Original Article

Effects of Six Weeks Donkey Kick and Squat Resistance Exercises on Gluteal Adiposity, Muscle Strength, and Muscle Bulk of Young Nigerian Female Adults: A Randomized Controlled Trial

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Abstract

Background: Rounded protruding gluteus has been asserted to be an important feature of feminine beauty and self-image. Currently, there is large influx of gymnasiums to achieve this end as claimed by gym operators amid the dearth in literature to support their claims. **Aim:** The aim of this study was to provide an empirical evidence to support or disprove claims about the effectiveness of resistance training exercises such as squats and donkey kick on the gluteal muscles. **Materials and Methods:** Randomized controlled trial involving 111 young females, aged 18–30 years, were equally assigned into the squat group (SG), donkey kick group (DKG), and control group (CG) using table of random numbers method. Outcomes, such as gluteal muscle strength (GMS), gluteal muscle bulk (GMB), and gluteal adiposity (GA), were assessed at baseline, third week, and sixth week and analyzed descriptively and inferentially ($\alpha = 0.05$). **Result:** The post-intervention across group comparison revealed a significant difference in right ($F = 4.829$, $P = 0.010$) and left ($F = 7.252$, $P = 0.001$) GA, right ($F = 12.467$, $P < 0.0001$) and left ($F = 10.235$, $P < 0.0001$) GMS, and in the GMB ($F = 8.280$, $P = 0.001$). The *post hoc* test showed that the SG had the most profound effect in increasing GMS and GMB, whereas the DKG had a superlative effect on GA. **Conclusion:** Six weeks resistant training using squats and donkey kick can be used to improve gluteal muscle characteristic by building GMB, GMS and reducing GA of young female adults.

Keywords: *Donkey kick resistance exercise, gluteal adiposity, gluteal muscle bulk, gluteal muscle strength, squat resistance exercise*

Introduction

Body image is a significant developmental concern for both men and women. Adolescents and young adults are susceptible to pressure to conform to perceived standards of physical appearance, as these developmental periods are critical for the formation of one's identity related to physical self-evaluation and self-worth.[1] The round protruding gluteus signifies beauty, power, poise, and physical strength, especially among young women.[2] The size and shape of the buttocks are important attributes of feminine beauty. Some celebrities, especially in the movie and music industries, have risen to fame owing to their body image. This has led to a globalized trend of associating gluteal features with beauty and body image, which is being promulgated through media influence.[3,4]

The gluteus maximus is the strongest and biggest muscle in the body.[5] The gluteus maximus is not only a hip extensor but also plays an important role in pelvic

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and spinal stabilization. The gluteal muscles (gluteus maximus, gluteus medius, and gluteus minimus) stabilize the hip by counteracting gravity's hip adduction torque and maintaining proper leg alignment by eccentrically controlling adduction and internal rotation of the thigh.[6] When a skeletal muscle is subjected to an overload stimulus, it causes perturbations in myofibers and the related extracellular matrix.[7] This sets off a chain of myogenic events that ultimately leads to an increase in the size and amounts of the myofibrillar contractile proteins such as actin and myosin, as well as the total number of sarcomere in parallel.[8] This augments the diameter of individual fibers and results in an increase in muscle cross-sectional area.[9] The gluteus maximus is a combination of fast-twitch muscle fiber (rapid-firing fibers, which are tapped for bursts of speed or power) and slow-twitch muscle fibers (which are the workhorses during aerobic activities).[10] This implies that the gluteal muscles can benefit from both strength training with high load and low repetitions, for example, heavy-weight squats (to work the fast-twitch muscles), and with low load plus high repetition endurance exercises such as running and stair climbing (to work slow-twitch muscles).[10]

Resistance/strength training involves muscle contraction performed against a specific opposing force called resistance, for example, weight lifting. It gradually and progressively overloads the musculoskeletal system, thus strengthens and tones the muscles.[11] Numerous studies have documented that progressive resistance training causes gains in both strength and skeletal muscle size.[12-16] A study by Abe *et al*.[12] on whole body muscle hypertrophy from resistance training of three men for 16 weeks found a very significant increase in skeletal muscle mass. Seynnes *et al.*[13] worked with seven young healthy volunteers who performed bilateral leg extension three times per week on a gravity-free flywheel ergometer for 20 days; they not only found increased muscle strength, but also reported significant quadriceps muscle hypertrophy. Norrbrand *et al.*[14] studied flywheel resistance training for the quadriceps for 5 weeks using 15 healthy subjects and discovered increase in volume and strength of the individual muscles when viewed with magnetic resonance imaging (MRI). Similar increase in volume and strength was found in a study by Holcomb *et al.*[15] on the effect of hamstring-emphasized resistance training on hamstring-quadriceps strength ratios.

