EFFECTS OF PHYSICAL TRAINING AND BEHAVIOURAL STRATEGIES TOWARDS MUSCLE STRENGTH AND MENTAL HEALTH IN THE ELDERLY

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ABSTRACT

The promotion of physical training (PT) and positive behavior in the elderly requires effective interventions. This study shows the effect of PT during an 11-week intervention program by applying behavioral strategies. A total of 63 participants aged 65 years old were randomly divided into three groups: Physical with a behavioral group, PB (*n*=18), Physical group, PG (*n*=23), and Control group, CG (*n*=22). PB and PG participants underwent a six-week group-based multi-component PT for one hour per session, three sessions a week. After PT, participants in PB began five-week behavioral exercises for 30 min, twice a week. Meanwhile, CG participants only have to maintain their daily routines. Upper and lower limb muscle strength and mental health were assessed. Results from repeated measures ANOVA showed significant differences between groups due to time factor, group and time interaction, and between-group factor ($p<0.05$) for Right UL, Left UL, and LL strength. Analysis of covariance (ANCOVA) for mental health [$F(2.58) = 33.49$] ($p<0.05$)] showed significant main effects among participants in PB, thus indicating improved mental health. In conclusion, combined of PT and behavioral strategies may be a promising strategy in enhancing better physical and mental well-being of the elderly.

Key words: Behavioural, elderly, mental health, physical

INTRODUCTION

The world's elderly continues to grow at an unprecedented rate. In Malaysia, the population aged 60 years and above has increased from 10.3% in 2019 to 10.7% in 2020 (Department of Statistics Malaysia, 2020). By the year 2030, Malaysia is estimated to be an aging country, with 15% of the elderly population (Saharani *et al*., 2016). As the aging population is increasing every year, extra care needs to be paid to the elderly to ensure their well-being at an optimal stage. (Ramely *et al*., 2017). Physical inactivity levels are rising in developing countries, and Malaysia is no exception (Guthold *et al*., 2008; Bauman *et al*., 2009). A previous study by Sazlina, Browning, and Yasin (2012) reported that the level of physical activity is low, and most of the

Malay older persons are sedentary. This may suggest that an intervention is needed, especially for older persons living in Malaysia, to continue engaging in physical activity and seeking healthy lifestyles.

In aging, humans are slowly and steadily losing skeletal muscles that are primarily replaced by adipose and fibrous tissues (Mobasheri, 2012). A decline in muscle strength, slowing down muscle reflexes, and a lack of flexibility are the corresponding losses (Ketcham & Stelmach, 2004). Research has claimed that muscle mass and strength are mainly related to a decline in skeletal muscle mitochondria (Peterson *et al*., 2012). In 2012, Peterson and his colleagues discovered that mitochondria were altered by several mechanisms, including increased mitochondrial DNA mutations, decreased mitochondrial activity, lower respiratory function, and possibly apoptosis. In the elderly, this

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leads to progressive muscle loss which resulted in sarcopenia and dynapenia.

Physical activity in the elderly may further be restricted due to overall deterioration in muscle function, which made them prone to risky incidence such as falls. Hence, it is important to have adequate skeletal muscle strength for better physical functioning and low muscle strength is a predictor of physical limitation in the elderly (Wilson *et al.*, 2011). As seen in positive ways, the correlation of muscle function and age might be managed by controlling the involvement of individual physical activities despite their aging process.

As the most common mental disorder, depression did seriously affect the elderly, especially those who have other general conditions of comorbidities (Alcalá *et al.*, 2007). In 2011, Mukhtar and Oei found that the total prevalence of depression in Malaysia was from 29% to 46%. It was reported that community-dwelling elder was suffering from major depressive, mild depression, and clinically related depressive syndrome with a prevalence of 1.8%, 9.8%, and 13.5% respectively (Beekman *et al.*, 1999).

Condition of depression might be associated with cognitive deterioration and dementia. However, the exact causes of depression pathology are still not understood (Beekman *et al.*, 1999). Most experiments have found that brain modifications are the leading cause of depression which is related to changes in the levels of dopamine, norepinephrine, and serotonin (Ballmaier *et al.*, 2004; Smith, 2008; Tsopelas *et al.*, 2011). These chemicals can affect mood and impulse in a person.

