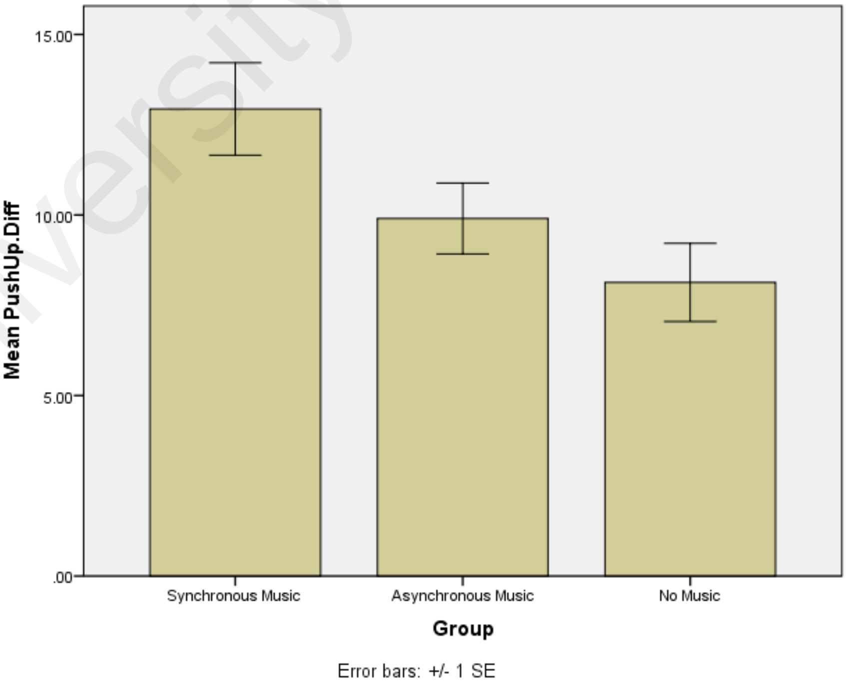

Figure 4.4.6 Push Up Difference

Next, we use SPANOVA (Split-Plot ANOVA) to investigate the significant difference of push up between groups by time. There are two assumption need to fulfill before using SPANOVA;

Table 4.4.6.1: Levene's Test of Equality of Error Variances^a

	F	df1	df2	Sig.
PushUp.Pre	.101	2	89	.904
PushUp.Post	.682	2	89	.508

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + Group

Within Subjects Design: pre.post

Since the significance value of both push up.pre and push up.post are > 0.01, meaning that both of them have equal variance.

Table 4.4.6.2: Box's Test of Equality of Covariance Matrices^a

Box's M	3.489
F	.563
df1	6
df2	196116.265
Sig.	.760

Tests the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups.

a. Design: Intercept + Group

Within Subjects Design: pre.post

Similar result, the significance value Box’s test of equality of covariance matrices is > 0.01, we may use the Wilk’s Lambda test.

Table 4.4.6.3: SPANOVA:Multivariate Tests^a

Effect		Value	F	Hypothesis df	Error df	Sig.	Noncent. Parameter	Observed Power^c
pre.post	Pillai's Trace	.041	3.764^b	1.000	89.000	.056	3.764	.484
	Wilks' Lambda	.959	3.764^b	1.000	89.000	.056	3.764	.484
	Hotelling's Trace	.042	3.764^b	1.000	89.000	.056	3.764	.484
	Roy's Largest Root	.042	3.764^b	1.000	89.000	.056	3.764	.484
pre.post * Group	Pillai's Trace	.003	.140^b	2.000	89.000	.870	.280	.071
	Wilks' Lambda	.997	.140^b	2.000	89.000	.870	.280	.071
	Hotelling's Trace	.003	.140^b	2.000	89.000	.870	.280	.071
	Roy's Largest Root	.003	.140^b	2.000	89.000	.870	.280	.071

a. Design: Intercept + Group

Within Subjects Design: pre.post

b. Exact statistic

c. Computed using alpha = .05

From the Multivariate Tests Table 4.4.6.3, we use the Wilk’s Lambda test (since two assumptions above fulfilled) to test whether there are differences of push up between the means of identified groups of subjects on a combination of times (before and after 12 weeks fitness management). Since the significance value (Sig.=0.870) is > 0.05, we conclude that the mean score of three groups, synchronous music, asynchronous music and no music, is not significantly different in push up across 12 weeks of obesity fitness management simultaneously.

Table 4.4.6.4: Tests of Between-Subjects Effects

Measure: MEASURE_1							
Transformed Variable: Average							
Source	Type III Sum of Squares	f	Mean Square	F	Sig.	Noncent. Parameter	Observed Power[a]
Intercept	33704.247		33704.247	666.952	.000	666.952	1.000
Group	46.061		23.030	.456	.635	.911	.122
Error	4497.591	9	50.535				
a. Computed using alpha = .05							

Table 4.4.6.5: Pairwise Comparisons

Measure: MEASURE_1						
					95% Confidence Interval for Difference[a]	
(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.[a]	Lower Bound	Upper Bound
Synchronous Music	Asynchronous Music	.194	1.277	1.000	-2.922	3.309
	No Music	1.151	1.287	1.000	-1.991	4.292
Asynchronous Music	Synchronous Music	-.194	1.277	1.000	-3.309	2.922
	No Music	.957	1.287	1.000	-2.184	4.098
No Music	Synchronous Music	-1.151	1.287	1.000	-4.292	1.991
	Asynchronous Music	-.957	1.287	1.000	-4.098	2.184
Based on estimated marginal means						
a. Adjustment for multiple comparisons: Bonferroni.						

The three types of groups do not have a statistical significance difference of push up between groups (Sig.=0.635 > 0.05).

Table 4.4.6.6: Pairwise Comparisons

Measure: MEASURE_1						
					95% Confidence Interval for Difference^b	
(I) pre.post	(J) pre.post	Mean Difference (I-J)	Std. Error	Sig.^{b}	Lower Bound	Upper Bound
1	2	-10.324*	.648	.000	-11.611	-9.037
2	1	10.324*	.648	.000	9.037	11.611
Based on estimated marginal means						
*. The mean difference is significant at the .05 level.						
b. Adjustment for multiple comparisons: Bonferroni.						

As shown in Table 4.4.6.6, there is a significant change from time 1 (pre test/before 12 weeks fitness management) to time 2 (post test/after 12 weeks fitness management) (Sig.=0.000 < 0.05).

The Profile plot for comparison between treatment & control groups in Push Ups is shown in Figure 4.4.6.7 below:

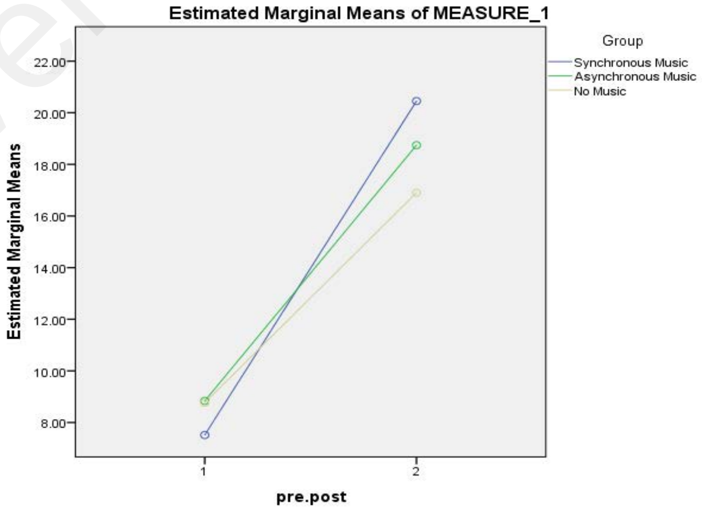

Figure 4.4.6.7: Fitness – Push Ups: Profile plot for comparison between treatment & control groups in Push Ups

4.4.7: Fitness - Curl-Up

Table 4.4.7: Descriptive Statistics

	Group	Mean	Std. Deviation	N
CurlUp.Pre	Synchronous Music	9.4839	6.22292	31
	Asynchronous Music	10.1613	5.59819	31
	No Music	8.7333	5.09180	30
	Total	9.4674	5.63047	92
CurlUp.Post	Synchronous Music	26.3226	10.36786	31
	Asynchronous Music	20.4839	7.12213	31
	No Music	18.6667	5.98465	30
	Total	21.8587	8.62348	92

By looking at the descriptive statistics Table 4.4.7, all of the groups have a difference in curl up before (curl up.pre) and after (curl up.post) 12 weeks fitness management program. In addition, Synchronous Music group shows a larger difference of curl up compare to the other groups as shown in Figure 4.4.7a.

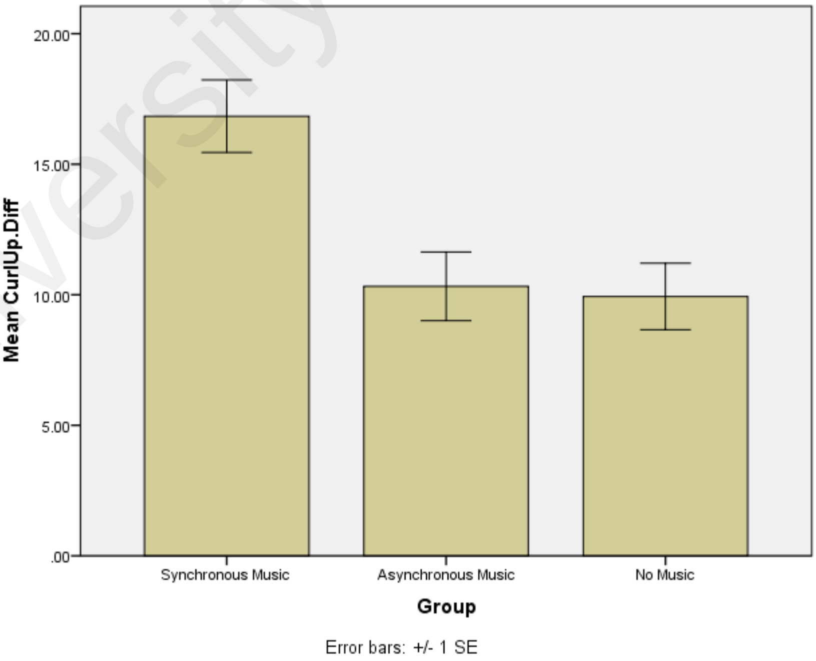

Figure 4.4.7: Curl Up Difference

Next, we use SPANOVA (Spli-Plot ANOVA) to investigate the significant difference of curl up between groups by time. There are two assumption need to fulfill before using SPANOVA.

Table 4.4.7.1: Levene's Test of Equality of Error Variances[a]

	F	df1	df2	Sig.
CurlUp.Pre	.136	2	89	.873
CurlUp.Post	2.627	2	89	.078
Tests the null hypothesis that the error variance of the dependent variable is equal across groups.				
a. Design: Intercept + Group Within Subjects Design: pre.post				

Since the significance value of both curl up.pre and curl up.post are > 0.01, meaning that both of them have equal variance.

Table 4.4.7.2: Box's Test of Equality of Covariance Matrices[a]

Box's M	11.862
F	1.913
df1	6
df2	196116.265
Sig.	.075
Tests the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups.	
a. Design: Intercept + Group Within Subjects Design: pre.post	

Similar result, the significance value Box's test of equality of covariance matrices is > 0.01, we may use the Wilk's Lambda test.

Table 4.4.7.3: SPANOVA: Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.	Noncent. Parameter	Observed Power[c]
pre.post	Pillai's Trace	.745	259.831[b]	1.000	89.000	.000	259.831	1.000
	Wilks' Lambda	.255	259.831[b]	1.000	89.000	.000	259.831	1.000
	Hotelling's Trace	2.919	259.831[b]	1.000	89.000	.000	259.831	1.000
	Roy's Largest Root	2.919	259.831[b]	1.000	89.000	.000	259.831	1.000
pre.post * Group	Pillai's Trace	.161	8.565[b]	2.000	89.000	.000	17.130	.963
	Wilks' Lambda	.839	8.565[b]	2.000	89.000	.000	17.130	.963
	Hotelling's Trace	.192	8.565[b]	2.000	89.000	.000	17.130	.963
	Roy's Largest Root	.192	8.565[b]	2.000	89.000	.000	17.130	.963

a. Design: Intercept + Group

Within Subjects Design: pre.post

b. Exact statistic

c. Computed using alpha = .05

From the Multivariate Tests Table 4.4.7.3, we use the Wilk's Lambda test (since two assumptions above fulfilled) to test whether there are differences of curl up between the means of identified groups of subjects on a combination of times (before and after 12 weeks fitness management). Since the significance value (Sig.=0.000) is < 0.05, we conclude that the mean score of three groups, synchronous music, asynchronous music and no music, is significantly different in curl up across 12 weeks of obesity fitness management simultaneously.

Table 4.4.7.4: Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	f	Mean Square	F	Sig.	Noncent. Parameter	Observed Power[a]
Intercept	45008.552		45008.552	642.921	.000	642.921	1.000
Group	549.541		274.770	3.925	.023	7.850	.693
Error	6230.568	9	70.006				

a. Computed using alpha = .05

Table 4.4.7.5 Pairwise Comparisons

Measure: MEASURE_1

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
Synchronous Music	Asynchronous Music	2.581	1.503	.268	-1.086	6.247
	No Music	4.203*	1.515	.020	.506	7.900
Asynchronous Music	Synchronous Music	-2.581	1.503	.268	-6.247	1.086
	No Music	1.623	1.515	.861	-2.075	5.320
No Music	Synchronous Music	-4.203*	1.515	.020	-7.900	-.506
	Asynchronous Music	-1.623	1.515	.861	-5.320	2.075

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

The three types of groups do have a statistical significance difference of curl ups between groups (Sig. = 0.023 < 0.05). The mean difference of curl ups between Synchronous Music and No Music is significant at the 0.05 level.

Table 4.4.7.6: Pairwise Comparisons

Measure: MEASURE_1						
					95% Confidence Interval for Difference[b]	
(I) pre.post	(J) pre.post	Mean Difference (I-J)	Std. Error	Sig.[b]	Lower Bound	Upper Bound
1	2	-12.365*	.767	.000	-13.889	-10.841
2	1	12.365*	.767	.000	10.841	13.889

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

There is a significant change from time 1 (pre-test/before 12 weeks fitness management) to time 2 (post-test/after 12 weeks fitness management) (Sig.=0.000 < 0.05).

The Profile plot for comparison between treatment & control groups in Curl Ups is shown in Figure 4.4.7.7 below:

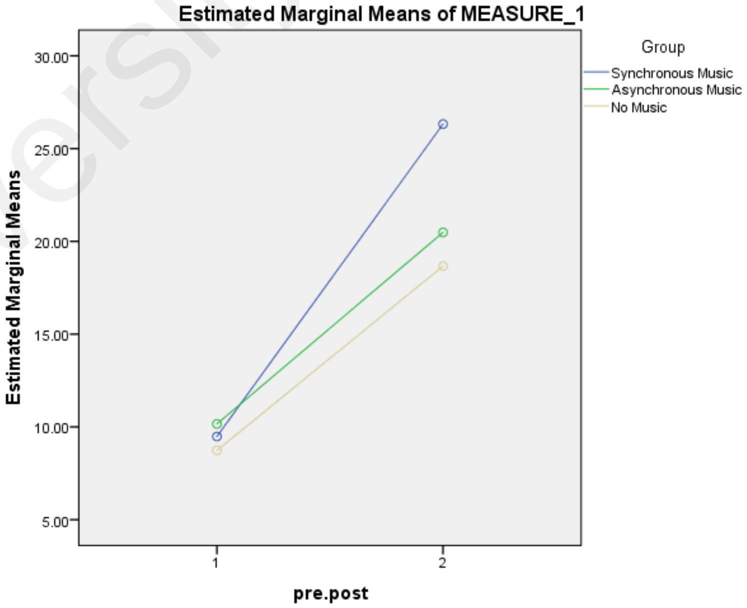

Figure 4.4.7.7: Curl Ups: Profile plot for comparison between treatment & control groups in Curl Ups

4.4.8: Fitness - Bodyweight Squats

Table 4.4.8: Descriptive Statistics

	Group	Mean	Std. Deviation	N
Squat.Pre	Synchronous Music	10.5161	8.95124	31
	Asynchronous Music	12.1613	14.64490	31
	No Music	11.5000	9.25780	30
	Total	11.3913	11.17587	92
Squat.Post	Synchronous Music	37.2258	13.47024	31
	Asynchronous Music	32.1290	18.69535	31
	No Music	24.1333	9.33194	30
	Total	31.2391	15.22893	92

By looking at the descriptive statistics Table 4.4.8, all of the groups have a difference in bodyweight squats before (bodyweight squats.pre) and after (bodyweight squats.post) 12 weeks fitness management program. In addition, Synchronous Music group shows a larger difference of bodyweight squats compare to the other groups as shown in Figure 4.4.8a.

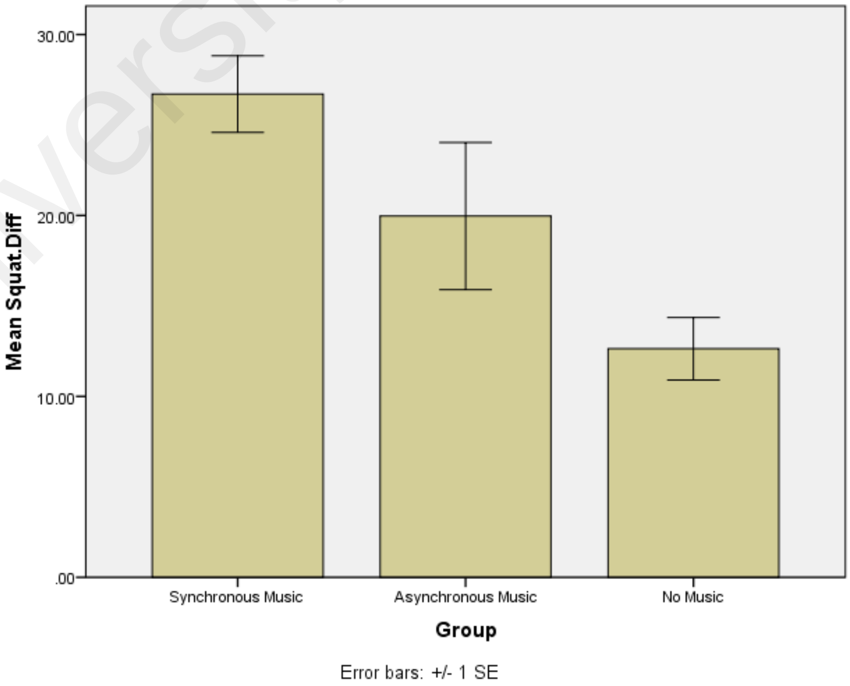

Figure 4.4.8: Bodyweight Squat Difference

Next, we use SPANOVA (Split-Plot ANOVA) to investigate the significant difference of bodyweight squats between groups by time. There are two assumption need to fulfil before using SPANOVA.

Table 4.4.8.1: Levene's Test of Equality of Error Variances^{a}

	F	df1	df2	Sig.
Squat.Pre	.535	2	89	.587
Squat.Post	1.725	2	89	.184
Tests the null hypothesis that the error variance of the dependent variable is equal across groups.				
a. Design: Intercept + Group Within Subjects Design: pre.post				

Since the significance value of both squat.pre and squat.post are > 0.01, meaning that both of them have equal variance.

Table 4.4.8.2: Box's Test of Equality of Covariance Matrices^{a}

Box's M	33.643
F	5.425
df1	6
df2	196116.265
Sig.	.000
Tests the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups.	
a. Design: Intercept + Group Within Subjects Design: pre.post	

The significance value Box’s test of equality of covariance matrices is < 0.01, we may use the Pillai’s Trace test.