Resistance exercises such as deep squats maximally hit the gluteal muscles from a lengthened position, whereas donkey kick hit the gluteal muscles in contracted position.[16] Most effective gluteal muscles mass building workouts appear to incorporate both types of resistance exercises. Gym operators claimed they would put a lower-body workout together for someone focusing on adding more mass to their gluteal muscles, without losing hard earned muscles in their legs.[10,17] They have laid claims on the efficacy of resistance training exercises in building gluteal muscles but there is a dearth of empirical evidence to this regard. Also, the most effective type of resistance training for the gluteal muscles appears unknown. Hence, this study sought to assess and compare the efficacies of two modes of resistance training exercises targeted at building the gluteal muscles. We hypothesized that the squat and donkey kick resistance trainings would each produce significant effect on the gluteal muscle strength (GMS), gluteal muscle bulk (GMB), and gluteal adiposity (GA) among young women. We also hypothesized that the donkey kick will much more than the squat resistance training improve the GMS, GMB, and GA.

Materials and Methods

Experimental approach to the problem

This randomized control trial was conducted in the gymnasium of the department of medical rehabilitation, University of Nigeria. The trial duration was four months and it was registered and approved by the Health Research and Ethics Committee of the University of Nigeria Teaching Hospital (NHREC/05/01/2008B-FWA00002458-IRB00002323). Power analysis was used to estimate minimum sample size using G-power 3.1 software with a medium effect size (d = 0.36) and high power (0.95) to give a minimum of 75 participants (25 in each group). Adverts for recruitment of study participants was done using posters and fliers and social media adverts targeted at female undergraduates within the university environment. A total of 111 healthy females within the age-group of 18–30 (20.95 [1.79]) years, with mean body mass index (BMI) 21.61 (3.28) kg/m^2, and with grade 5 quadriceps muscle strength were included in the study after screening them with the Physical Activity and Readiness Questionnaire (PAR-Q and YOU).[18] Females with knee pathology or surgery, recent history of fall, and performing a gym program with any dietary restrictions or considerations were excluded from the study. A signed informed consent including detailed explanation about the purpose and procedure of the study was obtained from all the subjects before beginning the intervention. Demographic data were obtained from all the subjects before the intervention.

The following outcomes were assessed at baseline (pre-intervention), after 3 weeks of training (mid-intervention), and after 6 weeks of training (post-intervention):

- GA: This was assessed using Accu-Measure skinfold caliper to measure the skinfold thickness to the nearest millimeter.[19] This was taken at a point measured with tape from the greater trochanter to the middle (bulkiest area) of both the right and left buttocks for each participant—noting the landmark for retest.
- GMS: This was assessed as the product of weight (kg) and time (seconds) measured with Sandbag Muscle Strength Protocol (SMSP) (unit, kg/s).
- GMB: This was assessed as the circumference from the left greater trochanter as the reference point (unit, m).

Other parameters for body weight and adiposity measured were as follows:

- Body mass index (BMI): This was assessed in kg/m^2 using the following equation:

$$\text{BMI} = \text{weight}/(\text{height})^2$$

- Conicity index (CI): This was assessed using the following equation:

$$\text{CI} = \frac{\text{waist circumference (m)}}{(0.109)\times 1/\sqrt{[\text{weight(kg)}/\text{height(m)}]}}$$

- Abdominal volume index (AVI): This was assessed using the following equation:

$$\text{AVI} = \left[2\text{cm}(\text{waist})^2 + 0.7\text{cm}(\text{waist - hip})^2\right]/1000$$

CI and AVI are good measures of intra-abdominal fat and adipose tissue volumes and for estimation of obesity.[20,21]

Validation of SMSP

SMSP was used to assess the GMS in this study. This protocol was validated in a preliminary study that involved 30 participants (15 males and 15 females). The participants' age ranged from 18 to 29 years with a mean score of 23.17 (2.31) years. Each of the participants performed both the Delorme's quadriceps muscle strength protocol (DQMSP) (which was the gold standard for the SMSP) and also the SMSP. Their one repetition maximum (1 RM) was assessed using Delorme quadriceps muscle strength. Then, SMSP was assessed by lifting a sandbag (either 2.5, 5, 7, or 7.5 kg depending on the subject's capability) and timed with a stopwatch until the first sign of muscle fatigue (muscle fibrillation). On analysis, a significant positive correlation was found between DQMSP and SMSP ($r = 0.455$, $P = 0.012$) as shown in Table 1. Thus, the protocol is another correlate of Delorme's muscle strength test.

