STUDIA SPORTIVA 2022/1

The Effects of Different Rest Interval Lengths on Acute Quarter-squat Performance in Female

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Abstract

Inclusion of resistance training in the athletic preparation of young athletes is associated with increased time and personal demands. This study compared the effect of different rest interval (RI) lengths on quarter-squat performance in two age groups. Sixteen girls (age 12.20 ± 0.55) and 16 women (age 23.13 ± 2.23) performed three series of 10 quarter squats (10 repetition maximum [RM] load) with different RI times (1 min, 2 min, 3 min) between the three series. Each participant was randomly tested under all the RI conditions. The number of successful repetitions, power and speed were recorded for each set using by FitroDyne device. *The women completed significantly less repetitions in the third set than in the first set for the 2-min and 1-min RIs (9.38 ± 1.54, p = .05 and 8.44 ± 2.42; p = .003, respectively). There was observed a significant decrease in mean power and speed in the 3-min RI between the first and second set and in the 1-min RI between the first and third sets. No significant differences in numbers of completed repetitions and mean power were evident in girls for any RI condition, but there was a significant decrease in mean velocity in the 2-min RI between the first and second sets in this group. These results show that recommendations for adults may be not suitable for girls; the girls' performance in three sets of 10 quarter squats was less affected by RI than the women's performance.*

Key words: *Age, Exercise, Fatigue, Number of repetitions, Recovery, Resistance training*

INTRODUCTION

Studies have provided evidence that resistance training (RT) is a safe and effective method for enhancing athletes' muscular strength, power, and endurance (Benjamin & Glow, 2003; Faigenbaum et al., 2003, 2008; Guy & Micheli, 2001; Hernandez et al., 2020; Malina, 2006; Ratel, 2011) and improving athletic performance (Faigenbaum et al., 2016). The effect of RT is similar for adults and children (Haff et al., 2016). Previous research has shown that RT (2–3 times per week) can increase bone mineral density and improve body composition (Faigenbaum et al., 2003; McGuigan et al., 2009; Shaibi et al., 2006); and lower blood pressure (Winett & Carpinelli, 2001). Moreover, it has been found that RT can reduce the risk of injuries in other sports and recreational activities for young athletes (Council on Sports Medicine and Fitness, 2008; Faigenbaum et al., 2003; Zatsiorsky & Kraemer, 2006). Well-designed RT programs (sufficient warm-up, proper technique, progressive loading, supervision by a qualified professional, etc.) can instill a lifelong positive sports habit in children (Zatsiorsky & Kraemer, 2006), and it has a positive effect on children's psychological health, especially their self-confidence and self-efficacy (Schranz et al., 2013).

However, RT alone does not provide optimal gains in performance. A systematically structured program is needed to achieve maximum results (Faigenbaum et al., 2008). The main program variables include exercise selection, training volume, training intensity, movement velocity, and

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rest interval (RI) length (Grgic et al., 2018). RI length should be selected based on training intensity, training goals, the athlete's fitness level or the targeted energy system (De Salles et al., 2009; Ratamess et al., 2007). In adults, the RI length between multiple sets appears to be a significant factor that impacts many variables, such as the metabolic and hormonal response (Faigenbaum et al., 2008; Ratamess et al., 2007, 2012) and the immune cell acute response (Ratamess et al., 2012). RI length also affects acute power output (Faigenbaum et al., 2008; Ratamess et al., 2007, 2012) and the performance of subsequent sets (Faigenbaum et al., 2008; Ratamess et al., 2007), muscular strength improvements (Faigenbaum et al., 2008; Ratamess et al., 2007), and changes in post-resistance exercise creatine kinase concentrations (Ratamess et al., 2012). Previous studies suggested differences in recovery speed and a lower force output between sets at different RI lengths (De Salles et al., 2009; Iglesias-Soler et al., 2012; Ratamess et al., 2012). Kraemer described the differences in the total number of repetitions in three consecutive sets of 10 repetition maximum (RM) loads on leg press and bench press exercises. At an RI of 3 min, all highly trained athletes were able to perform 10 repetitions; at an RI of 1 min, the mean number of repetitions were: set 1=10 ± 0, set 2=8 ± 1.4, set 3=7.1 ± 3.5 (Kraemer, 1997). Different results were obtained by Richmond and Godard, who reported that an RI of 5 min was not sufficient to maintain repetitions over two consecutive sets. This result suggests that while a 3-min RI interval may be sufficient for highly-trained athletes, a 5-min RI is not satisfactory for healthy recreationally-trained men to achieve the desired performance (Richmond & Godard, 2004). There is a growing body of literature that recognizes that an RI that is too short (30 – 120 sec) between sets performed near or to muscular exhaustion causes a reduction in the number of repetitions performed in each successive set in adults. For example, Miranda et al. showed that a 1-min RI caused a significant decrease in the number of performed repetitions for all the selected exercises. The recommended length of the RI also depends on the training goal (Miranda et al., 2007). While longer RIs (i.e., at least 2–3 min) are recommended for strength and power multiple-joint exercises, shorter RI lengths (i.e., ≤ 1–2 minutes) are recommended for strength endurance (De Salles et al., 2009; Grgic et al., 2017; Ratamess et al., 2012) and single-joint exercises (De Salles et al., 2009; Grgic et al., 2017; Ratamess et al., 2007).