A psychiatric depression may be identified by a group of symptoms lasting for more than two weeks, including feelings of unbearable sadness and loss of enjoyment, such as sleep disruption, lack of energy, lack of focus, feelings of insignificance, and thoughts of suicide (Fitzgerald *et al.*, 2008). Elderly with depression are less likely to resolve the disorder and result in a poor state of health (Donaghy, 2007; Majdi *et al.*, 2011). Thus, this group of the population may trigger a worsening disease progression and changes in physical and psycho-logical functions. In exchange, they may have an impact on their health-related social functions (HRQOL) (Wada *et al.*, 2005; Majdi *et al.*, 2011; Salguero, Martínez-García, Molinero & Márquez, 2011). Previously the effect towards physical activities and behavioral components might become one of the challenging variables as it involves belief and different perceptions, thus results are inconclusive. Therefore, this current study aims to determine the effects of combined physical training and behavioral strategies towards muscle strength and mental health in the elderly.

MATERIALS AND METHODS

Participants

A controlled quasi-experimental analysis was carried out over an 11-week duration. Ninety elderly people over 60 years of age have been recruited from three separate villages around Selangor in Malaysia. Only one form of intervention was assigned to each village to prevent communications between the participants (Village 1 = PB; Village 2 = PG; Village 3 = CG). Until the intervention was implemented, eligibility was screened for all participants. Participants were included based on the following criteria: (1) aged 60 and above, (2) no cognitive impairments (< 24 were excluded for MMSE score), (3) active in daily life activities, (4) English or Malay comprehensible and (5) residing in the study setting. Participants who had chronic musculoskeletal issues, dementia or neurologic conditions, significant auditory disability, visual impairment, and unable to walk were removed from this research. This research included 73 elderly (PB = 25, PG = 25 and CG = 23) who met the inclusion criteria. At the end of the study, 18 in PB, 23 in PG, and 22 in CG dropped out in the study. Common explanations given by the dropout participants were transportation problems, time limitations, and bad weather.

Exercise and Behavioural Protocol

The PB has received a six-week training program with increasing frequency and intensity adapted from a previous study Azliyana and Maria (2016). The exercise program finished with another five weeks of a behavioral program. For six weeks the PG received the same protocol as in the PB group, but without the behavioral program. In contrast, no intervention but instructions were given to the control group (CG) to continue its regular activities. The measurements were taken at baseline, 12th and 24th weeks. The University Ethics Committee accepted the procedure for this study. Each participant was guaranteed confidentiality and an option to withdraw without penalty at any time.

Measurements of muscle strength and mental health

The primary outcome of this research was muscle strength and mental health. The arm curl test was used in this study to measure the upper limb strength, which was the ability of the arm to lift a 5-lb dumbbell for women and an 8-lb dumbbell for males (Milanović *et al.*, 2013). The number of repetitions in 30 sec was recorded using a stopwatch. While, for the lower limb strength, the chair rise test was used (Milanović *et al.*, 2013). In this test, the number of repetitions performed (sit to stand) in 30 sec was measured. While for mental health, the 15-items Geriatrics Depression Scales were used to

obtain the level of depression among the elderly (Kørner *et al*., 2006). According to Nyunt *et al*. (2009) the GDS-15 is a reliable and valid screening tool for Major Depressive Disorder across different ages, gender, ethnicity, and chronic illness status in the community and social service setting. The 15-item GDS was found to have sufficient internal consistency reliability (α=0.86) and retest reliability (r=0.81) to support its use as a clinical instrument (Brown & Schinka, 2005).

Statistical Analysis

The key findings of this analysis were improvements in muscle strengths and depression levels. Results have been recorded as standard deviations (SD) and mean (m). The baseline demographic differences between groups were calculated with a one-way ANOVA and Chi-square test. The covariance analysis was carried out to assess the existence of confusing variables for all classes in baselines. The repeated measurement variance analyses (ANOVA) were used to determine whether time factor effects, group effects, and interaction between the two variables (group and time) were present for all groups. For all statistical studies, an alpha level was considered significant.

RESULTS

The final sample included 63 people (18 from PB, 23 from PG, and 22 from the CG group) with demographic characteristics tabulated in Table 1. Subjects' average age was 63.8 (SD = 4.5 years). Mean height, body weight and BMI were 1.55 (SD = 0.12 m), 63.53 kg (SD = 10.87 kg) and 26.42 kg/m^2, respectively (SD = 4.52 kg/m^2). There were no substantial demographic differences between groups except for the age variable where the significant difference was observed between PB and CG $p<0.05$, refer to Table 1.