Procedure

One hundred and eleven subjects were randomly assigned into three equal groups (37 in each group): SG (squats only), DKG (donkey kick only), and CG (no intervention). The test groups (SG and DKG) were supervised during the training sessions, which lasted for 6 weeks for each person, three times weekly with at least a day interval, a total of 18 training sessions, and measurements were taken three times at 3-week interval: pre-, mid-, and post-intervention.

Phase 1 (week 1–3)

This phase required a total of 100 repetitions (reps) per session, with SG carrying 5 kg barbell and DKG wearing 2.5 kg sandbag on each lower limb around the ankle. Each session started with 5 min for warm-up exercises, followed by 20 reps and 2 min of rest interval until the 100th rep, and finally 5 min of cooldown exercises. The participants in DKG [Figure 1] performed 20 reps each on right lower limb followed by left lower limb before the 2 min rest; a total of 100 reps on each lower limb. The aforementioned interval protocol also was used for SG [Figure 2].

Phase 2 (week 4–6)

There was a progression in load at the second phase (from 5 to 10 kg); however, same 100 reps were performed in each training group. SG carried 10 kg barbell, whereas DKG wore 5 kg sandbag on each lower limb around

Table 1: Pilot study participants' variables (n = 30)

	Descriptive statistics				Pearson product moment correlation		
Variables	Min.	Max.	Mean	SD		DQMS	SMSP
Age	18.00	29.00	23.17	2.31	DQMSP	1	r = 0.455*
Sex	1	2	1.50	0.51			P = 0.012
Height	160.50	191.50	1.71.10	8.50			
Weight	45.80	91.10	64.35	12.10	SMSP	r = 0.455*	1
DQMSP	5.00	17.50	11.17	2.92		P = 0.012	
SMSP	35.00	175.00	75.67	33.50			

DQMSP = Delorme's quadriceps muscle strength protocol, Min = minimum, SMSP = sandbag muscle strength protocol, SD = standard deviation, Max = maximum the ankle totaling 10 kg. The training session started with 5 min of warm-up exercises, followed by 20 reps and 2 min of rest interval until the 100th rep, and finally 5 min of cooldown exercises.

Figure 1: A subject performing donkey kick with sandbag

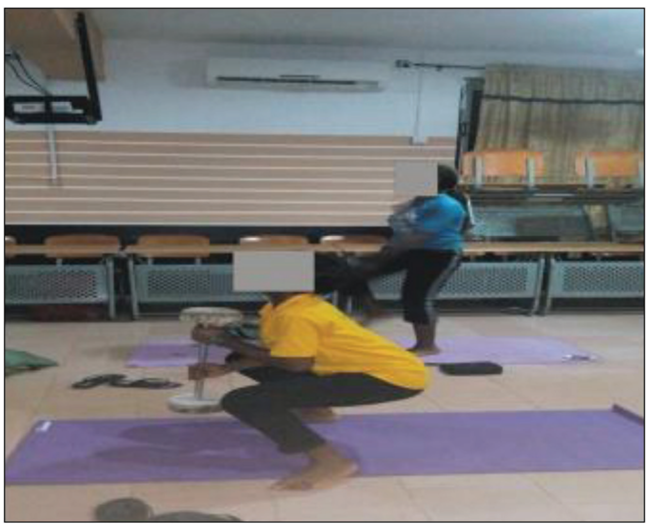

Figure 2: A subject performing squat with barbell

The warm-up exercise for the sessions in both phases included brisk walking, upper, and lower limb muscle stretching, whereas the cooldown exercises were basically stretches.

Statistical analyses

Data obtained were analyzed using the Statistical Package for Social Sciences software (SPSS, Chicago, Illinois), version 22.0. Descriptive statistics of mean, standard deviation, and frequency was used to summarize the participants' variables. Pearson product moment correlation was used in the validity pilot study to find correlation between the Delorme's quadriceps muscle strength protocol and the SMSP. One-way analysis of variance (ANOVA) was used to compare pre-intervention variables across the three groups (squat, donkey kick, and control). Analysis of covariance (ANCOVA) was used to compare mid- and post-intervention variables across the groups using the pre-intervention variables as the covariates (between groups comparison). Repeated measure analysis of variance (RE-ANOVA) was used to compare variables across time series (within group comparison). *Post hoc* Bonferroni correction was used for pair-wise comparison for only significant results in the aforementioned inferential analysis. Level of significance was set at $\alpha = 0.05$.

Results

Table 2 provides a general description of the study participants' characteristics at baseline.