Table 4.4.8.3: SPANOVA: Table Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.	Noncent. Parameter	Observed Power[c]
pre.post	Pillai's Trace	.619	144.555[b]	1.000	89.000	.000	144.555	1.000
	Wilks' Lambda	.381	144.555[b]	1.000	89.000	.000	144.555	1.000
	Hotelling's Trace	1.624	144.555[b]	1.000	89.000	.000	144.555	1.000
	Roy's Largest Root	1.624	144.555[b]	1.000	89.000	.000	144.555	1.000
pre.post * Group	Pillai's Trace	.120	6.075[b]	2.000	89.000	.003	12.149	.876
	Wilks' Lambda	.880	6.075[b]	2.000	89.000	.003	12.149	.876
	Hotelling's Trace	.137	6.075[b]	2.000	89.000	.003	12.149	.876
	Roy's Largest Root	.137	6.075[b]	2.000	89.000	.003	12.149	.876

a. Design: Intercept + Group

Within Subjects Design: pre.post

b. Exact statistic

c. Computed using alpha = .05

From the Multivariate Tests Table 4.4.8.3, we use the Wilk's Lambda test (since two assumptions above fulfilled) to test whether there are differences of bodyweight squats between the means of identified groups of subjects on a combination of times (before and after 12 weeks fitness management). Since the significance value (Sig.=0.003) is < 0.05, we conclude that the mean score of three groups, synchronous music, asynchronous music and no music, is significantly different in bodyweight squats across 12 weeks of obesity fitness management simultaneously.

Table 4.4.8.4: Tests of Between-Subjects Effects

Measure: MEASURE_1							
Transformed Variable: Average							
Source	Type III Sum of Squares	f	Mean Square	F	Sig.	Noncent. Parameter	Observed Power[a]
Intercept	83283.560		83283.560	396.151	.000	396.151	1.000
Group	1182.073		591.036	2.811	.065	5.623	.540
Error	18710.645	9	210.232				
a. Computed using alpha = .05							

Table 4.4.8.5: Pairwise Comparisons

Measure: MEASURE_1						
					95% Confidence Interval for Difference[a]	
(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.[a]	Lower Bound	Upper Bound
Synchronous Music	Asynchronous Music	1.726	2.604	1.000	-4.629	8.080
	No Music	6.054	2.626	.070	-.353	12.461
Asynchronous Music	Synchronous Music	-1.726	2.604	1.000	-8.080	4.629
	No Music	4.328	2.626	.308	-2.079	10.736
No Music	Synchronous Music	-6.054	2.626	.070	-12.461	.353
	Asynchronous Music	-4.328	2.626	.308	-10.736	2.079
Based on estimated marginal means						
a. Adjustment for multiple comparisons: Bonferroni.						

The three types of groups do not have a statistical significance difference of bodyweight squats between groups (Sig. = 0.065 > 0.05).

Table 4.4.8.6: Pairwise Comparisons

Measure: MEASURE_1						
					95% Confidence Interval for Difference[b]	
(I) pre.post	(J) pre.post	Mean Difference (I-J)	Std. Error	Sig.[b]	Lower Bound	Upper Bound
1	2	-19.770*	1.644	.000	-23.038	-16.503
2	1	19.770*	1.644	.000	16.503	23.038
Based on estimated marginal means						
*. The mean difference is significant at the .05 level.						
b. Adjustment for multiple comparisons: Bonferroni.						

As shown in Table 4.4.8.6, there is a significant change from time 1 (pre-test/before 12 weeks fitness management) to time 2 (post-test/after 12 weeks fitness management) (Sig.=0.000 < 0.05).

The Profile plot for comparison between treatment & control groups in Bodyweight Squats is shown in Figure 4.4.8.7 below:

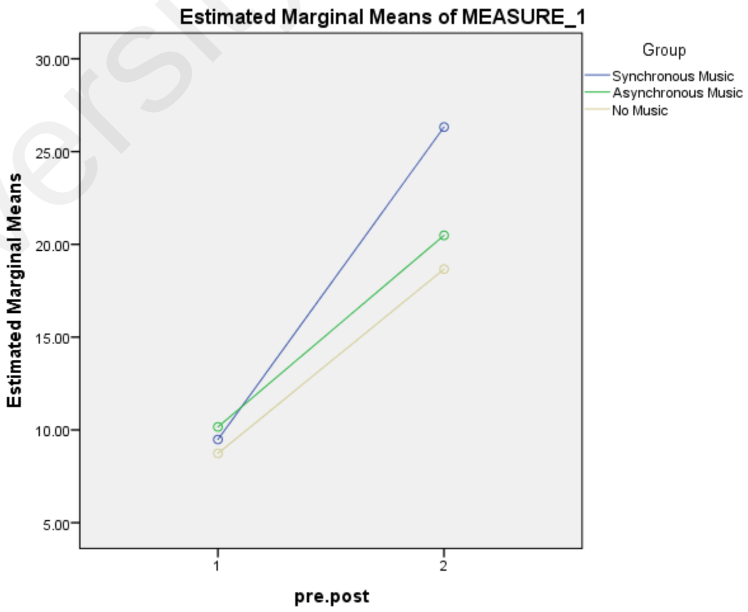

Figure 4.4.8.7: Fitness - Bodyweight Squats: Profile plot for comparison between treatment & control groups in Bodyweight Squats

4.4.9: Fitness - Heart Rate

Table 4.4.9: Descriptive Statistics

	Group	Mean	Std. Deviation	N
HR.Pre	Synchronous Music	74.7419	8.07039	31
	Asynchronous Music	71.0323	5.78783	31
	No Music	75.2333	10.04021	30
	Total	73.6522	8.25877	92
HR.Post	Synchronous Music	69.6774	6.30548	31
	Asynchronous Music	68.1935	6.43127	31
	No Music	71.8667	6.85180	30
	Total	69.8913	6.63235	92

By looking at the descriptive statistics Table 4.4.9, all of the groups have a difference in heart rate before (HR.pre) and after (HR.post) 12 weeks fitness management program. In addition, Synchronous Music group shows a larger difference compare to the other groups as shown in Figure 4.4.9 below:

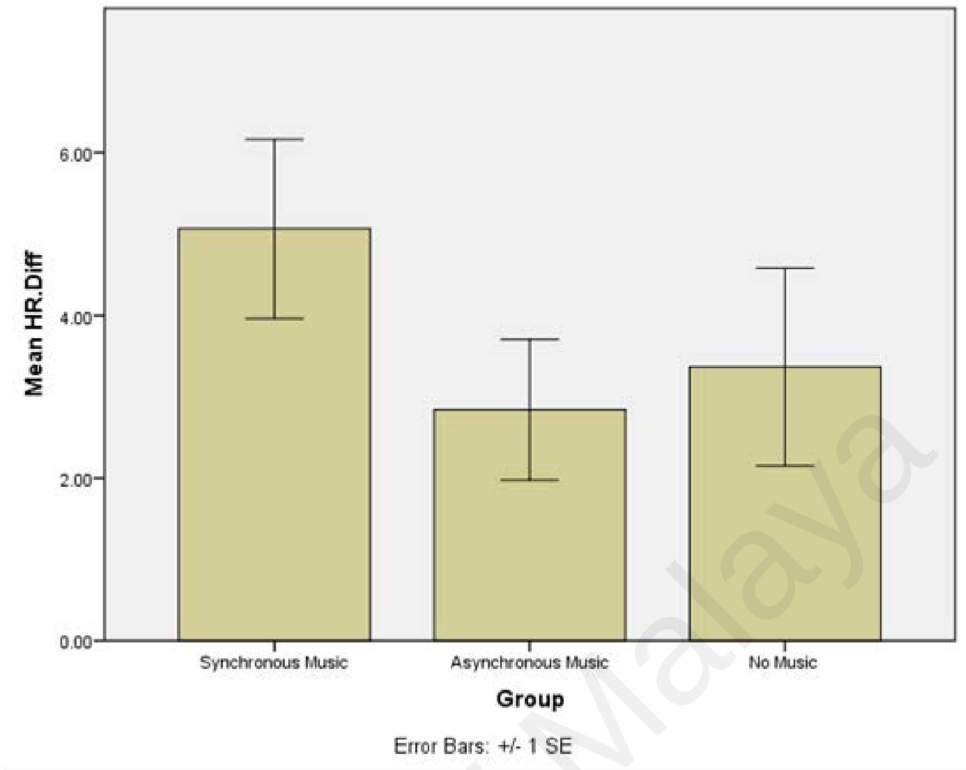

Figure 4.4.9: Heart Rate Difference

Next, we use SPANOVA (Split-Plot ANOVA) to investigate the significant difference of between groups by time. There are two assumption need to be fulfilled before using SPANOVA.

Table 4.4.9.1: Levene's Test of Equality of Error Variances^{a}

	F	df1	df2	Sig.
HR.Pre	2.441	2	89	.093
HR.Post	1.032	2	89	.361
Tests the null hypothesis that the error variance of the dependent variable is equal across groups.				
a. Design: Intercept + Group Within Subjects Design: pre.post				

Since the significance value of both HR.pre and HR.post are > 0.01, we may use the Split-Plot ANOVA analysis because both of them have equal variance.

Table 4.4.9.2: Box's Test of Equality of Covariance Matricesa

Box's M	11.170
F	1.801
df1	6
df2	196116.265
Sig.	.095
Tests the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups.	
a. Design: Intercept + Group Within Subjects Design: pre.post	

The significance value Box's test of equality of covariance matrices is > 0.01, we use the Wilks' Lambda test.

Table 4.4.9.3: SPANOVA: Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.
pre.post	Pillai's Trace	.294	37.134[b]	1.000	89.000	.000
	Wilks' Lambda	.706	37.134[b]	1.000	89.000	.000
	Hotelling's Trace	.417	37.134[b]	1.000	89.000	.000
	Roy's Largest Root	.417	37.134[b]	1.000	89.000	.000
pre.post * Group	Pillai's Trace	.026	1.197[b]	2.000	89.000	.307
	Wilks' Lambda	.974	1.197[b]	2.000	89.000	.307
	Hotelling's Trace	.027	1.197[b]	2.000	89.000	.307
	Roy's Largest Root	.027	1.197[b]	2.000	89.000	.307
a. Design: Intercept + Group Within Subjects Design: pre.post						
b. Exact statistic						

From the Multivariate Tests Table 4.4.9.3, we use the Wilks' Lambda test (since one of two assumptions above violated) to test whether there are differences between the means of identified groups of subjects on a combination of times (before and after 12 weeks fitness management). Since the significance value (Sig.=0.307) is > 0.05, we conclude that the mean score of three groups, synchronous music, asynchronous music and no music, is not significantly different in heart rate across 12 weeks of obesity fitness management simultaneously.

Table 4.4.9.4: Tests of Between-Subjects Effects

Measure: MEASURE_1					
Transformed Variable: Average					
Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Intercept	948096.134	1	948096.134	10389.348	.000
Group	490.579	2	245.290	2.688	.074
Error	8121.834	89	91.257		

A shown in Table 4.4.9.4, the three types of groups do not have a significance difference of resting heart rates between groups (Sig.=0.074 > 0.05).

Table 4.4.9.5: Pairwise Comparisons

Table 4.4.9.5: Pairwise Comparisons						
Measure: MEASURE_1						
					95% Confidence Interval for Difference^b	
(I) pre.post	(J) pre.post	Mean Difference (I-J)	Std. Error	Sig.^{b}	Lower Bound	Upper Bound
1	2	3.757*	.616	.000	2.532	4.982
2	1	-3.757*	.616	.000	-4.982	-2.532
Based on estimated marginal means						
*. The mean difference is significant at the .05 level.						
b. Adjustment for multiple comparisons: Bonferroni.						

As shown in Table 4.4.9.5, there is a significant change from time 1 (pre-test/before 12 weeks fitness management) to time 2 (post-test/after 12 weeks fitness management) (Sig.=0.00 < 0.05).

The profile plot for comparison between treatment & control groups in Heart Rate is shown in Figure 4.4.9.6 below:

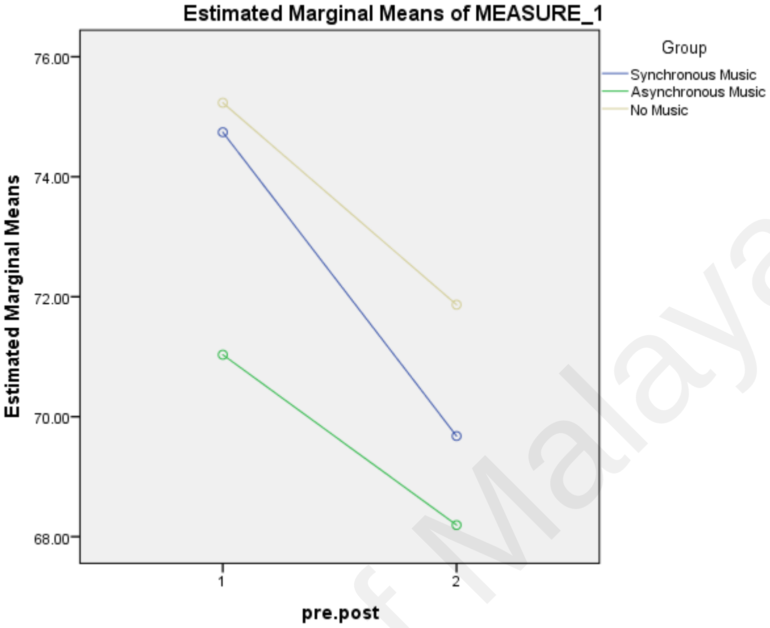

Figure 4.4.9.6: Resting Heart Rate: Profile plot for comparison between treatment & control groups in Resting Heart Rate

4.4.10: Metabolic Profile- Cholesterol

Table 4.4.10: Descriptive Statistics

Table 4.4.10: Descriptive Statistics

	Group	Mean	Std. Deviation	N
Tot.Chol.Pre	Synchronous Music	207.0000	33.54897	31
	Asynchronous Music	198.9032	38.83843	31
	No Music	210.4697	33.42098	30
	Total	205.4032	35.32727	92
Tot.Chol.Post	Synchronous Music	183.1165	28.18268	31
	Asynchronous Music	189.2371	30.71933	31
	No Music	194.5040	23.40733	30
	Total	188.8922	27.73699	92

By looking at the descriptive statistics Table 4.4.10, all of the groups have a difference in total cholesterol before (total cholesterol.pre) and after (total cholesterol.post) 12 weeks fitness management program. In addition, Synchronous

Music group shows a larger difference of total cholesterol compare to the other groups as shown in Figure 4.4.1.0 below:

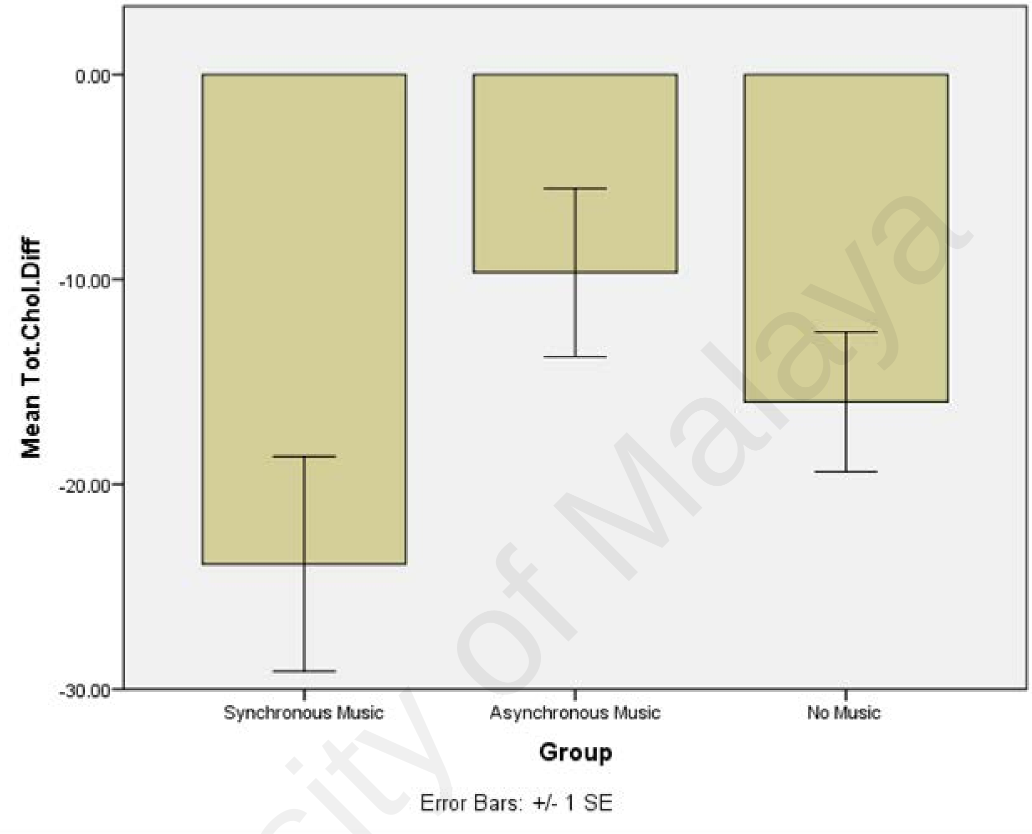

Figure 4.4.1.0: Cholesterol Difference

Next, we use SPANOVA (Split-Plot ANOVA) to investigate the significant difference of total cholesterol between groups by time. There are two assumption need to fulfil before using SPANOVA.

Table 4.4.10.1: Levene's Test of Equality of Error Variances^a

	F	df1	df2	Sig.
Tot.Chol.Pre	.872	2	89	.422
Tot.Chol.Post	1.439	2	89	.243
Tests the null hypothesis that the error variance of the dependent variable is equal across groups.				
a. Design: Intercept + Group Within Subjects Design: pre.post				

Since the significance value of both total cholesterol.pre and total cholesterol.post are > 0.01, meaning that both of them have equal variance.

Table 4.4.10.2: Box's Test of Equality of Covariance Matricesa

Box's M	12.738
F	2.054
df1	6
df2	196116.265
Sig.	.055
Tests the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups.	
a. Design: Intercept + Group Within Subjects Design: pre.post	

The significance value Box's test of equality of covariance matrices is > 0.01, we may use the Wilks' Lambda test.

Table 4.4.10.3: SPANOVA: Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.	Noncent. Parameter	Observed Power[c]
pre.post	Pillai's Trace	.328	43.501[b]	1.000	89.000	.000	43.501	1.000
	Wilks' Lambda	.672	43.501[b]	1.000	89.000	.000	43.501	1.000
	Hotelling's Trace	.489	43.501[b]	1.000	89.000	.000	43.501	1.000
	Roy's Largest Root	.489	43.501[b]	1.000	89.000	.000	43.501	1.000
pre.post * Group	Pillai's Trace	.058	2.731[b]	2.000	89.000	.071	5.462	.527
	Wilks' Lambda	.942	2.731[b]	2.000	89.000	.071	5.462	.527
	Hotelling's Trace	.061	2.731[b]	2.000	89.000	.071	5.462	.527
	Roy's Largest Root	.061	2.731[b]	2.000	89.000	.071	5.462	.527

a. Design: Intercept + Group

Within Subjects Design: pre.post

b. Exact statistic

c. Computed using alpha = .05

From the Multivariate Tests Table 4.4.10.3, we use the Wilk's Lambda test (since two assumptions above fulfilled) to test whether there are differences of total cholesterol between the means of identified groups of subjects on a combination of times (before and after 12 weeks fitness management). Since the significance value (Sig.=0.071) is > 0.05, we conclude that the mean score of three groups, synchronous music, asynchronous music and no music, is not significantly different in total cholesterol across 12 weeks of obesity fitness management simultaneously.