The repeated ANOVA tests on both the upper and lower limb strength were carried out. The study showed that none of the Levene's Tests was significant for both variables (all $p>0.05$), which is why it can be concluded that variances are homogeneous. In right upper limb, this study indicated that the lag period (baseline, week 12 & 24), [F (2.46, 147.37) = 61.11, $p>0.05$, η^2=0.51] has important effect on all three categories. There is also a significant time and group interaction difference [F(4.91, 147.37)= 71.79, $p<0.05$, α=0.71] and inter-group influence, [F(2,60)=63.83, $p<0.05$, η^2=0.68]. A significant has been shown in mean differences

Table 1. Demographic characteristic of the study sample

Characteristic	Group PB (*n*=18)		Group PG (*n*=23)		Group CG (*n*=22)		F test
	n (%)	m±SD	*n* (%)	m±SD	*n* (%)	m±SD	(*P*-value)
Age (years)		66.1 (6.21)		63.5 (3.39)		62.3 (3.07)	F=3.943, 0.025 *
Gender							F=0.872, NS
Male	8 (44.4)		15 (65.2)		12 (54.5)		
Female	10 (55.6)		8 (38.4)		10 (45.5)		
Bodyweight (kg)		59.82 (3.33)		65.89 (2.16)		64.19 (1.66)	F=1.642, NS
Height (m)		1.53 (0.03)		1.56 (0.02)		1.57 (0.02)	F=0.659, NS
BMI (kg/m^2)		25.83 (1.58)		27.05 (0.65)		26.27 (0.76)	F=0.370, NS
Marital status							F=1.225, NS
Single	–		2 (8.7)		–		
Married	17 (94.4)		18 (78.3)		19 (86.4)		
Divorced	1 (5.6)		1 (4.3)		3 (13.6)		
Widowed	–		2 (8.7)		–		
Education level							F=40.630, *p*<0.05
Never school	4 (22.2)		2 (8.7)		-		
Primary school	9 (50.0)		18 (78.3)		14 (63.6)		
Secondary school	4 (22.2)		3 (13.0)		8 (36.4)		
Others	1 (5.6)		–		–		
Working status							F=2.360, NS
Housewife	5 (27.8)		4 (17.4)		5 (22.7)		
Non-technical	9 (50.0)		6 (26.1)		9 (40.9)		
Work	2 (11.1)		2 (8.7)		2 (9.1)		
Technical work	2 (11.1)		5 (21.7)		4 (18.2)		
Retired	–		6 (26.1)		2 (9.1)		
Never work	–		–		–		

Data presented in mean and standard deviationp>0.05: Non-significant= NS.

($p<0.05$) between the groups of right upper limbs (PB & PG=5.34; PB & PG=8.65; PG & CG=3.31). Similarly in left upper limb strength, the analysis showed a significant difference in the time factor, [$F(2.49,149.12) = 35.33$, $p<0.05$, $\eta^2=0.37$]; time and group interaction, [$F(4.97,149.12) = 60.90$, $p<0.05$, $\eta^2=0.67$], and between group effect, [$F(2,60) = 45.48$, $p<0.05$, $\eta^2=0.60$]. The post hoc test showed significant mean differences ($p < 0.05$) for left upper limb strength among groups (PB & PG = 5.06; PB & PG = 8.22; PG & CG = 3.16). In terms of the lower limb strength, the study revealed a substantial differences between the time factor of [$F(2.55,152.94) = 95.81$, $p<0.05$, $\mu2=0.70$]; time and group interaction, and between the effects of the group of time and group of time of [$F(5.10,152.94)$] [$F(5.10,152.94) = 31.25$, $p<0.05$, $\mu2=0.51$] and group of effects. The post-hoc test revealed considerable mean differences of the

limb intensity ($p<0.05$) between the different groups (PB & PG = 4.44; PB & CG = 6.41; PG & CG = 1.97). Refer Table 2.

A significant main effect was found on level of depression among the three groups [$F(2,58) = 33.49$, $p<0.05$, $\eta^2=0.54$] following the completion of the programs. Participants in PB (adjusted mean, M = 1.26, standard error, SE = 0.12) reported less depressed compared to EG (adjusted mean, M = 2.04, standard error, SE = 0.10) and CG (adjusted mean, M = 2.67, standard error, SE = 0.11). Results of pairwise comparisons reported significant differences between PB and PG (mean difference = 0.78, standard error, SE = 0.15), EPB and CG (mean difference = 1.40, standard error, SE = 0.17), as well as PG and CG (mean difference = 0.62, standard error, SE = 0.16) with all $p<0.05$. Refer Table 3.