Comparison of participants' variables at pre-intervention across the groups

At baseline, no significant difference was observed in BMI ($F = 1.744$, $P = 0.180$), right GA ($F = 0.496$, $P = 0.610$), left GA ($F = 2.133$, $P = 0.123$), right GMS ($F = 0.852$, $P = 0.430$), and left GMS ($F = 0.423$, $P = 0.656$) across the three groups, same as other variables [Table 3].

Table 2: Mean distribution of variable of participants (*n* = 111)

Variables	Mean	SD	Min.	Max.
Age (years)	20.95	1.79	18.00	28.00
Height (m)	1.68	0.07	1.53	1.86
Weight (kg)	60.83	9.57	44.00	90.00
Body mass index (kg/m^2)	21.61	3.28	15.70	33.26
Right GA (mm)	5.68	1.94	2.00	10.00
Left GA (mm)	5.64	1.91	2.00	10.00
Waist circumference (m)	0.76	0.07	0.61	1.01
GMB (m)	0.94	0.08	0.74	1.18
Conicity index	1.15	0.06	0.98	1.30
Abdominal volume index	11.77	2.31	7.81	20.46
Right GMS (kg/s)	66.11	44.85	12.50	230.00
Left GMS (kg/s)	67.78	43.37	12.50	200.00

GA = gluteal adiposity, GMB = gluteal muscle bulk, GMS = gluteal muscle strength, SD = standard deviation, Min = minimum, Max = maximum

Comparison of participants' variables at third week (mid-intervention) across the groups

Table 4 shows that there was no significant difference in BMI (*F* = 1.545, *P* = 0.220), right GA (*F* = 2.530, *P* = 0.086), and left GA (*F* = 2.542, *P* = 0.186). However, significant difference was noted in GMB (*F* = 6.243, *P* = 0.003), right GMS (*F* = 5.382, *P* = 0.006), and left GMS (*F* = 5.449, *P* = 0.006). The *post hoc* analysis with Bonferroni correction revealed that the significant difference in GMB was between CG and the DKG (mean difference [MD] = 0.021, *P* = 0.049) as well as between SG and DKG (MD = 0.028, *P* = 0.003).

Table 3: Comparison of pre-intervention variables across the groups using one-way ANOVA (*n* = 111)

Variables	Mean (standard deviation)					*P*
	Squat	Donkey kick	Control	*F*	*df*	
Age (years)	20.95 (1.89)	21.03 (1.82)	20.86 (1.72)	0.074	2, 108	0.928
Height (m)	1.68 (0.07)	1.68 (0.06)	1.67 (0.07)	0.400	2, 108	0.672
Weight (kg)	60.95 (10.27)	59.17 (7.72)	62.36 (10.47)	1.037	2, 108	0.358
Body mass index (kg/m^2)	21.53 (3.37)	20.95 (2.79)	22.36 (3.56)	1.744	2, 108	0.180
Right GMB (mm)	5.86 (2.03)	5.76 (1.69)	5.43 (2.09)	0.496	2, 108	0.610
Left GA (mm)	6.14 (2.00)	5.24 (1.61)	5.54 (2.04)	2.133	2, 108	0.123
Waist circumference (m)	0.75 (0.08)	0.75 (0.06)	0.76 (0.08)	0.182	2, 108	0.834
GMB (m)	0.93 (0.09)	0.93 (0.07)	0.96 (0.07)	1.725	2, 108	0.183
Conicity index	1.15 (0.07)	1.16 (0.06)	1.15 (0.05)	1.034	2, 108	0.359
Abdominal volume index	11.72 (2.54)	11.60 (1.89)	12.00 (2.48)	0.288	2, 108	0.750
Right GMS (kg/s)	61.01 (37.31)	63.47 (42.50)	73.85 (53.40)	0.852	2, 108	0.430
Left GMS (kg/s)	64.73 (42.63)	65.47 (39.29)	73.15 (48.39)	0.423	2, 108	0.656

ANOVA = analysis of variance, GA = gluteal adiposity, GMB = gluteal muscle bulk, GMS = gluteal muscle strength, *df* = degree of freedom, *P* = significance level

Table 4: Comparison of mid-intervention (third week) variables across the group using ANCOVA (*n* = 80)