Table 4.4.10.4: Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	f	Mean Square	F	Sig.	Noncent. Parameter	Observed Power[a]
Intercept	7154021.301		7154021.301	4139.678	.000	4139.678	1.000
Group	2568.284		1284.142	.743	.479	1.486	.172
Error	153806.146	9	1728.159				

a. Computed using alpha = .05

Table 4.4.10.5: Pairwise Comparisons

Measure: MEASURE_1

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.^{a}	95% Confidence Interval for Difference^a	
					Lower Bound	Upper Bound
Synchronous Music	Asynchronous Music	.988	7.466	1.000	-17.230	19.207
	No Music	-7.429	7.528	.979	-25.798	10.941
Asynchronous Music	Synchronous Music	-.988	7.466	1.000	-19.207	17.230
	No Music	-8.417	7.528	.800	-26.786	9.953
No Music	Synchronous Music	7.429	7.528	.979	-10.941	25.798
	Asynchronous Music	8.417	7.528	.800	-9.953	26.786

Based on estimated marginal means

a. Adjustment for multiple comparisons: Bonferroni.

The three types of groups do not have a statistical significance difference of total cholesterol between groups (Sig. = 0.479 > 0.05).

Table 4.4.10.6: Pairwise Comparisons

Measure: MEASURE_1

(I) pre.post	(J) pre.post	Mean Difference (I-J)	Std. Error	Sig.^{b}	95% Confidence Interval for Difference^b	
					Lower Bound	Upper Bound
1	2	16.505*	2.502	.000	11.533	21.477
2	1	-16.505*	2.502	.000	-21.477	-11.533

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

As shown in Table 4.4.10.6, there is a significant change from time 1 (pre-test/before 12 weeks fitness management) to time 2 (post-test/after 12 weeks fitness management) (Sig. = 0.000 < 0.05).

The profile plot for comparison between treatment and control groups in cholesterol is shown in Figure 4.4.10.7 below:

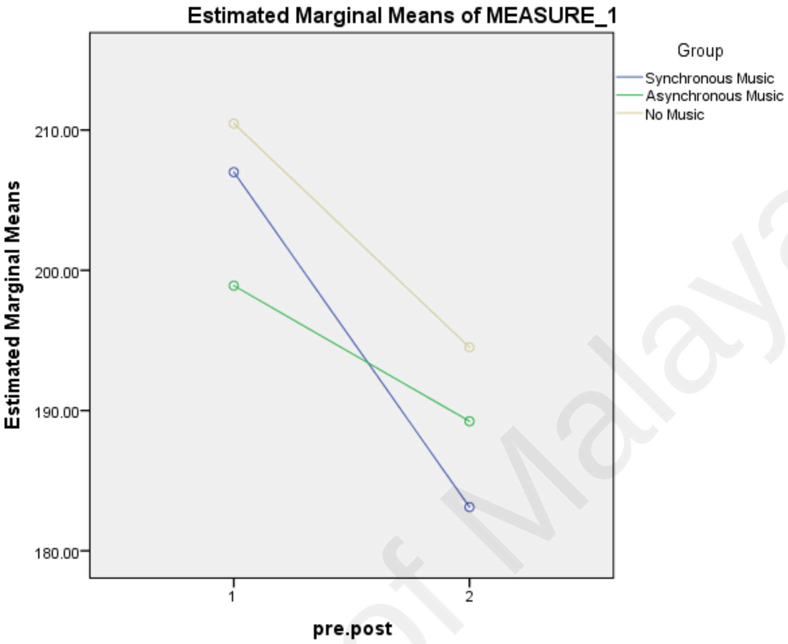

Figure 4.4.10.7 Cholesterol: Profile plot for comparison between treatment & control groups in Cholesterol

4.4.11: Metabolic Profile- LDL

Table 4.4.11: Descriptive Statistics

	Group	Mean	Std. Deviation	N
LDL.Chol.Pre	Synchronous Music	125.3226	28.41172	31
	Asynchronous Music	120.9348	32.63292	31
	No Music	129.9127	29.01181	30
	Total	125.3409	29.98200	92
LDL.Chol.Post	Synchronous Music	110.9445	25.30748	31
	Asynchronous Music	118.1977	27.75153	31
	No Music	121.2183	23.57864	30
	Total	116.7387	25.70967	92

By looking at the descriptive statistics Table 4.4.11, all of the groups have a difference in LDL before (LDL.pre) and after (LDL.post) 12 weeks fitness management program. In addition, Synchronous Music group shows a larger difference of LDL compare to the other groups as shown in Figure 4.4.1.1 below:

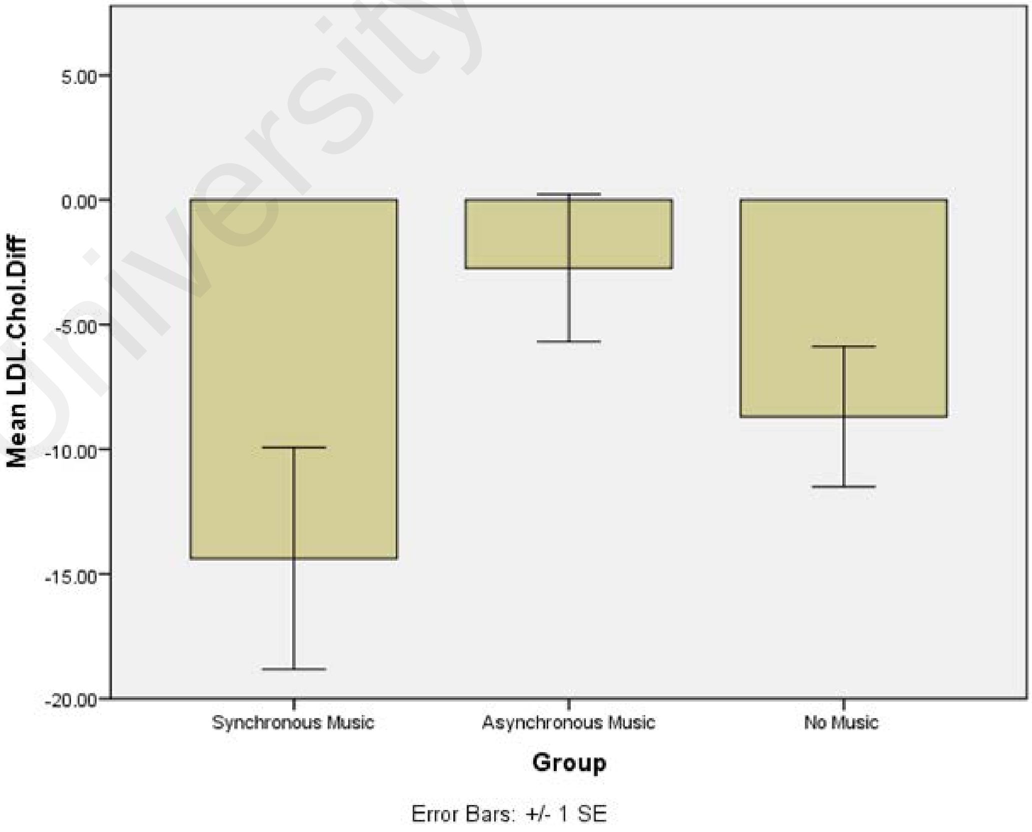

Figure 4.4.11.1: LDL Difference

Next, we use SPANOVA (Split-Plot ANOVA) to investigate the significant difference of LDL between groups by time. There are two assumption need to fulfil before using SPANOVA.

Table 4.4.11.1: Levene's Test of Equality of Error Variances[a]

	F	df1	df2	Sig.
LDL.Chol.Pre	.086	2	89	.917
LDL.Chol.Post	.381	2	89	.684
Tests the null hypothesis that the error variance of the dependent variable is equal across groups.				
a. Design: Intercept + Group Within Subjects Design: pre.post				

Since the significance value of both LDL.pre and LDL.post are > 0.01, meaning that both of them have equal variance.

Table 4.4.11.2: Box's Test of Equality of Covariance Matrices[a]

Box's M	11.948
F	1.927
df1	6
df2	196116.265
Sig.	.073
Tests the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups.	
a. Design: Intercept + Group Within Subjects Design: pre.post	

The significance value Box’s test of equality of covariance matrices is > 0.01, we may use the Wilks’ Lambda test.

Table 4.4.11.3: SPANOVA: Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.	Noncent. Parameter	Observed Power[c]
pre.post	Pillai's Trace	.169	18.143[b]	1.000	89.000	.000	18.143	.988
	Wilks' Lambda	.831	18.143[b]	1.000	89.000	.000	18.143	.988
	Hotelling's Trace	.204	18.143[b]	1.000	89.000	.000	18.143	.988
	Roy's Largest Root	.204	18.143[b]	1.000	89.000	.000	18.143	.988
pre.post * Group	Pillai's Trace	.059	2.799[b]	2.000	89.000	.066	5.599	.538
	Wilks' Lambda	.941	2.799[b]	2.000	89.000	.066	5.599	.538
	Hotelling's Trace	.063	2.799[b]	2.000	89.000	.066	5.599	.538
	Roy's Largest Root	.063	2.799[b]	2.000	89.000	.066	5.599	.538

a. Design: Intercept + Group

Within Subjects Design: pre.post

b. Exact statistic

c. Computed using alpha = .05

From the Multivariate Tests Table 4.4.11.3, we use the Wilk's Lambda test (since two assumptions above fulfilled) to test whether there are differences of LDL between the means of identified groups of subjects on a combination of times (before and after 12 weeks fitness management). Since the significance value (Sig.=0.066) is > 0.05, we conclude that the mean score of three groups, synchronous music, asynchronous music and no music, is not significantly different in LDL across 12 weeks of obesity fitness management simultaneously.

Table 4.4.11.4: Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	f	Mean Square	F	Sig.	Noncent. Parameter	Observed Power[a]
Intercept	2697239.272		2697239.272	1962.570	.000	1962.570	1.000
Group	1887.204		943.602	.687	.506	1.373	.162
Error	122316.273	9	1374.340				

a. Computed using alpha = .05

Table 4.4.11.5: Pairwise Comparisons

Measure: MEASURE_1

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a]	
					Lower Bound	Upper Bound
Synchronous Music	Asynchronous Music	-1.433	6.658	1.000	-17.680	14.814
	No Music	-7.432	6.714	.814	-23.814	8.950
Asynchronous Music	Synchronous Music	1.433	6.658	1.000	-14.814	17.680
	No Music	-5.999	6.714	1.000	-22.381	10.382
No Music	Synchronous Music	7.432	6.714	.814	-8.950	23.814
	Asynchronous Music	5.999	6.714	1.000	-10.382	22.381

Based on estimated marginal means

a. Adjustment for multiple comparisons: Bonferroni.

The three types of groups do not have a statistical significance difference of LDL between groups (Sig. = 0.506 > 0.05).

Table 4.4.11.6: Pairwise Comparisons

Table 4.4.11.6 Pairwise Comparisons

Measure: MEASURE_1

(I) pre.post	(J) pre.post	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
1	2	8.603*	2.020	.000	4.590	12.616
2	1	-8.603*	2.020	.000	-12.616	-4.590

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

As shown in Table 4.4.11.6, there is a significant change from time 1 (pre-test/before 12 weeks fitness management) to time 2 (post-test/after 12 weeks fitness management) (Sig. = 0.000 < 0.05).

The Profile plot for comparison between treatment & control groups in LDL is shown in Figure 4.4.11.7.

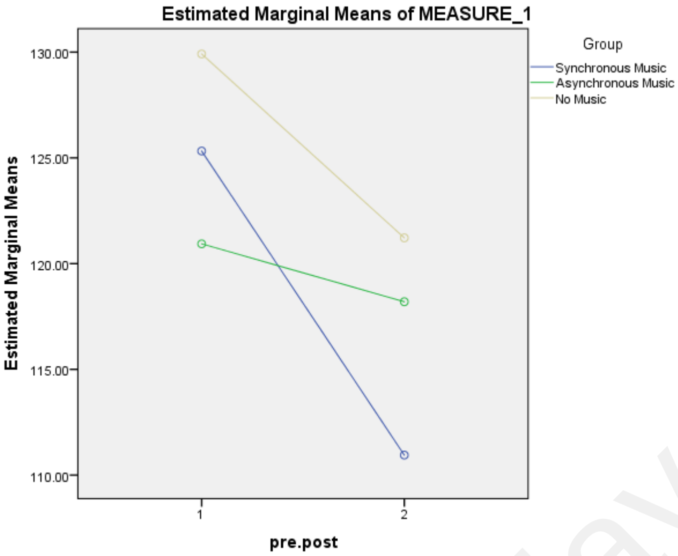

Figure 4.4.11.7: Blood Lipid - LDL: Profile plot for comparison between treatment & control groups in LDL.

4.4.12: Metabolic Profile- HDL

Table 4.4.12: Descriptive Statistics

	Group	Mean	Std. Deviation	N
HDL.Chol.Pre	Synchronous Music	59.3226	11.53368	31
	Asynchronous Music	53.1290	8.80054	31
	No Music	59.2130	11.37622	30
	Total	57.1999	10.91545	92
HDL.Chol.Post	Synchronous Music	53.5397	9.39261	31
	Asynchronous Music	50.6110	5.49323	31
	No Music	54.5737	8.06007	30
	Total	52.8900	7.91092	92

By looking at the descriptive statistics table, all of the groups have a difference in HDL before (HDL.pre) and after (HDL.post) 12 weeks fitness management program. In addition, Synchronous Music group shows a larger difference of HDL compare to the other groups as shown in Figure 4.4.1.2 below:

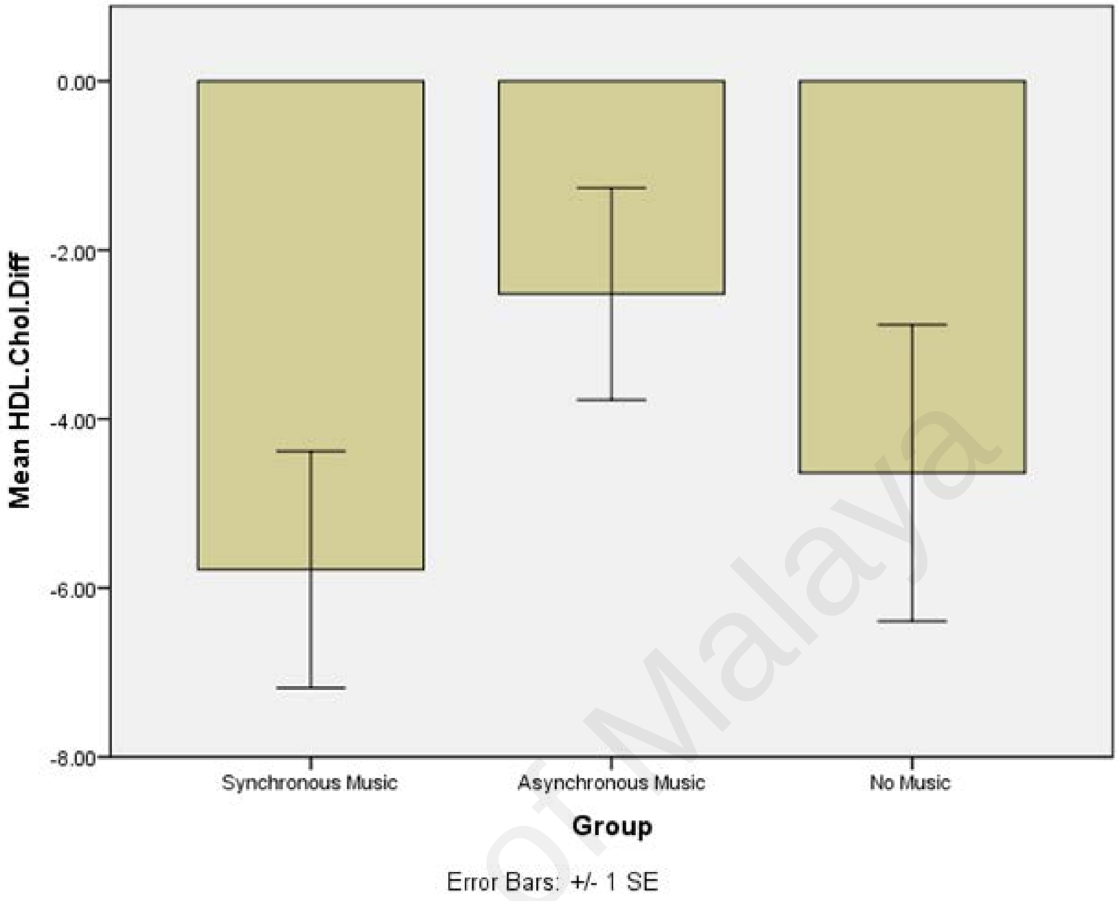

Figure 4.4.12: HDL Difference

Next, we use SPANOVA (Split-Plot ANOVA) to investigate the significant difference of HDL between groups by time. There are two assumption need to fulfil before using SPANOVA.

Table 4.4.12.1: Levene's Test of Equality of Error Variances[a]

Table 4.4.12.1 Levene's Test of Equality of Error Variances[a]

	F	df1	df2	Sig.
HDL.Chol.Pre	1.214	2	89	.302
HDL.Chol.Post	1.977	2	89	.144

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + Group

Within Subjects Design: pre.post

Since the significance value of both HDL.pre and HDL.post are > 0.01, meaning that both of them have equal variance.

Table 4.4.12.2: Box's Test of Equality of Covariance Matrices[a]

Box's M	11.564
F	1.865
df1	6
df2	196116.265
Sig.	.083

Tests the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups.

a. Design: Intercept + Group

Within Subjects Design: pre.post

The significance value Box’s test of equality of covariance matrices is > 0.01, we may use the Wilks’ Lambda test.

Table 4.4.12.3: SPANOVA: Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.	Noncent. Parameter	Observed Power[c]
pre.post	Pillai's Trace	.222	25.468[b]	1.000	89.000	.000	25.468	.999
	Wilks' Lambda	.778	25.468[b]	1.000	89.000	.000	25.468	.999
	Hotelling's Trace	.286	25.468[b]	1.000	89.000	.000	25.468	.999
	Roy's Largest Root	.286	25.468[b]	1.000	89.000	.000	25.468	.999
pre.post * Group	Pillai's Trace	.028	1.265[b]	2.000	89.000	.287	2.531	.268
	Wilks' Lambda	.972	1.265[b]	2.000	89.000	.287	2.531	.268
	Hotelling's Trace	.028	1.265[b]	2.000	89.000	.287	2.531	.268
	Roy's Largest Root	.028	1.265[b]	2.000	89.000	.287	2.531	.268

a. Design: Intercept + Group

Within Subjects Design: pre.post

b. Exact statistic

c. Computed using alpha = .05

From the Multivariate Tests Table 4.4.12.3, we use the Wilk’s Lambda test (since two assumptions above fullfiled) to test whether there are differences of HDL between the means of identified groups of subjects on a combination of times (before and after 12 weeks fitness management). Since the significance value (Sig.=0.287) is > 0.05, we conclude that the mean score of three groups, synchronous music, asynchronous music and no music, is not significantly different in HDL across 12 weeks of obesity fitness management simultaneously.

