

1. Introduction

- In elementary school, health care is very important for physical and mental growth of students.
- It has been known that rope skipping exercise could improve physical fitness and growth factors on child.
- But, rope skipping has high frequency to injury and it is difficult to continue exercising due to monotonous movement pattern.
- According to recent studies, it has been reported that wireless rope skipping promotes physical fitness as well as decreases injury frequency more than rope skipping .
- Thus, the purpose of this study was to investigate effect of wireless rope skipping for 12 weeks on the growth factors and physical fitness in elementary school students.

2. Materials and Methods

2. 1 Participants

- Subjects for this study were 30 elementary school students and randomly divided into 3 groups as follows.
- A rope skipping group (n=10. male=5, female=5), wireless rope skipping group (n=10. male=5, female=5) and control group (n=10. male=5, female=5).

Table 1. Physical characteristics of the subjects

Variable	CG	RSG	WRSG
Age (yr)	10.72±0.43	10.50±0.53	10.33±0.25
Height (cm)	141.68±8.24	142.47±4.36	141.22±5.37
Weight (kg)	36.02±6.03	38.33±7.98	37.99±6.34
BMI (kg/m ²)	17.55±2.71	18.79±3.08	18.98±2.84

Values are mean ± Standard Deviation

CG, control group; RSG, rope skipping group; WRSG, wireless rope skipping group; BMI, body mass index

2. 2 Growth factors test

- Growth factors were composed of adult height predictor (AHP) and bone age X-ray test.
- The AHP test was measured by using BP (Bayley-Pinneau) and TW (Tanner-Whitehouse) methods.
- Bone age test was measured by using special ultrasonication techniques (Sunlight Medical Ltd., Israel) and the RUS(Radius, Ulna and Short bones of hand) and CARP (Carpal bones) score were represented.

2. 3 Physical activity promotion system(PAPS) test

- PAPS test was composed of body mass index, grip strength, 50M run, sit and reach and 15M shuttle run and each factors were represented as absolute values.

2. 4 Statistical analysis

- All measurement values are presented as mean±SD
- Significant differences between pre- and post-test were determined by using paired t-test.
- Differences between groups were analysed by one-way repeated ANOVA followed scheffe post-hoc test.
- The level of significance was $P<.05$

3. Rope skipping training program

- The rope skipping training was preformed three times a week for 12 weeks at physical education, sports clubs and intermediate play time.
- Training program in rope skipping and wireless rope skipping groups were showed in Table 2.
- Control group was maintained during the same period physical education class in school.

Table 2. Rope skipping and wireless rope skipping training program

Week	Personal rope skipping	Time	Group rope skipping	Time
1, 5, 9	<ul style="list-style-type: none">• Basic bounce• Jump rope on one leg• Boxer step	Physical education (40 min, 3 days/week)	Team rope skipping	Sports clubs (40 min, 1 day/week)
		Intermediate play time (20 min, 2 days/week)		
2, 6, 10	<ul style="list-style-type: none">• Side Double Tapping• Forward Double Tapping• Side Straddles	Physical education (40 min, 3 days/week)		
		Intermediate play time (20 min, 2 days/week)		
3, 7, 11	<ul style="list-style-type: none">• Forward Straddles• Side and Forward Straddles• High Step	Physical education (40 min, 2 days/week)		
		Intermediate play time (20 min, 3 days/week)		
4, 8, 12	<ul style="list-style-type: none">• Cross open• Cross over• 1 line 2 jump	Physical education (40 min, 3 days/week)		
		Intermediate play time (20 min, 2 days/week)		

4. Results

4. 1 Changes of growth indicators according to types of rope skipping training

- RSG($P<.01$) and WRSG($P<.001$) significantly increased post-AHP-BP values compered to those in CG.
- Post-AHP-TW values in WRSG($P<.000$) was significantly increased compared to the other groups.
- There was no significant differences of bone age among all groups.

Table 3. Adult height predictor test and bone age

Variable	Group	Pre	Post	<i>t</i>	<i>P</i>
AHP-BP(cm)	CG	165.14±11.01	164.06±10.93	0.956	.006
	RSG	166.00±10.44	168.28±9.97	-3.568	.001
	WRSG	167.17±12.06	168.78±12.83	-4.867	.364
	<i>F</i>	0.083	0.526		
	<i>P</i>	9.21	.597		
AHP-TW(cm)	CG	168.90±9.15	168.58±9.91	.428	.101
	RSG	168.45±8.49	171.81±8.80	-1.8280	.000
	WRSG	170.42±9.54	172.07±9.52	-6.072	.680
	<i>F</i>	0.129	0.502		
	<i>P</i>	.880	.611		
Bone age	CG	11.25±1.89	11.99±1.12	-1.750	.057
	RSG	11.50±1.16	11.04±1.34	2.184	.306
	WRSG	11.05±1.30	10.72±1.26	1.086	.114
	<i>F</i>	.228	2.082		
	<i>P</i>	.797	.078		

Values are mean ± Standard Deviation

CG, control group; RSG, rope skipping group; WRSG, wireless rope skipping group; AHP-BP, adult height predictor Bayley-Pinneau; AHP-TW, adult height predictor Tanner-Whitehouse.

4. 2 Changes of PAPS scores according to types of rope skipping training

- All groups were no significant differences in post-strength and flexibility results.
- RSG($P<.01$) and WRSG($P<.01$) significantly increased post-cardiovascular endurance compered to CG.
- Post-body mass index in WRSG($P<.01$) was significantly increased compared to the other groups.
- RSG($P<.001$) and WRSG($P<.004$) significantly decreased post-power values compered to those in CG.

Table 4. Physical activity promotion system

Variable	Group	Pre	Post	<i>t</i>	<i>P</i>
Strength (kg)	CG	16.89±3.58	16.52±2.76	0.493	.634
	RSG	16.39±2.16	16.37±2.63	0.060	.954
	WRSG	16.81±3.58	16.96±3.77	-0.921	.381
	<i>F</i>	0.071	0.098		
	<i>P</i>	.931	.907		
Cardiovascular endurance (count)	CG	61.30±23.50	62.60±22.95	-1.285	.231
	RSG	61.80±22.41	65.20±20.90	-3.392	.008
	WRSG	63.90±20.90	68.40±21.87	-4.392	.002
	<i>F</i>	0.038	0.176		
	<i>P</i>	.963	.840		
Flexibility (cm)	CG	7.22±8.19	7.41±8.12	-1.285	.231
	RSG	9.27±6.49	9.00±7.02	0.608	.558
	WRSG	12.69±5.57	12.55±6.07	0.373	.718
	<i>F</i>	1.632	1.366		
	<i>P</i>	.214	.272		
Power (sec)	CG	10.64±0.76	10.87±1.23	-0.341	.741
	RSG	11.67±1.65	10.82±1.75	6.066	.000
	WRSG	11.66±1.74	10.71±1.53	3.872	.004
	<i>F</i>	1.654	0.030		
	<i>P</i>	.210	.971		
BMI (kg/m ²)	CG	17.55±2.71	17.67±2.86	-0.3391	.705
	RSG	18.79±3.08	18.71±3.25	0.629	.545
	WRSG	18.98±2.84	18.73±2.76	4.038	.003
	<i>F</i>	0.724	0.417		
	<i>P</i>	.494	.663		

Values are mean ± Standard Deviation

CG, control group; RSG, rope skipping group; WRSG, wireless rope skipping group; BMI, body mass index.

5. Conclusion

Our findings suggested important evidence that the wireless rope skipping might be more effective for improving the growth and physical fitness to elementary school students.