Variables	Mean (standard deviation)			*F*	*df*	*P*
	Squat	Donkey kick	Control			
Weight (kg)	60.22 (9.16)	59.59 (8.51)	57.96 (7.66)	1.499	2, 79	0.230
Body mass index (kg/m^2)	21.24 (3.17)	20.78 (2.78)	20.48 (2.63)	1.545	2, 79	0.220
Right GA (mm)	5.36 (2.03)	5.55 (2.01)	5.04 (1.77)	2.530	2, 79	0.086
Left GA (mm)	5.36 (1.94)	5.34 (1.84)	5.07 (1.72)	2.542	2, 79	0.184
Waist circumference (m)	0.75 (0.07)	0.75 (0.07)	0.74 (0.06)	0.275	2, 79	0.761
GMB (m)	0.94 (0.07)	0.94 (0.07)	0.92 (0.06)	6.243	2, 79	0.003*
Conicity index	1.16 (0.05)	1.16 (0.05)	1.16 (0.05)	0.105	2, 79	0.900
Abdominal volume index	11.70 (2.22)	11.58 (2.16)	11.29 (1.79)	0.440	2, 79	0.645
Right GMS (kg/s)	75.69 (45.59)	82.33 (44.01)	78.57 (43.75)	5.382	2, 79	0.006*
Left GMS (kg/s)	71.99 (42.77)	81.38 (40.94)	73.93 (40.97)	5.449	2, 79	0.006*

ANCOVA = analysis of covariance, GA = gluteal adiposity, GMB = gluteal muscle bulk, GMS = gluteal muscle strength, *df* = degree of freedom, *P* = significance level

*Significant

Table 5: *Post hoc* (Bonferroni) analysis of third week ANCOVA comparison across groups

Variables	Groups	MD	SE	*P*
GMB (m)	Control–Squat	-0.007	0.008	1.000
	Control–DK	0.021	0.009	0.049*
	Squat–DK	0.028	0.008	0.003*
Right GMS (kg/s)	Control–Squat	-24.616	7.782	0.007*
	Control–DK	-18.819	7.833	0.056
	Squat–DK	5.797	7.607	1.000
Left GMS (kg/s)	Control–Squat	-24.069	7.368	0.005*
	Control–DK	-15.714	7.428	0.113
	Squat–DK	-8.355	7.226	0.753

ANCOVA = analysis of covariance, DK = donkey kick, GMB = gluteal muscle bulk, GMS = gluteal muscle strength, MD = mean difference, SE = standard error, *P* = significance level

*Significant

Likewise, pair-wise comparison between CG and SG revealed the significant difference to be found in right GMS (MD = 24.616, $P = 0.007$) and left GMS (MD = 24.069, $P = 0.005$) as shown in Table 5.

Comparison of participants' variables at sixth week (post-intervention) across the groups

Table 6 shows that there was a significant difference in each of the following variables across the groups: right GA ($F = 4.892$, $P = 0.010$), left GA ($F = 7.252$, $P = 0.001$), GMB ($F = 8.280$, $P = 0.001$), right GMS ($F = 12.467$, $P < 0.0001$), and left GMS ($F = 10.235$, $P < 0.0001$). In the *post hoc* analysis (with Bonferroni correction), comparison for right GA revealed that the significant difference existed only between the CG and DGK (MD = 1.494, $P = 0.012$), whereas in the left GA, the significant difference was found between the SG and CG (MD = 1.432, $P = 0.008$) and between DKG and CG (MD = 1.565, $P = 0.003$). Furthermore, the *post hoc* for GMB showed significant difference only between SG and DKG (MD = 0.021, $P = 0.049$). Then, the *post hoc* for right GMS revealed significant difference to lie in the pair-wise comparison between the SG and CG (MD = 35.412, $P < 0.0001$) and between DKG and CG (MD = 21.337, $P = 0.011$), whereas the left GMS revealed significant difference to lie in the pair-wise comparison between SG and CG (MD = 33.426, $P < 0.0001$) and between SG and DKG (MD = 21.336, $P = 0.017$) as shown in Table 7.

Comparison of participants' variables across time series for BMI, left, and right GA

There was a significant difference in BMI for the SG ($F = 3.807$, $P = 0.049$) and DKG ($F = 4.981$, $P = 0.023$)

Table 6: Comparison of post-intervention (sixth week) variables across the group using ANCOVA ($n = 80$)

Variables	Mean (standard deviation)			*F*	*df*	*P*
	Squat	Donkey kick	Control			
Weight (kg)	59.88 (9.04)	57.41 (7.84)	62.64 (10.66)	2.649	2, 83	0.077
Body mass index (kg/m^2)	20.92 (3.07)	20.37 (2.70)	22.35 (3.74)	2.696	2, 83	0.073
Right GA (mm)	4.76 (2.28)	4.52 (2.10)	5.59 (2.15)	4.829	2, 83	0.010*
Left GA (mm)	4.83 (2.04)	4.34 (1.84)	5.79 (1.82)	7.252	2, 83	0.001*
Waist circumference (m)	0.75 (0.07)	0.74 (0.06)	0.77 (0.08)	2.570	2, 83	0.083
GMB (m)	0.95 (0.07)	0.91 (0.06)	0.96 (0.07)	8.280	2, 83	0.001*
Conicity index	1.16 (0.05)	1.16 (0.04)	1.15 (0.05)	0.928	2, 83	0.399
Abdominal volume index	11.68 (2.08)	11.11 (1.68)	12.16 (2.57)	2.972	2, 83	0.057
Right GMS (kg/s)	89.91 (42.34)	80.17 (34.17)	55.74 (40.48)	12.467	2, 83	<0.0001*
Left GMS (kg/s)	92.50 (43.21)	74.57 (33.21)	59.05 (41.36)	10.235	2, 83	<0.0001*