Table 4.4.12.4: Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	f	Mean Square	F	Sig.	Noncent. Parameter	Observed Power[a]
Intercept	557779.465		557779.465	3967.232	.000	3967.232	1.000
Group	949.103		474.551	3.375	.059	6.751	.623
Error	12513.101	9	140.597				

a. Computed using alpha = .05

Table 4.4.12.5: Pairwise Comparisons

Measure: MEASURE_1

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a] Lower Bound	Upper Bound
Synchronous Music	Asynchronous Music	4.561	2.130	.105	-.635	9.758
	No Music	-.462	2.147	1.000	-5.702	4.777
Asynchronous Music	Synchronous Music	-4.561	2.130	.105	-9.758	.635
	No Music	-5.023	2.147	.065	-10.263	.216
No Music	Synchronous Music	.462	2.147	1.000	-4.777	5.702
	Asynchronous Music	5.023	2.147	.065	-.216	10.263

Based on estimated marginal means

a. Adjustment for multiple comparisons: Bonferroni.

The three types of groups do not have a statistical significance difference of HDL between groups (Sig. = 0.059 > 0.05).

Table 4.4.12.6: Pairwise Comparisons

Measure: MEASURE_1

(I) pre.post	(J) pre.post	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b] Lower Bound	Upper Bound
1	2	4.313*	.855	.000	2.615	6.012
2	1	-4.313*	.855	.000	-6.012	-2.615

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

As shown in Table 4.4.12.6, there is a significant change from time 1 (pre-test/before 12 weeks fitness management) to time 2 (post-test/after 12 weeks fitness management) (Sig.=0.000 < 0.05).

The Profile plot for comparison between treatment & control groups in HDL is shown in Table 4.4.12.7 below:

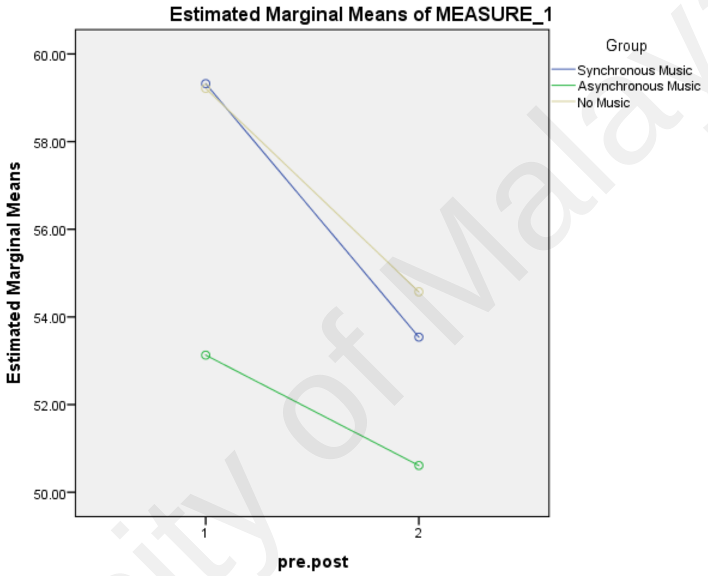

Figure 4.4.12.7 HDL: Profile plot for comparison between treatment & control groups in HDL.

Table 4.4.13: Metabolic Profile – Triglyceride

Table 4.4.1.3 Descriptive Statistics

	Group	Mean	Std. Deviation	N
Triglyceride.Pre	Synchronous Music	112.4839	48.91617	31
	Asynchronous Music	138.8065	142.82237	31
	No Music	109.3963	38.41105	30
	Total	120.3466	90.33484	92
Triglyceride.Post	Synchronous Music	92.2394	33.23017	31
	Asynchronous Music	101.8458	35.04795	31
	No Music	93.1950	23.31408	30
	Total	95.7879	31.00348	92

By looking at the descriptive statistics table 4.4.13, all of the groups have a difference in Triglyceride before (Triglyceride.pre) and after (Triglyceride.post) 12 weeks fitness management program. In addition, Asynchronous Music group shows a larger difference of triglycerides compare to the other groups as shown in Figure 4.4.1.3 below:

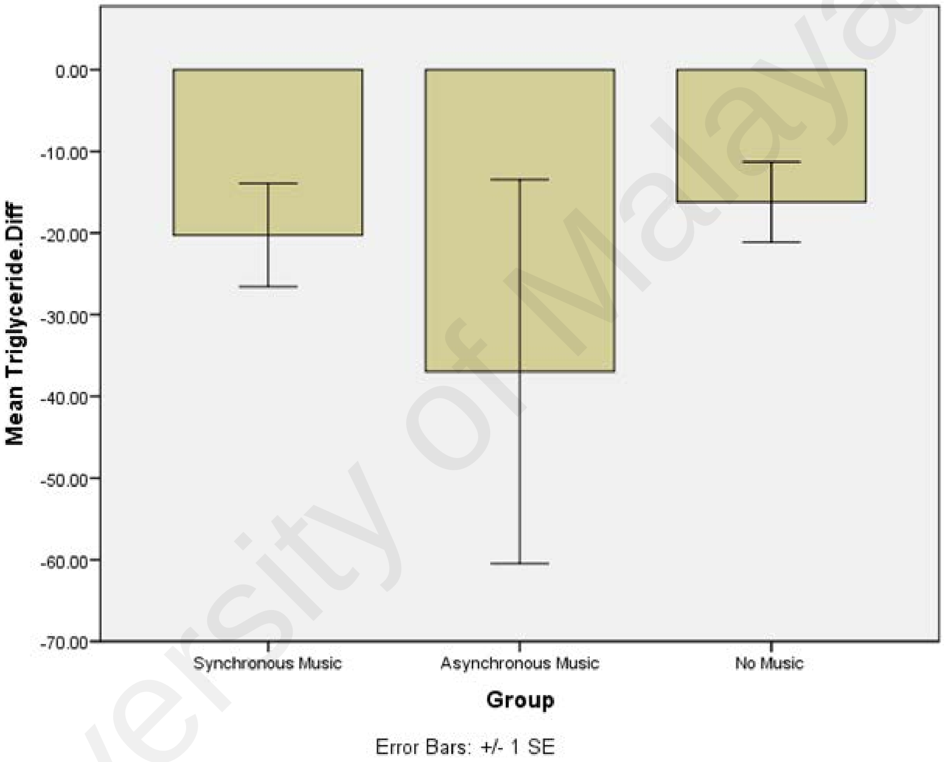

Figure 4.4.1.3: Triglyceride Difference

Next, we use SPANOVA (Split-Plot ANOVA) to investigate the significant difference of Triglyceride between groups by time. There are two assumption need to fulfil before using SPANOVA.

Table 4.4.13.1: Levene's Test of Equality of Error Variances[a]

	F	df1	df2	Sig.
Triglyceride.Pre	5.134	2	89	.008
Triglyceride.Post	1.370	2	89	.259

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + Group

Within Subjects Design: pre.post

Since the significance value of Triglyceride.pre is < 0.01, meaning that they do not have equal variance.

Table 4.4.13.2: Box's Test of Equality of Covariance Matrices[a]

Box's M	88.651
F	14.295
df1	6
df2	196116.265
Sig.	.000

Tests the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups.

a. Design: Intercept + Group

Within Subjects Design: pre.post

The significance value Box’s test of equality of covariance matrices is < 0.01, we may use the Pillai’s Trace test.

Table 4.4.13.3: SPANOVA: Table Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.	Noncent. Parameter	Observed Power[c]
pre.post	Pillai's Trace	.088	8.559[b]	1.000	89.000	.004	8.559	.825
	Wilks' Lambda	.912	8.559[b]	1.000	89.000	.004	8.559	.825
	Hotelling's Trace	.096	8.559[b]	1.000	89.000	.004	8.559	.825
	Roy's Largest Root	.096	8.559[b]	1.000	89.000	.004	8.559	.825
pre.post * Group	Pillai's Trace	.013	.578[b]	2.000	89.000	.563	1.156	.143
	Wilks' Lambda	.987	.578[b]	2.000	89.000	.563	1.156	.143
	Hotelling's Trace	.013	.578[b]	2.000	89.000	.563	1.156	.143
	Roy's Largest Root	.013	.578[b]	2.000	89.000	.563	1.156	.143

a. Design: Intercept + Group

Within Subjects Design: pre.post

b. Exact statistic

c. Computed using alpha = .05

From the Multivariate Tests Table 4.4.13.3, we use the Pillai's test (since two assumptions above violated) to test whether there are differences of Triglyceride between the means of identified groups of subjects on a combination of times (before and after 12 weeks fitness management). Since the significance value (Sig.=0.563) is > 0.05, we conclude that the mean score of three groups, synchronous music, asynchronous music and no music, is not significantly different in Triglyceride across 12 weeks of obesity fitness management simultaneously.

Table 4.4.13.4: Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	f	Mean Square	F	Sig.	Noncent. Parameter	Observed Power[a]
Intercept	2145443.552		2145443.552	363.053	.000	363.053	1.000
Group	14086.994		7043.497	1.192	.308	2.384	.255
Error	525941.439	9	5909.454				

a. Computed using alpha = .05

Table 4.4.13.4: Pairwise Comparisons

Measure: MEASURE_1

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a]	
					Lower Bound	Upper Bound
Synchronous Music	Asynchronous Music	-17.965	13.807	.590	-51.654	15.725
	No Music	1.066	13.921	1.000	-32.903	35.035
Asynchronous Music	Synchronous Music	17.965	13.807	.590	-15.725	51.654
	No Music	19.030	13.921	.525	-14.939	53.000
No Music	Synchronous Music	-1.066	13.921	1.000	-35.035	32.903
	Asynchronous Music	-19.030	13.921	.525	-53.000	14.939

Based on estimated marginal means

a. Adjustment for multiple comparisons: Bonferroni.

The three types of groups do not have a statistical significance difference of Triglyceride between groups (Sig. = 0.308 < 0.05).

Table 4.4.13.5: Pairwise Comparisons

Measure: MEASURE_1

(I) pre.post	(J) pre.post	Mean Difference (I-J)	Std. Error	Sig.^{b}	95% Confidence Interval for Difference^b	
					Lower Bound	Upper Bound
1	2	24.469*	8.364	.004	7.850	41.087
2	1	-24.469*	8.364	.004	-41.087	-7.850

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

As shown in Table 4.4.13.5, there is a significant change from time 1 (pre-test/before 12 weeks fitness management) to time 2 (post-test/after 12 weeks fitness management) (Sig.=0.004 < 0.05).

The Profile plot for comparison between treatment & control groups in Triglyceride is shown in Figure 4.4.13.6 below:

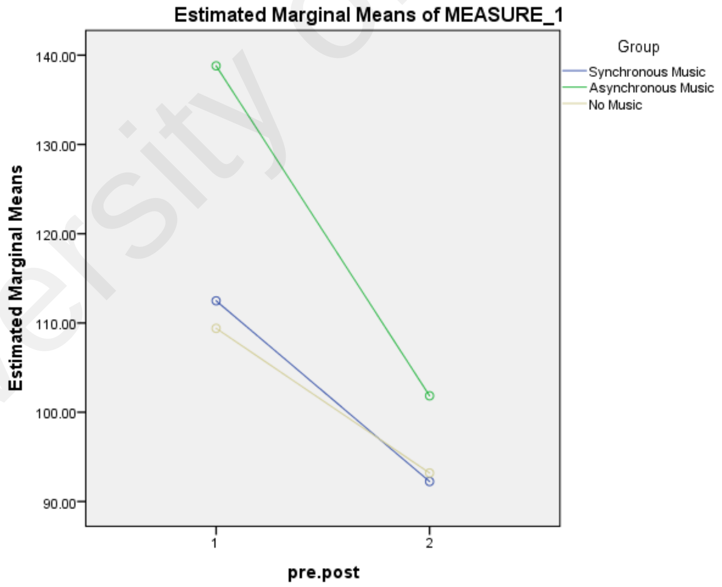

Figure 4.4.13.6: Blood Lipid - Triglyceride: Profile plot for comparison between treatment & control groups in Triglyceride.

4.4.14: Blood Glucose

Table 4.4.14: Descriptive Statistics

	Group	Mean	Std. Deviation	N
Blood.Glucose.Pre	Synchronous Music	87.6352	10.40447	31
	Asynchronous Music	104.0968	53.84382	31
	No Music	105.1130	56.44969	30
	Total	98.8813	45.52041	92
Blood.Glucose.Post	Synchronous Music	84.9961	8.57285	31
	Asynchronous Music	96.5168	24.86060	31
	No Music	96.3977	34.14995	30
	Total	92.5960	25.08607	92

By looking at the descriptive statistics Table 4.4.14, all of the groups have a difference in Blood Glucose before (Blood Glucose.pre) and after (Blood Glucose.post) 12 weeks fitness management program. In addition, the Control Group using No Music shows a larger difference of blood glucose compare to the other groups as shown in Figure 4.4.1.4 below:

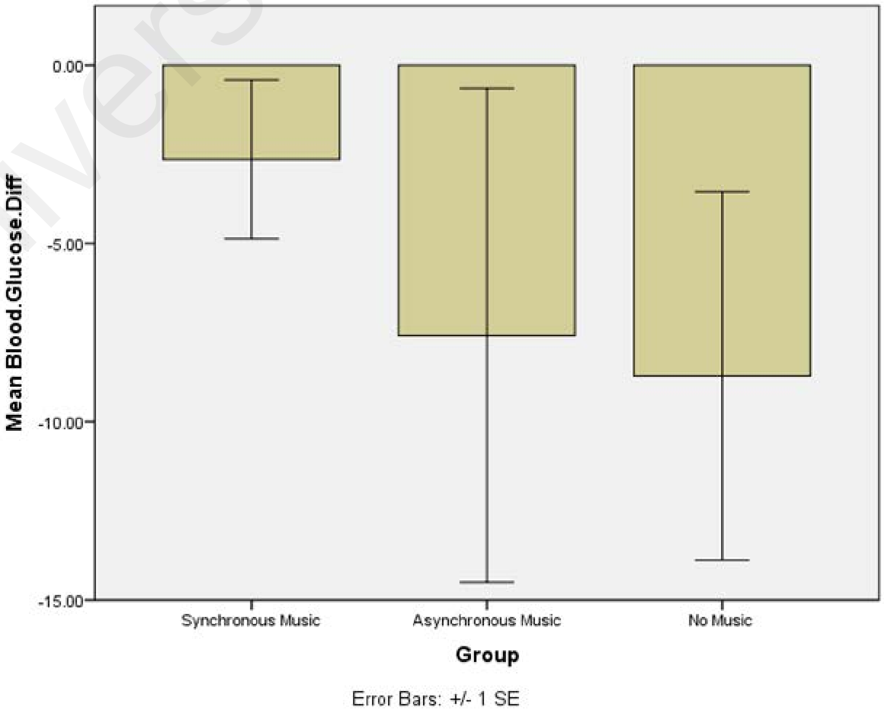

Figure 4.4.1.4: Blood Glucose Difference

Next, we use SPANOVA (Split-Plot ANOVA) to investigate the significant difference of Blood Glucose between groups by time. There are two assumption need to fulfil before using SPANOVA.

Table 4.4.14.1: Levene's Test of Equality of Error Variances[a]

Table 4.4.14.1 Levene's Test of Equality of Error Variances[a]

	F	df1	df2	Sig.
Blood.Glucose.Pre	3.733	2	89	.028
Blood.Glucose.Post	2.127	2	89	.125

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + Group

Within Subjects Design: pre.post

Since the significance value of both Blood Glucose.pre and Blood Glucose.pre more than 0.01, meaning that they have equal variance.

Table 4.4.14.2: Box's Test of Equality of Covariance Matrices[a]

Box's M	89.378
F	14.412
df1	6
df2	196116.265
Sig.	.000

Tests the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups.

a. Design: Intercept + Group

Within Subjects Design: pre.post

The significance value Box’s test of equality of covariance matrices is < 0.01, we may use the Pillai’s Trace test.

Table 4.4.14.3: SPANOVA: Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.	Noncent. Parameter	Observed Power[c]
pre.post	Pillai's Trace	.048	4.501[b]	1.000	89.000	.037	4.501	.555
	Wilks' Lambda	.952	4.501[b]	1.000	89.000	.037	4.501	.555
	Hotelling's Trace	.051	4.501[b]	1.000	89.000	.037	4.501	.555

	Roy's Largest Root	.051	4.501[b]	1.000	89.000	.037	4.501	.555
pre.post * Group	Pillai's Trace	.009	.394[b]	2.000	89.000	.676	.788	.112
	Wilks' Lambda	.991	.394[b]	2.000	89.000	.676	.788	.112
	Hotelling's Trace	.009	.394[b]	2.000	89.000	.676	.788	.112
	Roy's Largest Root	.009	.394[b]	2.000	89.000	.676	.788	.112

a. Design: Intercept + Group

Within Subjects Design: pre.post

b. Exact statistic

c. Computed using alpha = .05

From the Multivariate Tests table, we use the Pillai's test (since one of two assumptions above violated) to test whether there are differences of Blood Glucose between the means of identified groups of subjects on a combination of times (before and after 12 weeks fitness management). Since the significance value (Sig.=0.676) is > 0.05, we conclude that the mean score of three groups, synchronous music, asynchronous music and no music, is not significantly different in Blood Glucose across 12 weeks of obesity fitness management simultaneously.

Table 4.4.14.4: Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	f	Mean Square	F	Sig.	Noncent. Parameter	Observed Power[a]
Intercept	1688020.981		168802.981	747.526	.000	747.526	1.000
Group	8308.995		4154.497	1.840	.165	3.680	.374
Error	200974.660	9	2258.142				

a. Computed using alpha = .05

Table 4.4.14.5: Pairwise Comparisons

Measure: MEASURE_1						
					95% Confidence Interval for Difference[a]	
(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.[a]	Lower Bound	Upper Bound
Synchronous Music	Asynchronous Music	-13.991	8.535	.314	-34.817	6.834
	No Music	-14.440	8.606	.291	-35.438	6.559
Asynchronous Music	Synchronous Music	13.991	8.535	.314	-6.834	34.817
	No Music	-.449	8.606	1.000	-21.447	20.550
No Music	Synchronous Music	14.440	8.606	.291	-6.559	35.438
	Asynchronous Music	.449	8.606	1.000	-20.550	21.447

Based on estimated marginal means

a. Adjustment for multiple comparisons: Bonferroni.

The three types of groups do not have a statistical significance difference of Blood Glucose between groups (Sig. = 0.165 > 0.05).

Table 4.4.14.6: Pairwise Comparisons

Measure: MEASURE_1						
					95% Confidence Interval for Difference[b]	
(I) pre.post	(J) pre.post	Mean Difference (I-J)	Std. Error	Sig.[b]	Lower Bound	Upper Bound
1	2	6.311*	2.975	.037	.400	12.223
2	1	-6.311*	2.975	.037	-12.223	-.400

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

As shown in Table 4.4.14.6, there is a significant change from time 1 (pre-test/before 12 weeks fitness management) to time 2 (post-test/after 12 weeks fitness management) (Sig.=0.037 < 0.05).

The Profile plot for comparison between treatment & control groups in Blood Glucose is shown in Figure 4.4.14.7 below:

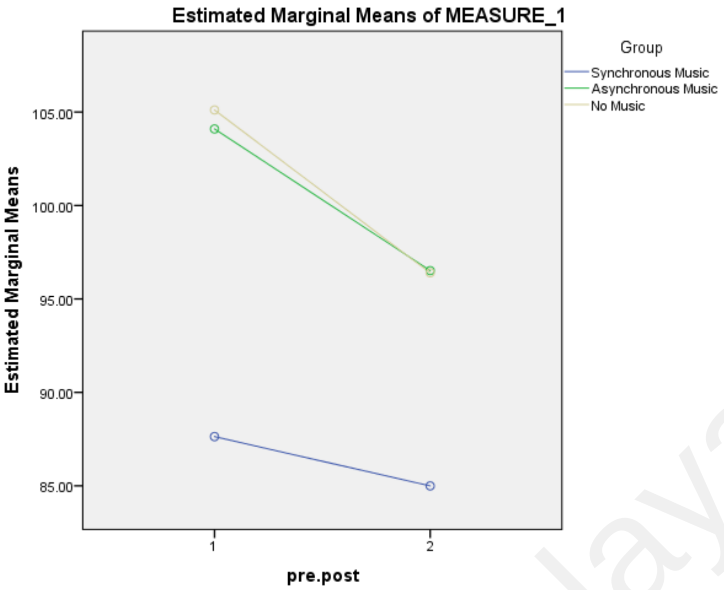

Figure 4.4.14.7: Profile plot for comparison between treatment & control groups in Blood Glucose

4.4.15: Blood Pressure

Since blood pressure is displayed as categorical data, we are not able to do SPANOVA analysis.