Table 2. Muscle strengths at baseline, 12th, and 24th weeks

Right upper limb strength

Time	PB (*n*=18)	PG (*n*=23)	CG (*n*=22)	Sig.	Mean difference between-group (F-test)
	Mean (SD)	Mean (SD)	Mean (SD)		
Baseline	11.39 (2.06)	10.83 (1.99)	11.36 (2.61)	0.65	PB-PG = 0.56 PB-CG = 0.03 PG-CG = 0.54
12th weeks	20.28 (3.80)	15.43 (2.45)	10.73 (2.88)	0.00 *	PB-PG = 4.84* PB-CG = 9.55* PG-CG = 4.71*
24th weeks	22.56 (3.33)	11.04 (2.55)	8.68 (1.91)	0.00 *	PB-PG = 11.51* PB-CG =13.87* PG-CG = 2.36*

Left upper limb strength

Baseline	11.50 (2.43)	12.39 (3.49)	12.86 (3.11)	0.38	PB-PG = 0.89 PB-CG = 1.36 PG-CG = 0.47
12th weeks	20.17 (4.40)	14.91 (2.92)	10.32 (2.89)	0.00 *	PB-PG = 5.25* PB-CG = 9.85* PG-CG = 4.60*
24th weeks	21.44 (3.76)	10.83 (2.81)	8.36 (1.99)	0.00 *	PB-PG = 10.62* PB-CG = 13.08* PG-CG = 2.46*

Lower limb muscle strength

Baseline	9.06 (1.16)	9.26 (1.45)	8.91 (1.85)	0.74	PB-PG = 0.21 PB-CG = 0.15 PG-CG = 0.35
12th weeks	18.44 (3.42)	13.00 (1.62)	11.86 (2.05)	0.00 *	PB-PG = 5.45* PB-CG = 6.58* PG-CG = 1.14
24th weeks	19.50 (2.81)	11.35 (2.12)	9.68 (2.08)	0.00 *	PB-PG = 8.15* PB-CG = 9.82* PG-CG = 1.67

Note: *$p>0.05$: Non-significant = NS.

Table 3. (A) Analysis of co-variance and (B) Pairwise comparisons of three interventions groups by the level of depression score

(A) Source	SS	Df	MS	F	P
Depression score	8.587	1	8.587	38.428	0.00*
Groups	14.965	2	7.483	33.485	0.00*
Error	12.961	58	0.223		
Total	56.774	61			
(B) Variables/Group	Mean	Adjusted Mean	EBG	EG	CG
Depression scores					
PB	1.0588	1.257	–	–	–
PG	1.8986	2.036	.778*	–	–
CG	2.9545	2.658	1.401*	.622*	–

Note: *p>0.05: Non-significant = NS.*

DISCUSSION

The PB participants conducted the workout continuously, even though the structured monitoring of the exercise had ended. The increase in muscle strength may be attributed in part to the resistance training integrated into the multiple component exercise training because it can continuously stimulate the synthesis of muscle protein in the skeletal muscle (Yang & Li, 2012). Besides, the resistance training was conducted at moderate to high intensity, twice a week, as indicated in the previous research (Chodzko-Zajko et al., 2009), and one meta-analysis (Peterson et al., 2012) could increase lean muscle mass and strength of elderly. Besides, the therapeutic program may have helped participants in the PB to maintain their exercise commitment and self-esteem. This is partly because they received a talk about the value of exercise within the behavioral program, determined their target setting, and received constructive self-talk. In the present research, the investigator found out, despite aging circumstances, a behavioral program would successfully improve sensitivity and change attitudes to exercise participation.

The researchers claimed that the implementation of a strengthening management approach to the behavioral program for PB participants had gained constructive incentives and are a role model for others to change their behavior. They played, for example, "UniFitt Garden," enabling the members to grow their gardens with their companions or groups. When participants reach their target in the garden project, which is 10,000 steps a day, the garden with different flowers will become nicer and enjoyable. This activity provides a fun and promotes the social support of the wives and friends of the elderly (Henderson & Ainsworth, 2003).