ANOVA = analysis of variance, GA = gluteal adiposity, GMB = gluteal muscle bulk, GMS = gluteal muscle strength, *df* = degree of freedom, *P* = significance level

*Significant at P <0.05

Table 7: *Post hoc* (Bonferroni) analysis of sixth week (post-intervention) variables

Variables	Groups	MD	SE	*P*
Right GA (mm)	Control–Squat	1.175	0.503	0.066
	Control–DK	1.494	0.506	0.012*
	Squat–DK	0.319	0.499	1.000
Left GA (mm)	Control–Squat	1.432	0.462	0.008*
	Control–DK	1.565	0.451	0.003*
	Squat–DK	0.133	0.457	1.000
GMB (m)	Control–Squat	-0.015	0.008	0.221
	Control–DK	0.018	0.008	0.089
	Squat–DK	0.033	0.088	<0.0001*
Right GMS (kg/s)	Control–Squat	-35.412	7.142	<0.0001*
	Control–DK	-21.337	7.148	0.011*
	Squat–DK	14.075	7.155	0.158
Left GMS (kg/s)	Control–Squat	-33.426	7.481	<0.0001*
	Control–DK	-12.090	7.491	0.331
	Squat–DK	21.336	7.491	0.017*

GA = gluteal adiposity, GMB = gluteal muscle bulk, GMS = gluteal muscle strength, MD = mean difference, SE = standard error, *P* = significance level, DK = donkey kick

*Significant at $P < 0.05$

across the time series (pre-, mid-, and post-intervention BMI), and *post hoc* analysis (with Bonferroni correction) for BMI in SG found significant difference to lie only between the pre- and mid-intervention (MD = 0.893, P = 0.010) as shown in Table 8. Also, comparison of the mean adiposity for the right and left gluteus across the time series revealed a significant difference in all the groups (P < 0.05) except CG as both right GA (F = 2.700, P = 0.095) and left GA (F = 2.708, P = 0.078). Furthermore, the pair-wise comparison for right GA revealed the significant difference in SG to exist between mid- and post-intervention (MD = 0.893, P = 0.010) and also between the pre- and post-intervention (MD = 1.179, P = 0.022). Similar result was found in DKG where significant difference was found between mid- and post-intervention (MD = 1.704, P = 0.004) and between pre- and post-intervention (MD = 0.741, P = 0.041). The pair-wise comparison for left GA revealed significant difference in SG to exist between pre- and mid-intervention (MD = 0.821, P = 0.029) and between the pre- and post-intervention (MD = 1.500, P = 0.001). Equally, in DKG, significant difference was found between mid- and post-intervention (MD = 1.259, P = 0.024) and between pre- and post-intervention (MD = 0.889, P = 0.001) as shown in Table 9.

Table 8: Repeated measure ANOVA for weight (kg) and body mass index (kg/m²) time series

Variable	Greenhouse–Geisser				*Post hoc* (Bonferroni) analysis			
	Group	*F*	*df*	*P*	Time	MD	SE	*P*
Weight (kg)	Squat	3.868	1.284, 34.655	0.048*	pre–mid	0.893	0.279	0.010*
					pre–post	1.339	0.623	0.122
					mid–post	0.446	0.506	1.000
	Donkey kick	4.752	1.366, 35.512	0.026*	pre–mid	0.378	0.254	0.447
					pre–post	0.933	0.395	0.077
					mid–post	0.556	0.241	0.088
	Control	3.454	1.829	0.044*	pre–mid	0.440	0.190	0.088
					pre–post	0.080	0.193	1.000
					mid–post	-0.360	0.149	0.070
Body mass index (kg/m²)	Squat	3.807	1.303, 35.168	0.049*	pre–mid	0.306	0.096	0.011*
					pre–post	0.445	0.209	0.127
					mid–post	0.139	0.169	1.000
	Donkey kick	4.981	1.355, 35.233	0.023*	pre–mid	0.140	0.091	0.409
					pre–post	0.346	0.143	0.069
					mid–post	0.206	0.087	0.079
	Control	3.520	1.860	0.410				