From our sample data, participants based on their descriptive statistics reflected

The following Figure 4.4.1.5 displays the range of Blood Pressure levels from healthy to hypertension.

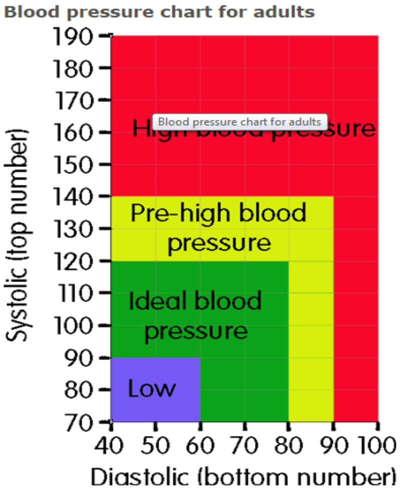

Figure 4.4.15: Classification of Blood Pressure –Systolic & Diastolic in Adults (National Heart Foundation of Australia, 2016)

Table 4.4.15.1: Effect of intervention on blood pressure (systolic and diastolic)

Metabolic profiles	Paired differences			t			Sig.		
	Group A	Group B	Group C	Group A	Group B	Group C	Group A	Group B	Group C
Systolic BP	5.25±10.23	5.24±10.92	-0.46±16.80	2.716	1.977	-0.090	**	n.s.	n.s.
Diastolic BP	8.68±10.85	7.94±9.91	1.91±11.27	4.234	3.304	0.562	**	**	n.s.
Resting heart rate	4.75±6.36	1.65±3.97	7.50±8.71	3.954	1.712	2.724	**	n.s.	*

Data were presented as the mean value ± standard deviation
** $p < 0.01$
* $p < 0.05$
n.s. non-significant

Comparing those in the asynchronous and controlled groups, those who were in the synchronous music group had a significantly greater decrease in SBP before and after ($P < 0.01$) but the asynchronous and no music groups registered non significance with significantly greater decrease in diastolic blood pressure for both synchronous and asynchronous groups ($P < 0.01$) but no significance in the control group. There is a significantly greatest decrease in heart rate in synchronous group ($P < 0.001$), significant change in the control group ($P < 0.05$) but no significant changes in the group with asynchronous music.

Our positive results in blood pressure improvements is consistent with 12 weeks high intensity training studies – which induces systolic improvements in adults with type 2 diabetes (Cassidy et al., 2016; Hollekim-Strand et al., 2014) and hypertension (Molmen-Hansen, 2012). Even hypertensive patients who underwent twelve weeks of high intensity training improved early events in systole. This correlates to contractility and are load independent (Molmen-Hansen, 2012).

Table 4.4.15.2: BP.Pre.Category

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Other cases	29	31.5	31.5	31.5
	Low	2	2.2	2.2	33.7
	Ideal	46	50.0	50.0	83.7
	Pre-High	10	10.9	10.9	94.6
	High	5	5.4	5.4	100.0
	Total	92	100.0	100.0	

Table 4.4.15.3: BP.Post.Category

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Other cases	34	37.0	37.0	37.0
	Low	3	3.3	3.3	40.2
	Ideal	46	50.0	50.0	90.2
	Pre-High	9	9.8	9.8	100.0
	Total	92	100.0	100.0	

Comparing those in the asynchronous and controlled groups, those who were in the synchronous music group had a significantly greater decrease in SBP before and after ($P < 0.001$) but the asynchronous and no music groups registered non significance with significantly greater decrease in diastolic blood pressure for both synchronous and asynchronous groups ($P < 0.001$) but no significance in the control group. There is a significantly greatest decrease in heart rate in synchronous group ($P < 0.001$), significant change in the control group ($P < 0.005$) but no significant changes in the group with asynchronous music. Based on Tables and Figures 4.4.15.2 and 4.4.15.3, the number of those who were in the Column "High" disappeared post study.

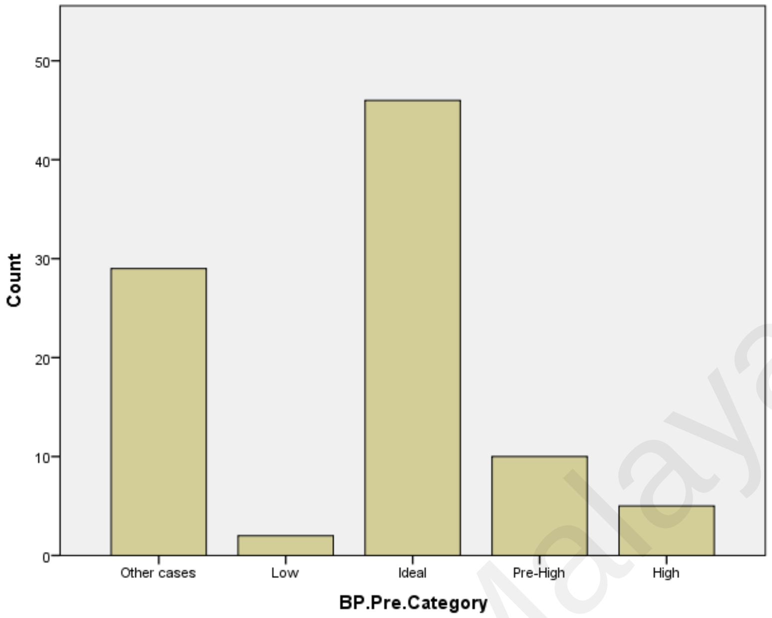

Figure 4.4.15.2: Blood Pressure Pre Intervention

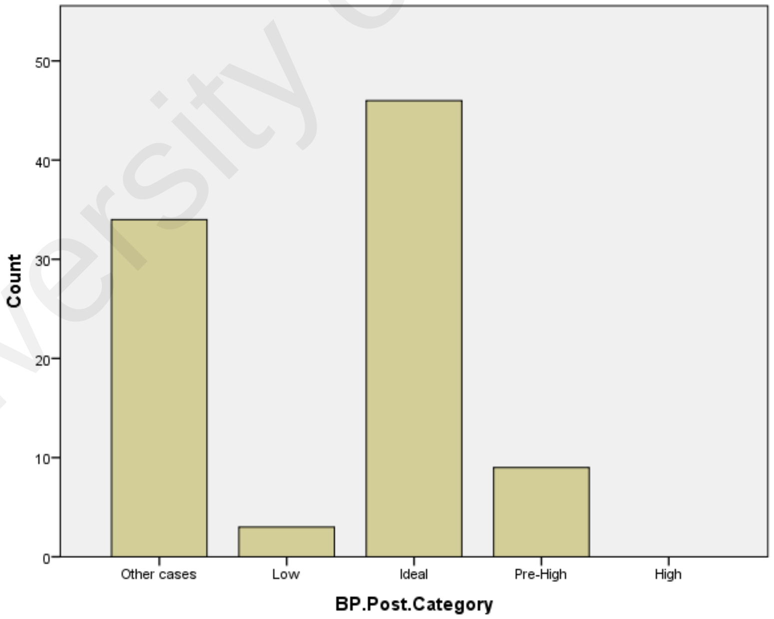

Figure 4.4.15.3: Blood Pressure Post Intervention

4.4.16: Target Heart Rate Percentage and RPE

4.4.16.1: Target Heart Rate Percentage (Curl Up) **For Curl up for the 3 subjects groups**

Table 4.4.16.1: Target Heart Rate Percentage Descriptives (Curl Up)

	Group	Mean	Std. Deviation	N
TARGET curl pre%intensity	Treatment A	85.8387	1.43983	31
	Treatment B	85.7742	1.56439	31
	Control	85.9667	1.60781	30
	Total	85.8587	1.52331	92
TARGET curl post%intensity	Treatment A	87.9355	2.33717	31
	Treatment B	88.5161	2.50161	31
	Control	88.3333	2.32428	30
	Total	88.2609	2.37602	92

Table 4.4.6.1a: Target Curl difference (descriptive)

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum	Between-Component Variance
						Lower Bound	Upper Bound			
Treatment A		31	-2.0968	2.79708	.50237	-3.1228	-1.0708	-6.00	5.00	
Treatment B		31	-2.7419	3.36618	.60458	-3.9767	-1.5072	-6.00	5.00	
Control		30	-2.3667	3.42892	.62603	-3.6470	-1.0863	-6.00	5.00	
Total		92	-2.4022	3.18327	.33188	-3.0614	-1.7429	-6.00	5.00	
Model	Fixed Effects			3.20746	.33440	-3.0666	-1.7377			
	Random Effects				.33440[a]	-3.8410[a]	-.9634[a]			-.22939
	a. Warning: Between-component variance is negative. It was replaced by 0.0 in computing this random effects measure.									

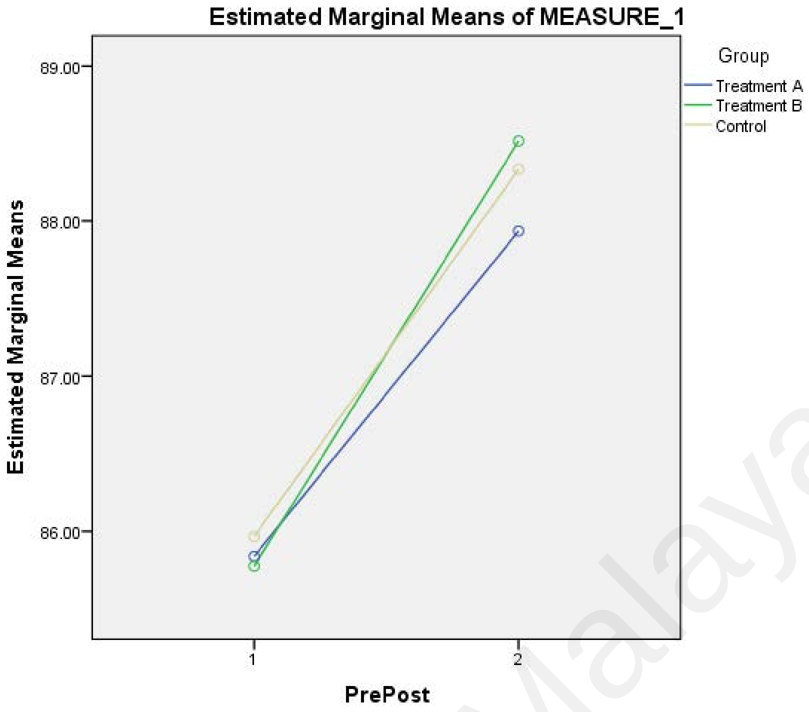

Figure 4.4.16.1: Target Heart Rate Percentage (Curl Up)

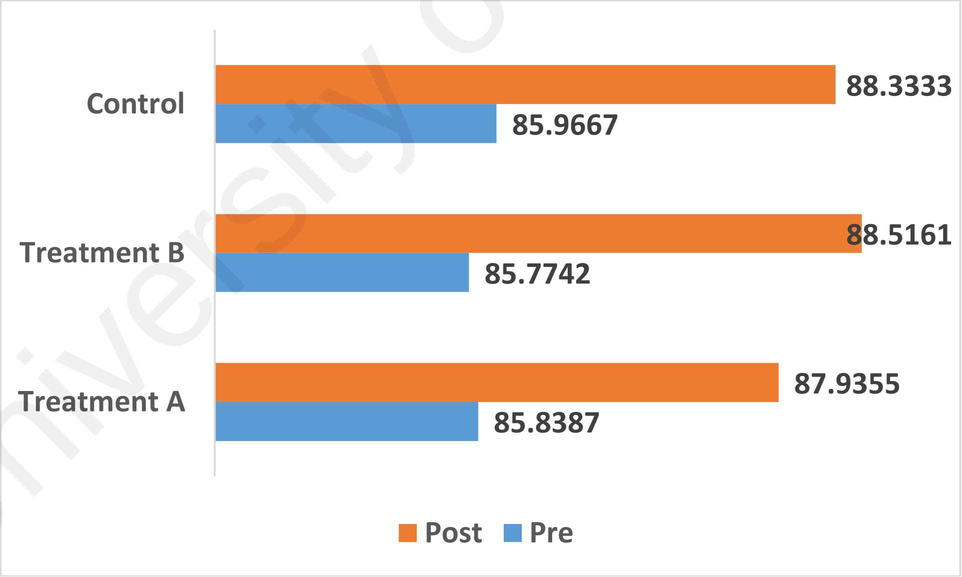

Figure 4.4.16.2: Target Heart Rate Percentage Comparison (Curl Up)

From Figure 1, the trends for each groups are similar.

Table 4.4.16.3: Levene's Test of Equality of Error Variances[a]

Levene's Test of Equality of Error Variances[a]				
	F	df1	df2	Sig.
TARGET curl pre%intensity	.243	2	89	.785
TARGET curl post%intensity	.762	2	89	.470
Tests the null hypothesis that the error variance of the dependent variable is equal across groups.				
a. Design: Intercept + Group Within Subjects Design: PrePost				

Since the significance values of sig. are larger than 0.01, we may use the Split-Plot ANOVA analysis because the assumption of equal variance is fulfilled.

Table 14.4.16.4: Box's Test of Equality of Covariance Matrices[a]

Box's M	4.306
F	.694
df1	6
df2	196116.265
Sig.	.654
Tests the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups.	
a. Design: Intercept + Group Within Subjects Design: PrePost	

The significance value Box's test of equality of covariance matrices is more than 0.01, we use the Wilks' Lambda test.

SPANOVA:

Table 14.4.16.5: Multivariate Tests

Multivariate Tests[a]						
Effect		Value	F	Hypothesis df	Error df	Sig.
PrePost	Pillai's Trace	.367	51.574[b]	1.000	89.000	.000
	Wilks' Lambda	.633	51.574[b]	1.000	89.000	.000
	Hotelling's Trace	.579	51.574[b]	1.000	89.000	.000
	Roy's Largest Root	.579	51.574[b]	1.000	89.000	.000
PrePost * Group	Pillai's Trace	.007	.316[b]	2.000	89.000	.730
	Wilks' Lambda	.993	.316[b]	2.000	89.000	.730
	Hotelling's Trace	.007	.316[b]	2.000	89.000	.730
	Roy's Largest Root	.007	.316[b]	2.000	89.000	.730

a. Design: Intercept + Group
Within Subjects Design: PrePost

b. Exact statistic

Multivariate Tests[a]

From the Multivariate Tests table, we use the Wilks' Lambda test (since two assumptions have been fulfilled) to test whether there are differences between the means of identified groups of subjects on a combination of times (before, after 12 weeks and after 2 years of fitness management). Since the significance value (Sig.=0.730) is larger than 0.05, we conclude that the mean score of three groups, treatment A, B and control group, is not significantly different in target curl up across 12 weeks of obesity fitness management simultaneously.

Table 14.4.16.6: Pairwise Comparisons

Measure: MEASURE_1

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a]	
					Lower Bound	Upper Bound
Treatment A	Treatment B	-.258	.308	.404	-.869	.353
	Control	-.263	.310	.399	-.879	.353
Treatment B	Treatment A	.258	.308	.404	-.353	.869
	Control	-.005	.310	.988	-.621	.611
Control	Treatment A	.263	.310	.399	-.353	.879
	Treatment B	.005	.310	.988	-.611	.621

Based on estimated marginal means

a. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

There is no significant difference of targeted curl up between all groups (all Sig. Values are larger than 0.05).

Table 14.4.16.7: Pairwise Comparisons

Measure: MEASURE_1

(I) PrePost	(J) PrePost	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
1	2	-2.402*	.334	.000	-3.066	-1.737
2	1	2.402*	.334	.000	1.737	3.066

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

There is a significant mean changes from time 1 to time 2 at 5% level.

4.4.17: Target Heart Rate Percentage (Push Up) For push up for the 3 subjects groups

Table 4.4.17.1: Target Heart Rate Percentage Descriptives (Push Up)

Descriptive Statistics

	Group	Mean	Std. Deviation	N
TARGET push up pre%intensity	Treatment A	85.7097	1.21638	31
	Treatment B	85.8710	1.60711	31
	Control	85.8667	1.59164	30
	Total	85.8152	1.46707	92
TARGET pushup post%intensity	Treatment A	87.8710	2.17167	31
	Treatment B	87.9032	2.30007	31
	Control	88.2333	2.32947	30
	Total	88.0000	2.24832	92

Descriptives

TargetPushDiff

						95% Confidence Interval for Mean				
		N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum	Between-Component Variance
Treatment A		31	-2.1613	2.31080	.41503	-3.0089	-1.3137	-6.00	5.00	
Treatment B		31	-2.0323	2.94939	.52973	-3.1141	-.9504	-6.00	5.00	
Control		30	-2.3667	3.30604	.60360	-3.6012	-1.1322	-6.00	5.00	
Total		92	-2.1848	2.85137	.29728	-2.7753	-1.5943	-6.00	5.00	
Model	Fixed Effects			2.87986	.30025	-2.7814	-1.5882			
	Random Effects				.30025[a]	-3.4766[a]	-.8929[a]			-.24225

a. Warning: Between-component variance is negative. It was replaced by 0.0 in computing this random effects measure.