Unlike the PG and CG participants, they were not sensible and encouraged enough to practice at home. They may think that exercise is another program or practice that is negative to their everyday routine. The side effects of workouts such as fatigue, sweat, and muscle soreness can also be due to poor motivation (Williams et al., 2002). In addition, sudden termination of exercises in the PG may lead to a loss of teammates, group results, and instructors' enthusiasm as these aspects are seen as obstacles to continue participatory action (Guerin et al., 2008). Contrasting to PB, participants in PG and CG do not provide motivational service, social support, or behavioral curriculum. These additional and external factors affect whether a person can continue or stop practicing active routine (Cohen-Mansfield et al., 2003; Schutzer & Graves, 2004). The individual physical effects of exercise will take several weeks to be identified. Therefore, after six weeks of detraining, their muscle strength will steadily decrease (Toraman & Ayceman, 2005).

Similarly, the participants in CG displayed the lowest efficiency in all muscle functions. The decline in muscle strength with aging is also correlated with both physical inactiveness and a decrease in different skeletal muscle functions because of natural aging processes. These physiological changes include decreased contractility (Faulkner et al., 2007), musculature atrophy (Suetta et al., 2013), increased occurrence of various neuromuscular conditions (Sharma & Goodwin, 2006). Sedentary individuals with a lack of physical activities may be at risk of physical disabilities due to generalized muscle weakness.

In the three groups, the lowest degree of depression was found in PB compared with the other groups following the conclusion of the research. The adaptation in PB might be influenced by the

behavioral techniques applied in this research, such as the "motivational interview". Participants can also feel relaxed since it is a customer-focused approach that is not only based on the teaching of new mental skills but also equipped to improve their self-esteem. Training programs have strengthened optimistic moods in aging stable communities, as previous studies have shown clinically that exercise helps to avoid or minimize depressive severity whether as a complementary or alternative to depression (Sjösten & Kivelä, 2006; Taekema *et al*., 2010).

Research has shown that exercise training can lead to substantial dendritic remodeling (Yau *et al*., 2011) and can facilitate the development of adult hippocampal neurogenesis (Folstein, 2007; Helmich *et al*., 2010) in the brain. Exercises have improved mechanism happens as the synthesis of brain neurons in the brain rises approximately 2 to 3 fold in the hippocampal region. (Craft & Perna, 2004), β- endorphin levels (Craft & Perna, 2004) and endothelial vascular growth factor (VEGF) (Ernst *et al*., 2006). The mechanism helps to increase the growth of β- Endorphins and extend their survival by stimulating VEGF and BDNF of new neurons in the dentate gyrus. 5-HT increases the mechanism of cell proliferation and improves neurogenesis (Craft & Perna, 2004). As early as 3 days, participants in PB and PG who have been trained may experience neurogenesis after the beginning of the training. When this occurs, the depression level may be lowered or sustained.

The increase in the PB standard may also be clarified because of the length of training. Those in the PB community may have extended their workout time because the therapeutic modification has improved them. According to Manos in his study, the Behavioural Activation Model of depression included strengthening, mood, actions, and depression in the relationship of the four main components that have a significant effect on one's behavior (Manos *et al*., 2010).

During the behavioral lessons, deep breathing exercises have been shown to alleviate depressive symptoms by increasing heart rate variability and parasympathetic response (Chung *et al*., 2010). As each of the participants in PMR played alternating muscle tension and relaxation involving major muscles such as neck (trapezius, sternocleidomastoids), shoulder (deltoids), chest (pectoral major), legs (hamstrings, quadriceps), wrist & hand (flexors, extender). During PMR, the participants had to focus their mind on the muscle group with closed eyes for 10 s (stress) and release it for 20 s, before proceeding with the next muscle group. The difference between feelings of tension and relaxation may require great attention, thus making them beneficial in handling positive sense, and therefore can lead to lower levels of depression.

CONCLUSION

There are certain limitations on the generalizability of these effects. For example, those with serious and major depressive diseases do not apply. The elderly with serious depression may need antidepressant medication and a personal approach. Moreover, the potential impact of attention and support by therapeutic alliances among PB subjects may occur. These differences need to be highlighted, and subsequent research should rely on handling the same exposure and regulated setting. Based on this study's hypothesis, it can now be stated that 6-week training in conjunction with a 5-week behavioral program can have beneficial effects on muscle strengths and mental health in the elderly.

ACKNOWLEDGEMENTS

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