ANOVA = analysis of variance, MD = mean difference, SE = standard error, P = significance level, *df* = degree of freedom

*Significant at P < 0.05

Table 9: Repeated measure ANOVA for the right and left gluteus adiposity (mm) time series

Variable	Greenhouse-Geisser				*Post hoc* (Bonferroni) analysis			
	Group	*F*	*df*	*P*	Time	MD	SE	*P*
Right GA (mm)	Squat	6.582	1.666, 44.989	0.005*	pre–mid	0.286	0.321	1.000
					pre–post	1.179	0.405	0.022*
					mid–post	0.893	0.279	0.010*
	Donkey kick	9.493	1.510, 39.265	0.001*	pre–mid	0.963	0.390	0.062
					pre–post	1.704	0.480	0.004*
					mid–post	0.741	0.280	0.041*
	Control	2.700	1.479, 35.504	0.095				
Left GA (mm)	Squat	10.789	1.856, 50.104	<0.0001*	pre–mid	0.821	0.296	0.029*
					pre–post	1.500	0.366	0.001*
					mid–post	0.679	0.305	0.103
	Donkey kick	5.917	1.303, 36.475	0.012*	pre–mid	0.370	0.428	1.000
					pre–post	1.259	0.439	0.024*
					mid–post	0.889	0.222	0.001*
	Control	2.708	1.968, 47.233	0.078				

ANOVA = analysis of variance, MD = mean difference, SE = standard error, P = significance level, *df* = degree of freedom, GA = gluteal adiposity

*Significant at P < 0.05

Table 10: Repeated measure ANOVA for GB, right GMS, and left GMS across time series

Variable	Greenhouse-Geisser				*Post hoc* (Bonferroni) analysis			
	Group	*F* value	*df*	*P*	Time	MD	SE	*P*
GMB (m)	Squat	2.280	1.496, 40.390	0.128				
	Donkey kick	6.833	1.904, 49.504	0.003*	pre–mid	0.014	0.004	0.010*
					pre–post	0.016	0.005	0.015*
					mid–post	0.002	0.005	1.000
	Control	0.446	1.705, 40.915	0.612				
Right GMS (kg/s)	Squat	15.221	1.903, 51.386	<0.0001*	pre–mid	-20.089	6.107	0.008*
					pre–post	-29.911	5.326	<0.0001*
					mid–post	-9.821	5.097	0.194
	Donkey kick	3.653	1.531, 39.814	0.046*	pre–mid	-15.056	7.310	0.149
					pre–post	-15.796	7.583	0.142
					mid–post	-0.741	4.421	1.000
	Control	7.547	1.514, 36.344	0.004*	pre–mid	6.500	3.208	0.162
					pre–post	10.740	3.097	0.006*
					mid–post	3.240	1.839	0.090
Left GMS (kg/s)	Squat	10.964	1.777, 47.990	<0.0001*	pre–mid	-16.518	6.748	0.063
					pre–post	-29.286	6.856	0.001*
					mid–post	-12.768	5.043	0.052
	Donkey kick	7.169	1.735, 41.645	0.003*	pre–mid	9.660	2.977	0.010*
					pre–post	5.960	2.577	0.089
					mid–post	-3.700	2.092	0.269
	Control	0.897	1.790, 46.531	0.405				

ANOVA = analysis of variance, GMB = gluteal muscle bulk, GMS = gluteal muscle strength, MD = mean difference, SE = standard error, *P* = significance level, *df* = degree of freedom

*Significant at *P* <0.05

Comparison of participants' variables across time series for GMB, right, and left GMS

Table 10 shows that significant difference was recorded in GMB for only the DKG (F = 6.833, *P* = 0.003). Also, there was a significant difference in right GMS only for SG (*F* = 15.221, *P* = <0.0001) and DKG (*F* = 7.547, *P* = 0.004). Similarly, a significant difference was found in SG (*F* = 10.964, *P* < 0.0001) and DKG (*F* = 7.169, *P* = 0.003) for left GMS. The pair-wise comparison for GMB of DKG showed that a significant difference was found between pre- and mid-intervention (MD = 0.014, *P* = 0.010) and between pre- and post-intervention (MD = 0.016, *P* = 0.015). In SG, the pair-wise comparison for right GMS revealed a significant difference to exist between pre- and mid-intervention (MD = 20.089, *P* = 0.008) and between pre- and post-intervention (MD = 29.911, *P* < 0.0001). However, a significant difference was found only between pre- and post-intervention (MD = 10.740, *P* = 0.006) in DKG. Furthermore, the pair-wise comparison for right GMS for SG revealed a significant difference to exist between pre- and mid-intervention (MD = 20.089, *P* = 0.008) and between the pre- and post-intervention (MD = 29.911, *P* < 0.0001), but a significant difference was found only between pre- and mid-intervention (MD = 10.740, *P* = 0.006) in DK. Finally, the pair-wise comparison for left GMS revealed a significant difference in SG to exist only between mid- and post-intervention (MD = 29.286, *P* = 0.001), but a significant difference was found only between pre- and mid-intervention (MD = 9.660, *P* = 0.010) in DKG.