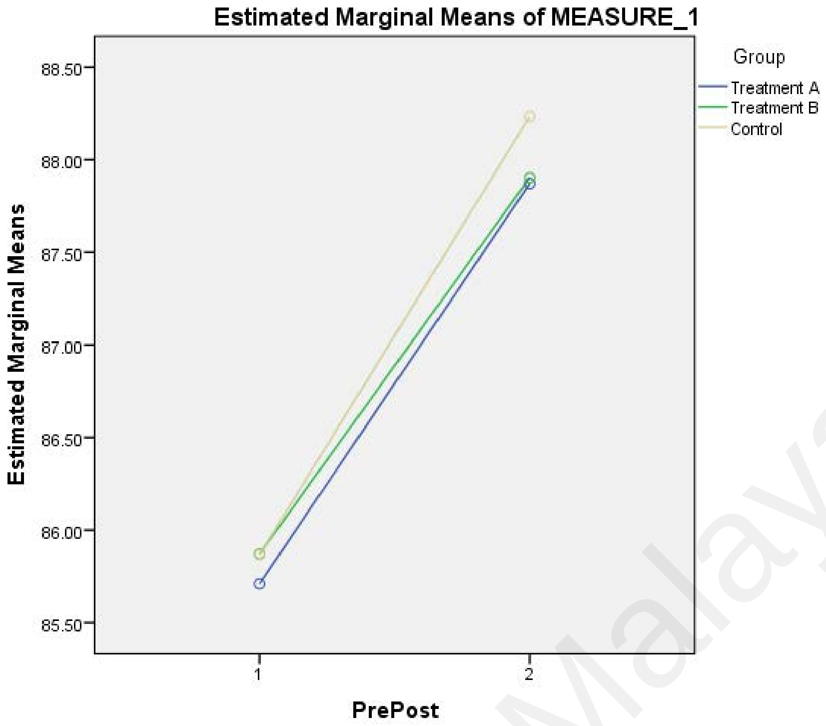

Figure 4.4.17.1 Target Heart Rate Percentage (Push Up)

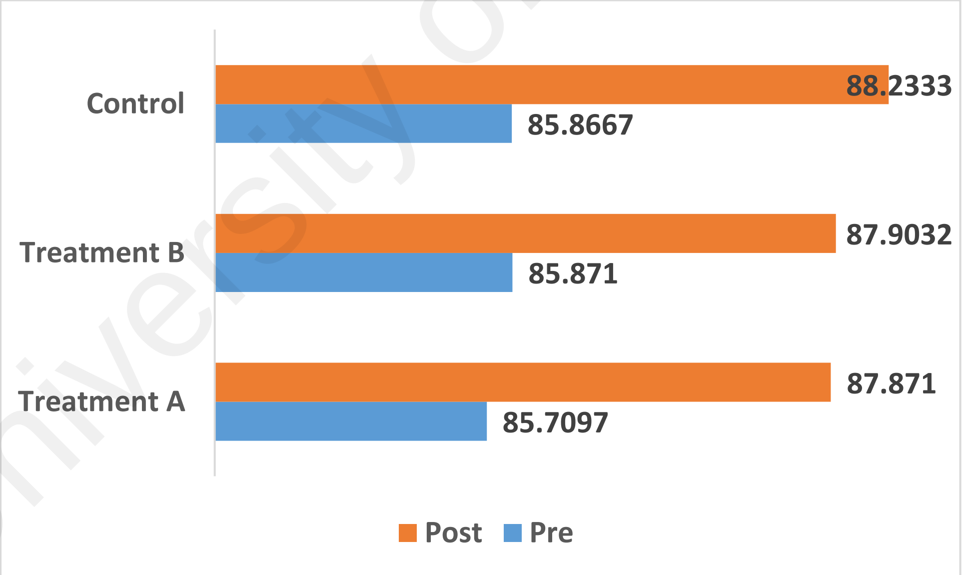

Figure 4.4.17.2 Target Heart Rate Comparison Percentage (Push Up)

From Figure 4.4.17.2, the trends for each groups are similar.

Table 4.4.17.2: Levene's Test of Equality of Error Variances[a]

Levene's Test of Equality of Error Variances[a]				
	F	df1	df2	Sig.
TARGET push up pre%intensity	.850	2	89	.431
TARGET pushup post%intensity	.354	2	89	.703
Tests the null hypothesis that the error variance of the dependent variable is equal across groups.				
a. Design: Intercept + Group Within Subjects De sign: PrePost				

Since the significance values of sig. are larger than 0.01, we may use the Split-Plot ANOVA analysis because the assumption of equal variance is fulfilled.

Table 4.4.17.3: Box's Test of Equality of Covariance Matrices[a]

Box's M	7.370
F	1.188
df1	6
df2	196116.265
Sig.	.309
Tests the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups.	
a. Design: Intercept + Group Within Subjects Design: PrePost	

The significance value Box’s test of equality of covariance matrices is more than 0.01, we use the Wilks' Lambda test.

SPANOVA:

Table 4.4.17.4: Multivariate Tests

Multivariate Tests[a]						
Effect		Value	F	Hypothesis df	Error df	Sig.
PrePost	Pillai's Trace	.373	53.032[b]	1.000	89.000	.000
	Wilks' Lambda	.627	53.032[b]	1.000	89.000	.000
	Hotelling's Trace	.596	53.032[b]	1.000	89.000	.000
	Roy's Largest Root	.596	53.032[b]	1.000	89.000	.000
PrePost * Group	Pillai's Trace	.002	.104[b]	2.000	89.000	.901
	Wilks' Lambda	.998	.104[b]	2.000	89.000	.901
	Hotelling's Trace	.002	.104[b]	2.000	89.000	.901
	Roy's Largest Root	.002	.104[b]	2.000	89.000	.901
a. Design: Intercept + Group Within Subjects Design: PrePost						
b. Exact statistic						

Multivariate Tests[a]

From the Multivariate Tests table, we use the Wilks' Lambda test (since two assumptions have been fulfilled) to test whether there are differences between the means of identified groups of subjects on a combination of times (before, after 12 weeks and after 2 years of fitness management). Since the significance value (Sig.=0.901) is larger than 0.05, we conclude that the mean score of three groups, treatment A, B and control group, is not significantly different in target push up across 12 weeks of obesity fitness management simultaneously.

Table4.4.17.5: Pairwise Comparisons

Measure: MEASURE_1						
					95% Confidence Interval for Difference[a]	
(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.[a]	Lower Bound	Upper Bound
Treatment A	Treatment B	-.097	.321	.764	-.734	.541
	Control	-.260	.323	.424	-.902	.383
Treatment B	Treatment A	.097	.321	.764	-.541	.734
	Control	-.163	.323	.616	-.806	.480
Control	Treatment A	.260	.323	.424	-.383	.902
	Treatment B	.163	.323	.616	-.480	.806

Based on estimated marginal means

a. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

There is no significant difference of targeted push up between all groups (all Sig. Values are larger than 0.05).

Table 4.4.17.6: Pairwise Comparisons

Measure: MEASURE_1						
					95% Confidence Interval for Difference[b]	
(I) PrePost	(J) PrePost	Mean Difference (I-J)	Std. Error	Sig.[b]	Lower Bound	Upper Bound
1	2	-2.187*	.300	.000	-2.783	-1.590
2	1	2.187*	.300	.000	1.590	2.783

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

There is a significant mean changes from time 1 to time 2 at 5% level.

4.4.18 Target Heart Rate Percentage (squats) (For Body Squat for the 3 subjects groups)

Table 4.4.18.1: Target Heart Rate Percentage Descriptives (Squats)

Descriptive Statistics

	Group	Mean	Std. Deviation	N
TARGET squat pre%intensity	Treatment A	85.9677	1.87054	31
	Treatment B	85.9032	1.59906	31
	Control	85.8333	1.59921	30
	Total	85.9022	1.67765	92
TARGET squatpost%intensity	Treatment A	88.0645	2.37957	31
	Treatment B	87.8065	2.22740	31
	Control	88.2667	2.28840	30
	Total	88.0435	2.28186	92

Descriptives

TargetSquatDiff

						95% Confidence Interval for Mean				
		N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum	Between-Component Variance
Treatment A		31	-2.0968	3.59958	.64650	-3.4171	-.7764	-6.00	5.00	
Treatment B		31	-1.9032	2.83261	.50875	-2.9422	-.8642	-6.00	5.00	
Control		30	-2.4333	3.20219	.58464	-3.6291	-1.2376	-6.00	5.00	
Total		92	-2.1413	3.19884	.33350	-2.8038	-1.4788	-6.00	5.00	
Model	Fixed Effects			3.22697	.33643	-2.8098	-1.4728			
	Random Effects				.33643[a]	-3.5889[a]	-.6937[a]			-.26823

a. Warning: Between-component variance is negative. It was replaced by 0.0 in computing this random effects measure.

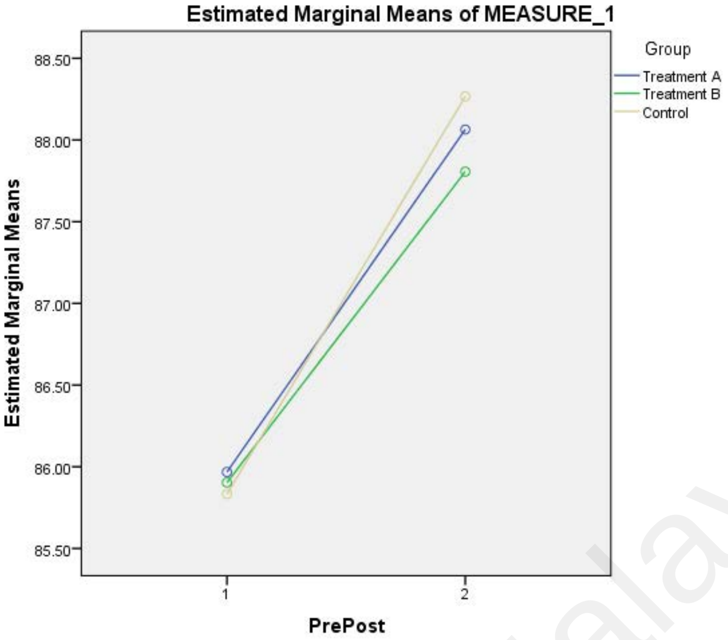

Figure 4.4.18.1: Target Heart Rate Percentage (Squats)

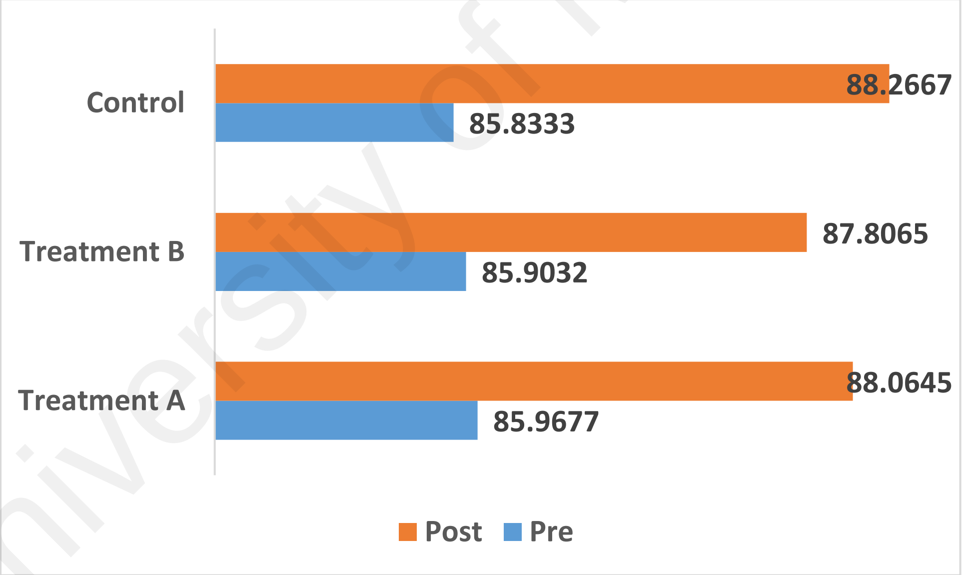

Figure 4.4.18.2: Target Heart Rate Percentage Comparison (Squats)

From Figure 4.4.18.2, the trends for each groups are similar.

Table 4.4.18.2: Levene's Test of Equality of Error Variances[a]

Levene's Test of Equality of Error Variances[a]				
	F	df1	df2	Sig.
TARGET squat pre%intensity	.412	2	89	.663
TARGET squatpost%intensity	.450	2	89	.639
Tests the null hypothesis that the error variance of the dependent variable is equal across groups.				
a. Design: Intercept + Group Within Subjects Design: PrePost				

Since the significance values of sig. are larger than 0.01, we may use the Split-Plot ANOVA analysis because the assumption of equal variance is fulfilled.

Table 4.4.18.3: Box's Test of Equality of Covariance Matrices[a]

Box's M	3.040
F	.490
df1	6
df2	196116.265
Sig.	.816
Tests the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups.	
a. Design: Intercept + Group Within Subjects Design: PrePost	

The significance value Box's test of equality of covariance matrices is more than 0.01, we use the Wilks' Lambda test.

SPANOVA:

Table 4.4.18.4: Multivariate Tests

Multivariate Tests[a]						
Effect		Value	F	Hypothesis df	Error df	Sig.
PrePost	Pillai's Trace	.313	40.619[b]	1.000	89.000	.000
	Wilks' Lambda	.687	40.619[b]	1.000	89.000	.000
	Hotelling's Trace	.456	40.619[b]	1.000	89.000	.000
	Roy's Largest Root	.456	40.619[b]	1.000	89.000	.000
PrePost * Group	Pillai's Trace	.005	.210[b]	2.000	89.000	.811
	Wilks' Lambda	.995	.210[b]	2.000	89.000	.811
	Hotelling's Trace	.005	.210[b]	2.000	89.000	.811
	Roy's Largest Root	.005	.210[b]	2.000	89.000	.811
a. Design: Intercept + Group Within Subjects Design: PrePost						
b. Exact statistic						

From the Multivariate Tests table, we use the Wilks' Lambda test (since two assumptions have been fulfilled) to test whether there are differences between the means of identified groups of subjects on a combination of times (before, after 12 weeks and after 2 years of fitness management). Since the significance value (Sig.=0.811) is larger than 0.05, we conclude that the mean score of three groups, treatment A, B and control group, is not significantly different in target squat across 12 weeks of obesity fitness management simultaneously.

Table 4.4.18.5: Pairwise Comparisons

Measure: MEASURE_1						
					95% Confidence Interval for Difference[a]	
(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.[a]	Lower Bound	Upper Bound
Treatment A	Treatment B	.161	.309	.603	-.452	.775
	Control	-.034	.311	.914	-.652	.585
Treatment B	Treatment A	-.161	.309	.603	-.775	.452
	Control	-.195	.311	.532	-.814	.423
Control	Treatment A	.034	.311	.914	-.585	.652
	Treatment B	.195	.311	.532	-.423	.814
Based on estimated marginal means						
a. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).						

There is no significant difference of targeted squat between all groups (all Sig. Values are larger than 0.05).

Table 4.4.18.6: Pairwise Comparisons

Measure: MEASURE_1						
					95% Confidence Interval for Difference[b]	
(I) PrePost	(J) PrePost	Mean Difference (I-J)	Std. Error	Sig.[b]	Lower Bound	Upper Bound
1	2	-2.144*	.336	.000	-2.813	-1.476
2	1	2.144*	.336	.000	1.476	2.813
Based on estimated marginal means						
*. The mean difference is significant at the .05 level.						
b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).						

There is a significant mean changes from time 1 to time 2 at 5% level.

4.4.19 RPE (Curl up for the 3 subjects groups)

Table 4.4.19.1: RPE Descriptives (Curl Up)

Descriptive Statistics				
	Group	Mean	Std. Deviation	N
RPE Curl Pre	Treatment A	15.8387	.82044	31
	Treatment B	16.0000	.96609	31
	Control	16.0333	.92786	30
	Total	15.9565	.90071	92
RPE Curl Post	Treatment A	16.0000	.85635	31
	Treatment B	16.2903	1.00643	31
	Control	16.2667	.90719	30
	Total	16.1848	.92498	92

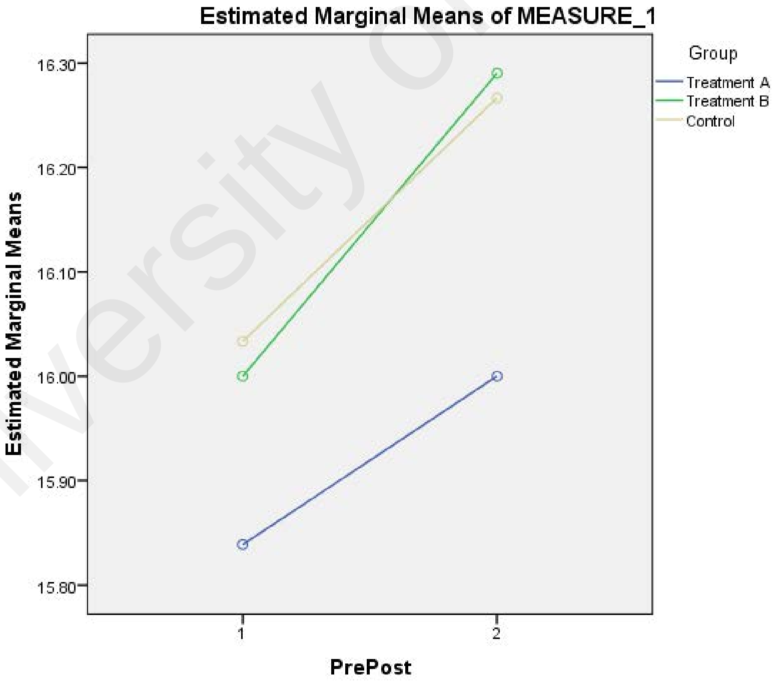

Figure 4.4.19.1: RPE Heart Rate (Curl Up)

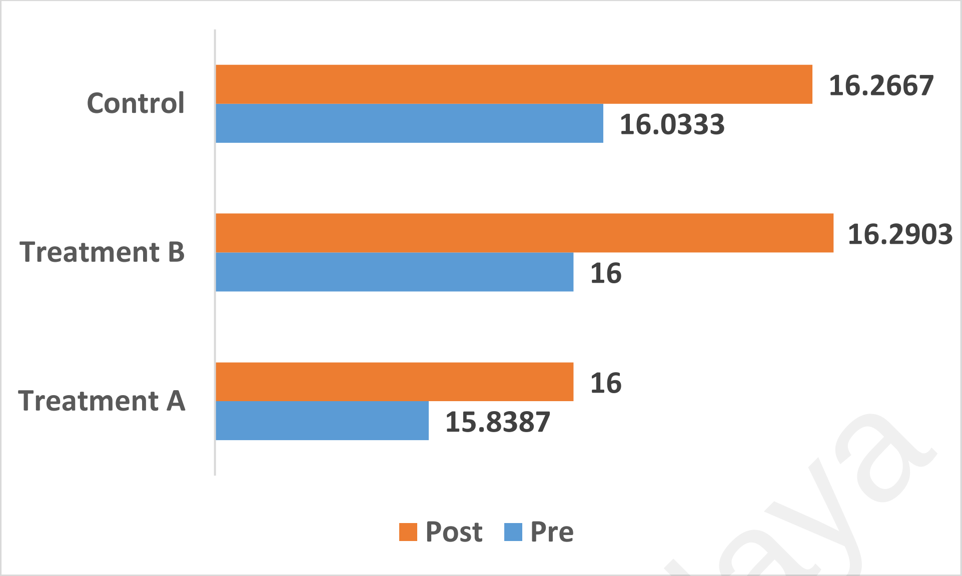

Figure 4.4.19.2: RPE Comparison (Curl Up)

From Figure 4.4.19.2, the trends for each groups are similar.

Table 4.4.19.2: Levene's Test of Equality of Error Variances[a]

	F	df1	df2	Sig.
RPE Curl Pre	.488	2	89	.615
RPE Curl Post	2.782	2	89	.067
Tests the null hypothesis that the error variance of the dependent variable is equal across groups.				
a. Design: Intercept + Group Within Subjects Design: PrePost				

Since the significance values of sig. are larger than 0.01, we may use the Split-Plot ANOVA analysis because the assumption of equal variance is fulfilled.

Table 4.4.19.3: Box's Test of Equality of Covariance Matrices[a]

Box's M	2.607
F	.420
df1	6
df2	196116.265
Sig.	.866
Tests the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups.	
a. Design: Intercept + Group Within Subjects Design: PrePost	

The significance value Box's test of equality of covariance matrices is more than 0.01, we use the Wilks' Lambda test.

SPANOVA:

Table 4.4.19.4: Multivariate Tests

Multivariate Tests[a]						
Effect		Value	F	Hypothesis df	Error df	Sig.
PrePost	Pillai's Trace	.167	17.819[b]	1.000	89.000	.000
	Wilks' Lambda	.833	17.819[b]	1.000	89.000	.000
	Hotelling's Trace	.200	17.819[b]	1.000	89.000	.000
	Roy's Largest Root	.200	17.819[b]	1.000	89.000	.000
PrePost * Group	Pillai's Trace	.011	.482[b]	2.000	89.000	.619
	Wilks' Lambda	.989	.482[b]	2.000	89.000	.619
	Hotelling's Trace	.011	.482[b]	2.000	89.000	.619
	Roy's Largest Root	.011	.482[b]	2.000	89.000	.619
a. Design: Intercept + Group Within Subjects Design: PrePost						
b. Exact statistic						

From the Multivariate Tests table, we use the Wilks' Lambda test (since two assumptions have been fulfilled) to test whether there are differences between the means of identified groups of subjects on a combination of times (before, after 12 weeks of fitness management). Since the significance value (Sig.=0.619) is larger than 0.05, we conclude that the mean score of three groups, treatment A, B and control group, is not significantly different in RPE curl up across 12 weeks of obesity fitness management simultaneously.

Table 4.4.19.5: Pairwise Comparisons

Measure: MEASURE_1

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a]	
					Lower Bound	Upper Bound
Treatment A	Treatment B	-.226	.223	.314	-.669	.218
	Control	-.231	.225	.308	-.678	.217
Treatment B	Treatment A	.226	.223	.314	-.218	.669
	Control	-.005	.225	.983	-.452	.442
Control	Treatment A	.231	.225	.308	-.217	.678
	Treatment B	.005	.225	.983	-.442	.452

Based on estimated marginal means

a. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

There is no significant difference of RPE curl up between all groups (all Sig. Values are larger than 0.05).

Table 4.4.19.6: Pairwise Comparisons

Measure: MEASURE_1

(I) PrePost	(J) PrePost	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
1	2	-.228*	.054	.000	-.336	-.121
2	1	.228*	.054	.000	.121	.336

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

There is a significant mean changes from time 1 to time 2 at 5% level.

4.4.20: RPE (For Push up for the 3 subjects groups)

Table 4.4.20.1: RPE Descriptives (Push Up)

Descriptive Statistics				
	Group	Mean	Std. Deviation	N
RPE PushUp Pre	Treatment A	15.8065	.83344	31
	Treatment B	16.0000	.96609	31
	Control	16.0333	.92786	30
	Total	15.9457	.90620	92
RPE PushUp Post	Treatment A	15.8710	.88476	31
	Treatment B	16.2258	1.05545	31
	Control	16.2000	.92476	30
	Total	16.0978	.96145	92

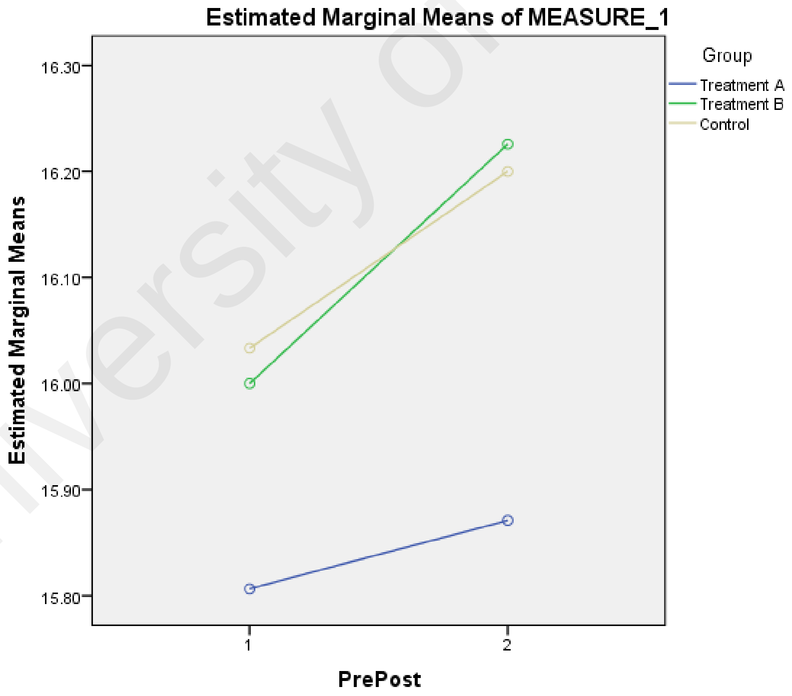

Figure 4.4.20.1 RPE (Push Up)

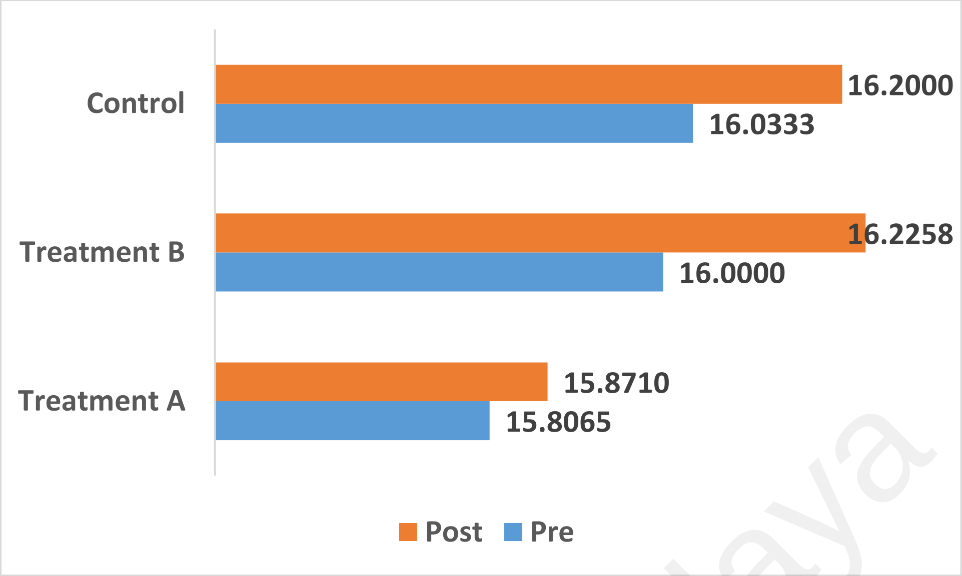

Figure 4.4.20.2: RPE Comparison (Push Up)

From Figure 4.4.20.2, the trends for each groups are similar.

Table 4.4.20.2: Levene's Test of Equality of Error Variances[a]

Levene's Test of Equality of Error Variances[a]				
	F	df1	df2	Sig.
RPE PushUp Pre	.884	2	89	.417
RPE PushUp Post	1.559	2	89	.216
Tests the null hypothesis that the error variance of the dependent variable is equal across groups.				
a. Design: Intercept + Group Within Subjects Design: PrePost				

Since the significance values of sig. are larger than 0.01, we may use the Split-Plot ANOVA analysis because the assumption of equal variance is fulfilled.

Table 4.4.20.3: Box's Test of Equality of Covariance Matrices[a]

Box's M	5.988
F	.966
df1	6
df2	196116.265
Sig.	.447
Tests the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups.	
a. Design: Intercept + Group Within Subjects Design: PrePost	

The significance value Box’s test of equality of covariance matrices is more than 0.01, we use the Wilks' Lambda test.

SPANOVA:

Table 4.4.20.4:

Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.
PrePost	Pillai's Trace	.090	8.853[b]	1.000	89.000	.004
	Wilks' Lambda	.910	8.853[b]	1.000	89.000	.004
	Hotelling's Trace	.099	8.853[b]	1.000	89.000	.004
	Roy's Largest Root	.099	8.853[b]	1.000	89.000	.004
PrePost * Group	Pillai's Trace	.019	.856[b]	2.000	89.000	.428
	Wilks' Lambda	.981	.856[b]	2.000	89.000	.428
	Hotelling's Trace	.019	.856[b]	2.000	89.000	.428
	Roy's Largest Root	.019	.856[b]	2.000	89.000	.428

a. Design: Intercept + Group
Within Subjects Design: PrePost

b. Exact statistic

From the Multivariate Tests table, we use the Wilks' Lambda test (since two assumptions have been fulfilled) to test whether there are differences between the means of identified groups of subjects on a combination of times (before, after 12 weeks of fitness management). Since the significance value (Sig.=0.428) is larger than 0.05, we conclude that the mean score of three groups, treatment A, B and control group, is not significantly different in RPE push up across 12 weeks of obesity fitness management simultaneously.

Table 4.4.20.5: Pairwise Comparisons

Pairwise Comparisons

Measure: MEASURE_1

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a]	
					Lower Bound	Upper Bound
Treatment A	Treatment B	-.274	.229	.235	-.729	.181
	Control	-.278	.231	.232	-.737	.181
Treatment B	Treatment A	.274	.229	.235	-.181	.729
	Control	-.004	.231	.987	-.463	.455
Control	Treatment A	.278	.231	.232	-.181	.737
	Treatment B	.004	.231	.987	-.455	.463

Based on estimated marginal means

a. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

There is no significant difference of RPE push up between all groups (all Sig. Values are larger than 0.05).

Table 4.4.20.6: Pairwise Comparisons

Pairwise Comparisons

Measure: MEASURE_1

(I) PrePost	(J) PrePost	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
1	2	-.152*	.051	.004	-.254	-.051
2	1	.152*	.051	.004	.051	.254

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

There is a significant mean changes from time 1 to time 2 at 5% level.

4.4.21 RPE (For squat for the 3 subjects groups)

Table 4.4.21.1: RPE Descriptives (Squats)

Descriptive Statistics				
	Group	Mean	Std. Deviation	N
RPE Squat Pre	Treatment A	15.9032	.87005	31
	Treatment B	16.0000	.96609	31
	Control	16.0000	.87099	30
	Total	15.9674	.89505	92
RPE Squat Post	Treatment A	16.0323	.83602	31
	Treatment B	16.1613	1.00322	31
	Control	16.2667	.98027	30
	Total	16.1522	.93685	92

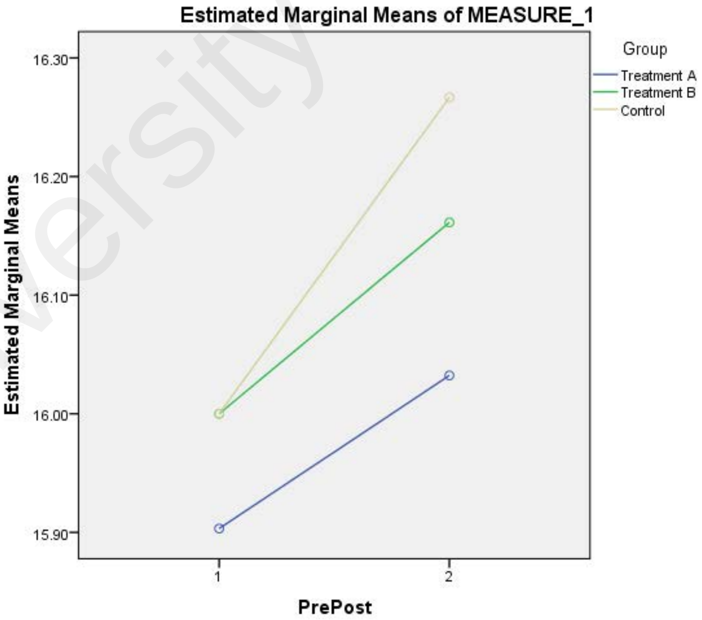

Figure 4.4.21.1: RPE (Squats)

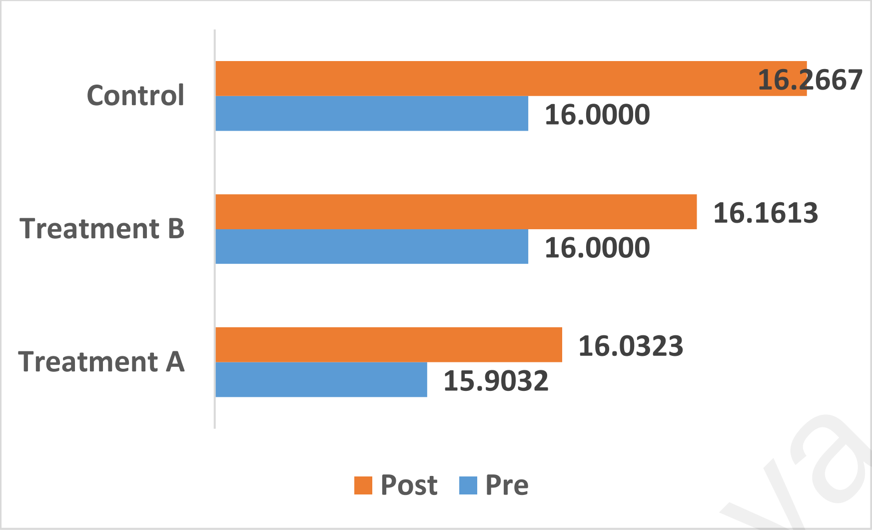

Figure 4.4.21.2 RPE Comparison (Squats)

From Figure 4.4.21.2, the trends for each groups are similar.

Table 4.4.21.2: Levene's Test

Levene's Test of Equality of Error Variances[a]				
	F	df1	df2	Sig.
RPE Squat Pre	.740	2	89	.480
RPE Squat Post	2.236	2	89	.113
Tests the null hypothesis that the error variance of the dependent variable is equal across groups.				
a. Design: Intercept + Group Within Subjects Design: PrePost				

Since the significance values of sig. are larger than 0.01, we may use the Split-Plot ANOVA analysis because the assumption of equal variance is fulfilled.

Table 4.4.21.3: **Box's Test of Equality of Covariance Matrices[a]**

Box's M	2.778
F	.448
df1	6
df2	196116.265
Sig.	.847
Tests the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups.	
a. Design: Intercept + Group Within Subjects Design: PrePost	

The significance value Box's test of equality of covariance matrices is more than 0.01, we use the Wilks' Lambda test.

SPANOVA:

Table 4.4.21.4: Multivariate Tests

Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.
PrePost	Pillai's Trace	.140	14.438[b]	1.000	89.000	.000
	Wilks' Lambda	.860	14.438[b]	1.000	89.000	.000
	Hotelling's Trace	.162	14.438[b]	1.000	89.000	.000
	Roy's Largest Root	.162	14.438[b]	1.000	89.000	.000
PrePost * Group	Pillai's Trace	.016	.716[b]	2.000	89.000	.491
	Wilks' Lambda	.984	.716[b]	2.000	89.000	.491
	Hotelling's Trace	.016	.716[b]	2.000	89.000	.491
	Roy's Largest Root	.016	.716[b]	2.000	89.000	.491

a. Design: Intercept + Group
Within Subjects Design: PrePost

b. Exact statistic

From the Multivariate Tests table, we use the Wilks' Lambda test (since two assumptions have been fulfilled) to test whether there are differences between the means of identified groups of subjects on a combination of times (before, after 12 weeks of fitness management). Since the significance value (Sig.=0.491) is larger than 0.05, we conclude that the mean score of three groups, treatment A, B and control group, is not significantly different in RPE squat across 12 weeks of obesity fitness management simultaneously.

Table 4.4.21.5: Pairwise Comparisons

Pairwise Comparisons						
Measure: MEASURE_1						
(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a]	
					Lower Bound	Upper Bound
Treatment A	Treatment B	-.113	.227	.620	-.564	.338
	Control	-.166	.229	.471	-.620	.289
Treatment B	Treatment A	.113	.227	.620	-.338	.564
	Control	-.053	.229	.818	-.507	.402
Control	Treatment A	.166	.229	.471	-.289	.620
	Treatment B	.053	.229	.818	-.402	.507
Based on estimated marginal means						
a. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).						

There is no significant difference of RPE squat between all groups (all Sig. Values are larger than 0.05).

Table 4.4.21.6: Pairwise Comparisons

Pairwise Comparisons						
Measure: MEASURE_1						
(I) PrePost	(J) PrePost	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
1	2	-.186*	.049	.000	-.283	-.089
2	1	.186*	.049	.000	.089	.283
Based on estimated marginal means						
*. The mean difference is significant at the .05 level.						
b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).						

There is a significant mean changes from time 1 to time 2 at 5% level.

4.7 Post intervention- 2-years follow up was conducted on weight and waist on the subjects.

Here are the results:

4.7 Post 2-year post follow up study on Weight and Waist Reduction

4.7.1 Post 2-year follow up on Weight Reduction

Table 4.7.1.1: Post 2-year follow up on Weight Reduction

Descriptive Statistics				
	Group	Mean	Std. Deviation	N
Wtpre	Synchronous Music	78.13	14.630	31
	AsynchronousMusic	76.71	10.422	31
	No Music	80.78	10.486	30
	Total	78.52	12.011	92
Wtpost14wks	Synchronous Music	71.49	11.683	31
	AsynchronousMusic	73.16	10.718	31
	No Music	77.09	9.863	30
	Total	73.88	10.927	92
Wtpost2yrs	Synchronous Music	70.319	11.5104	31
	AsynchronousMusic	72.881	10.8478	31
	No Music	80.967	10.3707	30
	Total	74.654	11.7199	92

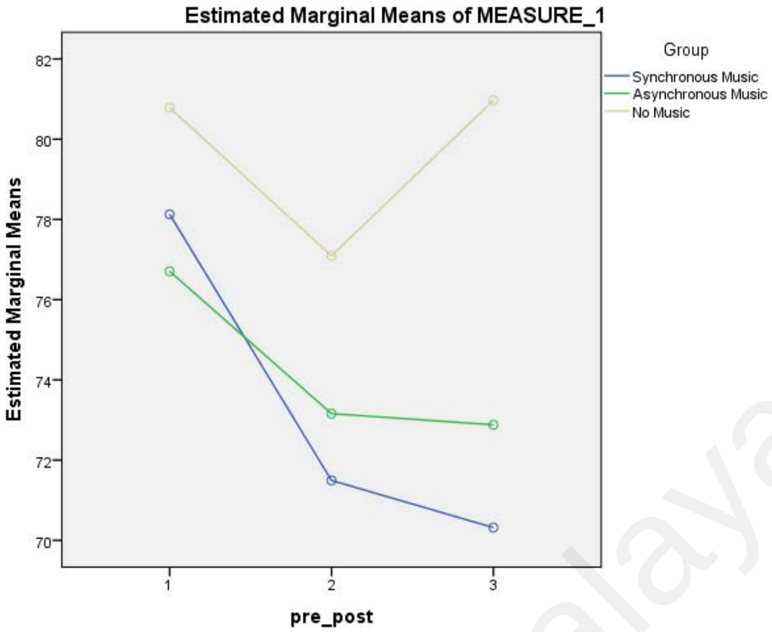

Figure 4.7.1.2: Post 2-year follow up on Weight Reduction

Table 4.7. 1.2: Levene's Test

Levene's Test of Equality of Error Variances[a]				
	F	df1	df2	Sig.
Wt pre	2.163	2	89	.121
Wt post	.479	2	89	.621
Wt2yrs	.435	2	89	.649
Tests the null hypothesis that the error variance of the dependent variable is equal across groups.				
a. Design: Intercept + Group Within Subjects Design: pre_post				

Since the significance values of sig. are larger than 0.01, we may use the Split-Plot ANOVA analysis because the assumption of equal variance is fulfilled.

Table 4.7.1.3: Box's Test of Equality of Covariance Matrices[a]

Box's M	40.978
F	3.247
df1	12
df2	38299.994
Sig.	.000
Tests the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups.	
a. Design: Intercept + Group Within Subjects Design: pre_post	

The significance value Box's test of equality of covariance matrices is less than 0.01, we use the Pillai's Trace test.

SPANOVA:

Table 4.7.1.4: Multivariate Tests

Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.
pre_post	Pillai's Trace	.637	77.299[b]	2.000	88.000	.000
	Wilks' Lambda	.363	77.299[b]	2.000	88.000	.000
	Hotelling's Trace	1.757	77.299[b]	2.000	88.000	.000
	Roy's Largest Root	1.757	77.299[b]	2.000	88.000	.000
pre_post * Group	Pillai's Trace	.338	9.051	4.000	178.000	.000
	Wilks' Lambda	.683	9.254[b]	4.000	176.000	.000
	Hotelling's Trace	.435	9.451	4.000	174.000	.000
	Roy's Largest Root	.347	15.450[c]	2.000	89.000	.000

From the Multivariate Tests table, we use the Pillai’s Trace test (since two assumptions have been fulfilled) to test whether there are differences between the means of identified groups of subjects on a combination of times (before, after 12 weeks and after 2 years of fitness management). Since the significance value (Sig.=0.000) is less than 0.05, we conclude that the mean score of three groups, synchronous music, asynchronous music and no music, is significantly different in weight across 12 weeks and 2 years of obesity fitness management simultaneously.