Discussion

A total of 111 young women were recruited for this study but only 80 of them completed the study—SG (28), DKG (27), and CG (25). The 27.9% attrition rate recorded was due to other commitments that arose, especially for some unanticipated changes in academic activities. The attrition was slightly more in the control group than the exercise groups; this may be attributed to the fact that they may have had no positive expectant drive to continue their participation as opposed to those in the exercise groups. Hence, subsequent study should introduce a placebo design, which could serve as a motivating factor for the control group.

There was no significant difference in waist circumference (WC), CI, and AVI both for within and across group comparison. Also, there was no significant difference in BMI across the groups. Outcome measures such as BMI, WC, CI, and AVI are measures of general body adiposity.[22] Thus, the interventions (squat and donkey kick) being region specific (here, gluteal region) had no effect on such measures. Similarly, Yaacob *et al.*[23] reported that progressive resistance training specific for the hamstrings and quadriceps had no effect on WC after 8 weeks. Also, Ghroubi *et al.*[24] found no change in weight and BMI after 8 weeks strength training. One common denominator in this study is the short training duration (6–8 weeks) that may be insufficient to produce training effects on these measures of central obesity.[25]

This study revealed that SG and DKG significantly decreased GA. This may be attributed to the exercise-specific induction of fatty acid oxidation at the gluteal region, which is required to meet the energy demand of the exercise.[26,27] This result corroborates with other studies[28-31] involving high-intensity resistance training, which also recorded significant reduction in adiposity. However, studies[32,33] involving low-intensity resistance training did not report significant change in adiposity, thereby suggesting that changes in adiposity could be dependent on exercise intensity.

Significant decrease in GMB was recorded in DKG. This suggests that a 6-week training with donkey kick may effectively reduce adiposity in the gluteal region (as recorded in the skinfold measurement) but may have no gluteal muscle toning effect, thus the decrease in gluteal muscle bulk (estimated by hip circumference). This is in agreement with the findings of a study by Yamaji *et al.*,[34] which reported significant reduction in hip circumference after 6 weeks of slow movement resistant training in women. However, there was a non-statistically significant increase in GMB among the participants in SG. The slight increase witnessed in SG may suggest an increase in free fat mass (gluteal muscle tone) as opined by some studies.[7,35] However, some studies reported a rather significant increase in muscle bulk. This disparity in the reports of these studies[36-38] compared with this study could be attributed to the difference in outcome measures and training duration, given that the change in muscle mass could vary depending on the duration and intensity of exercise.[39] Also, although this study (6 weeks duration) used tape to measure muscle bulk, the comparing studies by Holm *et al.*,[36] McNee *et al.*,[37] and Kosek *et al.*[38] used outcomes such as MRI and three-dimensional ultrasound imaging, and their trainings lasted for 10–16 weeks.

Significant gain in GMS was recorded in both SG and DKG. This implies that squat and donkey kick are effective interventions for achieving improvement in GMS. This is in agreement with previous studies,[7,15,36,40] although these studies concentrated on other muscle groups. However, the increase in SG was significantly more than those of the DKG. Results also revealed a declining trend in GMS in CG and greater increase in GMS in the right than that in the left gluteus (the bilateral difference in GMS was consistent in the two training groups). The declining trend in GMS in CG may infer that a lack of exercise intervention may lead to loss of muscle strength.[41] In addition, the greater increase in the right GMS compared to the left may be attributed to dexterity dominance, as there is a very high prevalence of right limb dominant people in the world population;[42] thus, suggesting the greater overload at the right gluteus.

Practical applications

Squat was found to be very effective in increasing GMS, therefore, it could be incorporated in treating conditions associated with gluteal muscle weakness such as seen among stroke survivors with typical Trendelenburg gait pattern. Also, squat showed greater effect on gluteal muscle mass increase within the 6 weeks of training, therefore, could be recommended to ladies who desire building and toning of the gluteus. Donkey kick was effective in fat reduction, which is of essential health benefit, hence, could be recommended to keep fit and healthy.

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Conflicts of interest

There are no conflicts of interest.

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