Table 4.7.1.5: Pairwise Comparisons

Pairwise Comparisons

Measure: MEASURE_1

					95% Confidence Interval for Difference[b]	
(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.[b]	Lower Bound	Upper Bound
Synchronous Music	Asynchronous Music	-.934	2.780	.738	-6.458	4.590
	No Music	-6.300*	2.803	.027	-11.870	-.731
Asynchronous Music	Synchronous Music	.934	2.780	.738	-4.590	6.458
	No Music	-5.366	2.803	.059	-10.936	.204
No Music	Synchronous Music	6.300*	2.803	.027	.731	11.870
	Asynchronous Music	5.366	2.803	.059	-.204	10.936

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

There is a significant difference of weight between Synchronous Music and No Music groups (Sig.=0.027 larger than 0.05). While, there is no significant difference between other paired of groups.

Table 4.7.1.6:Pairwise Comparisons

Pairwise Comparisons

Measure: MEASURE_1

(I) pre_post	(J) pre_post	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
1	2	4.625*	.383	.000	3.864	5.386
	3	3.817*	.600	.000	2.625	5.010
2	1	-4.625*	.383	.000	-5.386	-3.864
	3	-.807	.422	.059	-1.646	.032
3	1	-3.817*	.600	.000	-5.010	-2.625
	2	.807	.422	.059	-.032	1.646

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

There are significant changes from time 1 (pre test/before 12 weeks fitness management) to time 2 (post test/after 12 weeks fitness management) and time 1 to time 3 (post test/after 2 years fitness management) where both values of sig.=0.00 are less than 0.05. But there is no significant different changes from time 2 and time 3.

4.7.2 Post 2-year follow up on Waist Reduction

Table 4.7.2.1: Post 2-year follow up on Waist Reduction

Descriptive Statistics

	Group	Mean	Std. Deviation	N
Waist girth Pre	Synchronous Music	36.00	4.157	31
	Asynchronous Music	36.60	3.595	31
	No Music	36.97	2.603	30
	Total	36.52	3.504	92
Waist girth Post	Synchronous Music	33.58	3.006	31
	Asynchronous Music	34.48	3.242	31
	No Music	34.95	2.390	30
	Total	34.33	2.931	92
Waist2yrs	Synchronous Music	32.13	3.033	31
	Asynchronous Music	34.37	3.478	31
	No Music	37.18	3.166	30
	Total	34.53	3.809	92

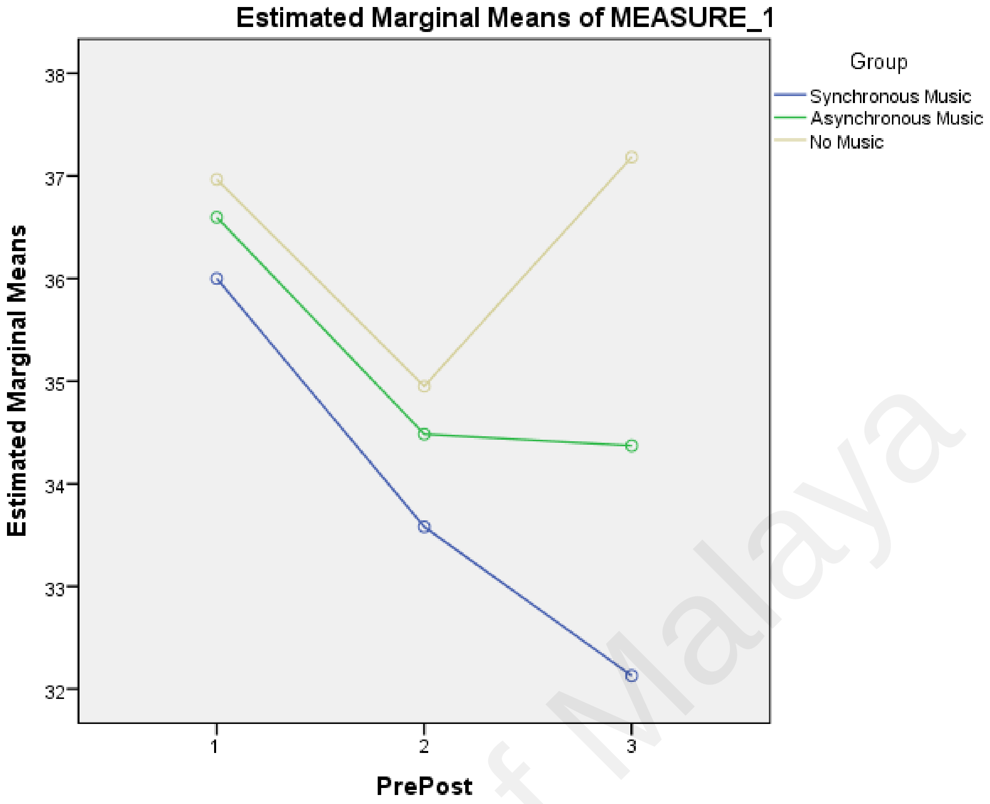

Figure 4.7.2.2: Post 2-year follow up on Waist Reduction

Table:

Levene's Test of Equality of Error Variances[a]				
	F	df1	df2	Sig.
Waist girth Pre	1.177	2	89	.313
Waist girth Post	.855	2	89	.429
Waist2yrs	.016	2	89	.984
Tests the null hypothesis that the error variance of the dependent variable is equal across groups.				
a. Design: Intercept + Group Within Subjects Design: PrePost				

Since the significance values of sig. are larger than 0.01, we may use the Split-Plot ANOVA analysis because the assumption of equal variance is fulfilled.

Table 4.7.2.2: Box's Test of Equality of Covariance Matrices[a]

Box's M	46.867
F	3.714
df1	12
df2	38299.994
Sig.	.000

Tests the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups.

a. Design: Intercept + Group

Within Subjects Design: PrePost

The significance value Box’s test of equality of covariance matrices is less than 0.01, we use the Pillai’s Trace test.

SPANOVA:

Table 4.7.2.3: Multivariate Tests

Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.
PrePost	Pillai's Trace	.521	47.762[b]	2.000	88.000	.000
	Wilks' Lambda	.479	47.762[b]	2.000	88.000	.000
	Hotelling's Trace	1.086	47.762[b]	2.000	88.000	.000
	Roy's Largest Root	1.086	47.762[b]	2.000	88.000	.000
PrePost * Group	Pillai's Trace	.337	9.012	4.000	178.000	.000
	Wilks' Lambda	.664	10.013[b]	4.000	176.000	.000
	Hotelling's Trace	.506	11.012	4.000	174.000	.000
	Roy's Largest Root	.505	22.474[c]	2.000	89.000	.000

a. Design: Intercept + Group

Within Subjects Design: PrePost

b. Exact statistic

c. The statistic is an upper bound on F that yields a lower bound on the significance level.

Multivariate Tests[a]

From the Multivariate Tests table, we use the Pillai's Trace test (since two assumptions have been fulfilled) to test whether there are differences between the means of identified groups of subjects on a combination of times (before, after 12 weeks and after 2 years of fitness management). Since the significance value (Sig.=0.000) is less than 0.05, we conclude that the mean score of three groups, synchronous music, asynchronous music and no music, is significantly different in waist across 12 weeks and 2 years of obesity fitness management simultaneously.

Table 4.7.2.4: Pairwise Comparisons

Pairwise Comparisons

Measure: MEASURE_1

					95% Confidence Interval for Difference[b]	
(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.[b]	Lower Bound	Upper Bound
Synchronous Music	Asynchronous Music	-1.247	.734	.093	-2.707	.212
	No Music	-2.463*	.741	.001	-3.935	-.992
Asynchronous Music	Synchronous Music	1.247	.734	.093	-.212	2.707
	No Music	-1.216	.741	.104	-2.688	.255
No Music	Synchronous Music	2.463*	.741	.001	.992	3.935
	Asynchronous Music	1.216	.741	.104	-.255	2.688

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

There is a significant difference of waist between Synchronous Music and No Music groups (Sig.=0.001 larger than 0.05). While, there is no significant difference between other paired of groups.

Table 4.7.2.5: Pairwise Comparisons

Pairwise Comparisons						
Measure: MEASURE_1						
(I) PrePost	(J) PrePost	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
1	2	2.183*	.223	.000	1.740	2.626
	3	1.960*	.317	.000	1.330	2.591
2	1	-2.183*	.223	.000	-2.626	-1.740
	3	-.223	.228	.330	-.675	.229
3	1	-1.960*	.317	.000	-2.591	-1.330
	2	.223	.228	.330	-.229	.675
Based on estimated marginal means						
*. The mean difference is significant at the .05 level.						
b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).						

There are significant changes from time 1 (pre test/before 12 weeks fitness management) to time 2 (post test/after 12 weeks fitness management) and time 1 to time 3 (post test/after 2 years fitness management) where both values of sig.=0.00 are less than 0.05. But there is no significant different changes from time 2 and time 3.

4.7.3 Post 2-year follow up on Waist-Hip Ratio

These are the Pre-post-2yrs post intervention analysis.

Table 4.7.3.1 Post 2-year follow up on Waist-to-Hip Ratio

Descriptive Statistics				
	Group	Mean	Std. Deviation	N
Waist/Hip Ratio Pre	Synchronous Music	.83	.063	31
	Asynchronous Music	.84	.046	31
	No Music	.82	.051	30
	Total	.83	.054	92
Waist/Hip Ratio Post	Synchronous Music	.84	.069	31
	Asynchronous Music	.85	.055	31
	No Music	.83	.052	30
	Total	.84	.060	92
Waist/Hip Ratio 2yrs	Synchronous Music	.81691	.072558	31
	Asynchronous Music	.84832	.050828	31
	No Music	.83549	.064234	30
	Total	.83356	.063813	92

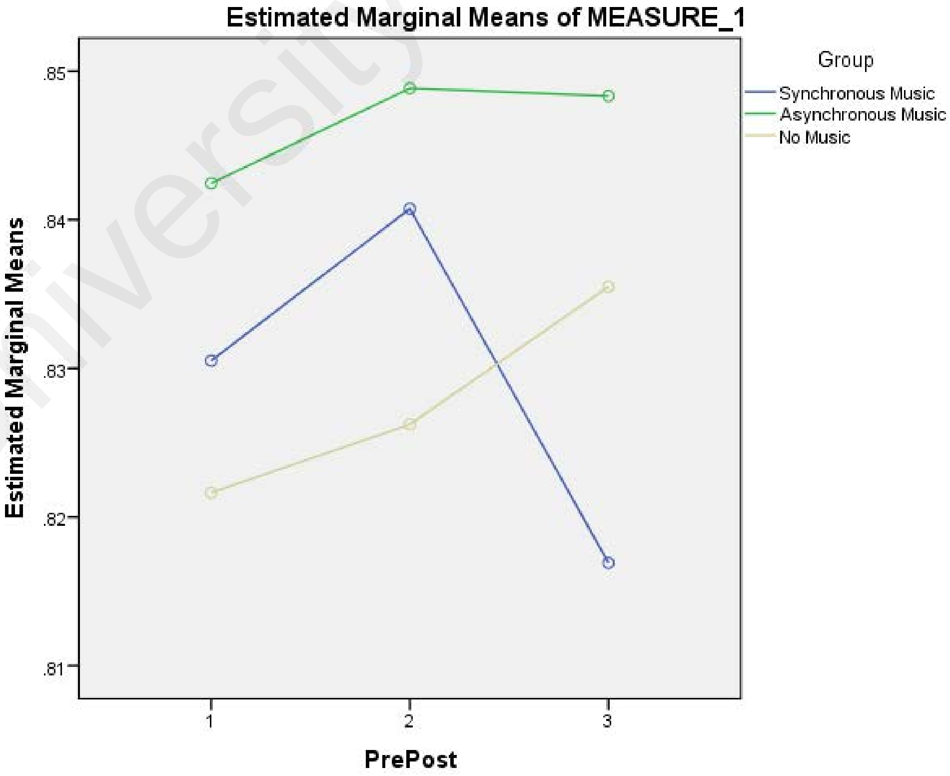

Figure 4.7.3.1: Post 2-year follow up on Waist-to-Hip Rati

Table 4.7.3.2: Levene's Test of Equality of Error Variances[a]

Levene's Test of Equality of Error Variances[a]				
	F	df1	df2	Sig.
Waist/Hip Ratio Pre	.488	2	89	.616
Waist/Hip Ratio Post	.222	2	89	.801
Waist/Hip Ratio 2yrs	.417	2	89	.660
Tests the null hypothesis that the error variance of the dependent variable is equal across groups.				
a. Design: Intercept + Group Within Subjects Design: PrePost				

Since the significance values of sig. are larger than 0.01, we may use the Split-Plot ANOVA analysis because the assumption of equal variance is fulfilled.

Table 4.7.3.3: Box's Test of Equality of Covariance Matrices[a]

Box's Test of Equality of Covariance Matrices[a]	
Box's M	41.192
F	3.264
df1	12
df2	38299.994
Sig.	.000
Tests the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups.	
a. Design: Intercept + Group Within Subjects Design: PrePost	

The significance value Box’s test of equality of covariance matrices is less than 0.01, we use the Pillai’s Trace test.

SPANOVA:

Table 4.7.3.4: Multivariate Tests

Multivariate Tests[a]						
Effect		Value	F	Hypothesis df	Error df	Sig.
PrePost	Pillai's Trace	.033	1.503[b]	2.000	88.000	.228
	Wilks' Lambda	.967	1.503[b]	2.000	88.000	.228
	Hotelling's Trace	.034	1.503[b]	2.000	88.000	.228
	Roy's Largest Root	.034	1.503[b]	2.000	88.000	.228
PrePost * Group	Pillai's Trace	.116	2.743	4.000	178.000	.030
	Wilks' Lambda	.884	2.801[b]	4.000	176.000	.027
	Hotelling's Trace	.131	2.858	4.000	174.000	.025
	Roy's Largest Root	.131	5.846[c]	2.000	89.000	.004

a. Design: Intercept + Group
Within Subjects Design: PrePost

b. Exact statistic

c. The statistic is an upper bound on F that yields a lower bound on the significance level.

Multivariate Tests[a]

From the Multivariate Tests table, we use the Pillai's Trace test (since two assumptions have been fulfilled) to test whether there are differences between the means of identified groups of subjects on a combination of times (before, after 12 weeks and after 2 years of fitness management). Since the significance value (Sig.=0.030) is less than 0.05, we conclude that the mean score of three groups, synchronous music, asynchronous music and no music, is significantly different in waist/hip ratio across 12 weeks and 2 years of obesity fitness management simultaneously.

Table 4.7.3.5: Pairwise Comparisons

Pairwise Comparisons

Measure: MEASURE_1

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a]	
					Lower Bound	Upper Bound
Synchronous Music	Asynchronous Music	-.017	.013	.207	-.044	.010
	No Music	.002	.014	.906	-.025	.029
Asynchronous Music	Synchronous Music	.017	.013	.207	-.010	.044
	No Music	.019	.014	.171	-.008	.046
No Music	Synchronous Music	-.002	.014	.906	-.029	.025
	Asynchronous Music	-.019	.014	.171	-.046	.008

Based on estimated marginal means

a. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

There is no significant difference of waist/hip ratio between all groups (all Sig. Value are larger than 0.05).

Table 4.7.3.6: Pairwise Comparisons

Pairwise Comparisons

Measure: MEASURE_1

(I) PrePost	(J) PrePost	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a]	
					Lower Bound	Upper Bound
1	2	-.007	.005	.129	-.016	.002
	3	-.002	.005	.697	-.012	.008
2	1	.007	.005	.129	-.002	.016
	3	.005	.004	.223	-.003	.013
3	1	.002	.005	.697	-.008	.012
	2	-.005	.004	.223	-.013	.003

Based on estimated marginal means

a. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

There is no significant changes from time 1, time 2 and time 3.

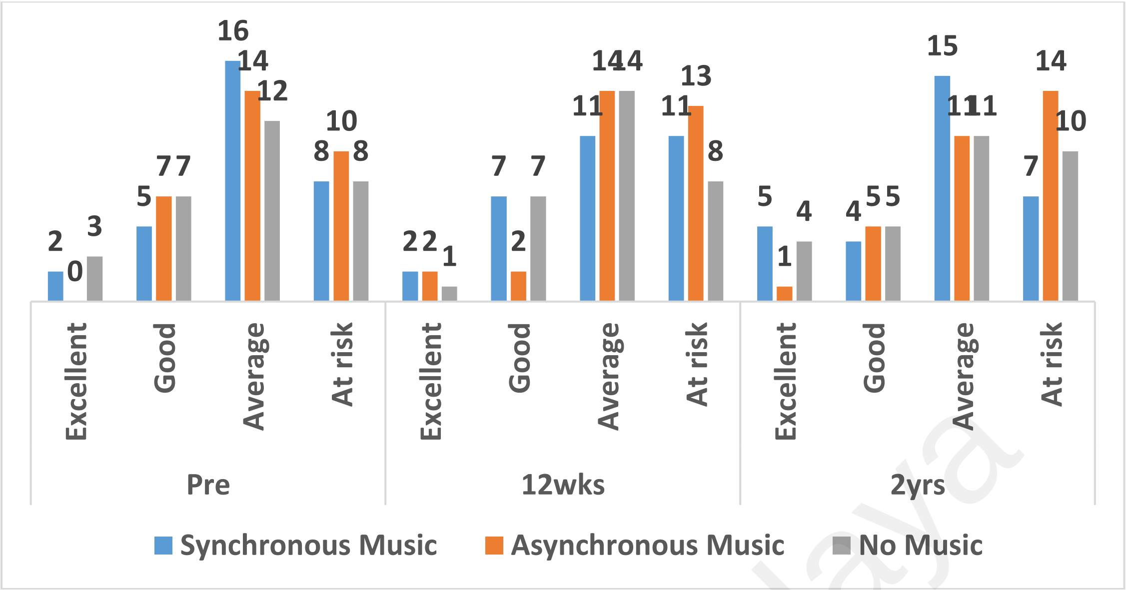

Figure 4.7.3.2: Changes in Risks Levels of Waist-to-Hip Ratio of all groups

Table: 4.7.3.7 Crosstabulations

Group * WHR_Group Crosstabulation						
Count						
		WHR_Group				Total
		Excellent	Good	Average	At risk	
Group	Synchronous Music	2	5	16	8	31
	Asynchronous Music	0	7	14	10	31
	No Music	3	7	12	8	30
Total		5	19	42	26	92

Group * WHR_Groupwks Crosstabulation						
Count						
		WHR_Groupwks				Total
		Excellent	Good	Average	At risk	
Group	Synchronous Music	2	7	11	11	31
	Asynchronous Music	2	2	14	13	31
	No Music	1	7	14	8	30
Total		5	16	39	32	92

Group * WHR_Groupyrs Crosstabulation						
Count						
		WHR_Groupyrs				Total
		Excellent	Good	Average	At risk	
Group	Synchronous Music	5	4	15	7	31
	Asynchronous Music	1	5	11	14	31
	No Music	4	5	11	10	30
Total		10	14	37	31	92

APPENDIX A

APPENDIX B

APPENDIX C

APPENDIX D

APPENDIX E

APPENDIX F

APPENDIX G

APPENDIX H

APPENDIX I

APPENDIX J

APPENDIX K