Previous evidence has suggested that RI recommendations that are valid for adults may not be appropriate for younger athletes (Faigenbaum et al., 2008). Children recover from physical exertion more quickly than adults, especially from high-intensity exercise (Falk et al., 2006). Faigenbaum et al. stated: "children (compared to adults) have a faster heart rate recovery, lower peak lactate concentrations, higher oxidative capacity, better acid-base regulation, and a tendency toward faster phosphocreatine resynthesis following high-intensity exercise" (Faigenbaum et al., 2008).

This is confirmed by the results reported by Zafeiridis et al., which showed that boys (age 11.4 ± 0.5 yrs.) recover faster during high-intensity 60- and 30-s intermittent anaerobic exercise in comparison to adolescents and adults. That study's research design consisted of a 30-s protocol including 18 maximal extensions and flexions of the knee joint, with a 1-min RT between sets and a 60-s protocol, including 34 maximal extensions and flexions, with a 2-min rest (Zafeiridis et al., 2005). Although some studies have addressed differences in muscle fatigue during high-intensity exercise, most of them used cycle ergometers; only a few investigated it in the context of RT (Faigenbaum et al., 2008).

Despite the differences between youth and adult athletes, recommendations for the RI length in children during different types of RT or for different RT goals are not well explored (Faigenbaum et al., 2008), especially for girls. This seems to be a serious gap in the literature because many coaches consider RT to be an essential part of a young athlete's training program (Faigenbaum et al., 2016). Thus, the present study aimed to examine the relation between age, muscular strength, and RI duration (1 min, 2 min, 3 min) and the number of repetitions completed and strength parameters in girls and women.

MATERIAL AND METHODS

Participants

The participants in this study were allocated into two groups. In the first group, 16 physically active women (age 23.13 ± 2.23) volunteered to participate in this study. All the participants were students recruited from a local university with an RT experience ranging from 1 year to 6 years (average of 2.8 years) and they were able to perform the quarter-squat (QS) using the correct technique.

The second group consisted of 16 girls (age 12.20 ± 0.55). All the girls were synchronized swimmers competing at the national level and international level. The girls had 4–5 training sessions per week. They had no previous experience with RT. Therefore, the research protocol was preceded by 4 months of proper technique training and RT practice.

Table 1. Physical and Performance Characteristics of the Subjects

	Girls (N=16)	Women (N=16)
Age (yrs.)	12.20 ± 0.55	23.13 ± 2.23
Tanner Stage	II–III	–
Height (cm)	158.28 ± 6.58	167.84 ± 5.07
Weight (kg)	46.38 ± 4.62	67.43 ± 7.53
1RM QS (kg)	59.47 ± 10.71	100.72 ± 16.04
10RM QS (kg)	44.60 ± 8.03	75.53 ± 12.03
Relative Strength (%)	129.73 ± 26.61	150.34 ± 24.50

Tanner Stage (scale of physical development) – evaluated by parents' self-report; RM = repetition maximum; QS = quarter-squat; Relative Strength = (1RM/body mass); Values are mean ± SD

Maximum Strength Testing

In the women, the 1RM QS (knee angle of 120°) strength test was performed before the experimental sessions. The test was carried out according to the standard 1RM bilateral back squat protocol (National Strength & Conditioning Association (U.S.) & Miller, 2012). The warm-up started with 10 reps with a light load (about 50% of the expected maximum), followed by a 1-min RI. Subsequently, the athletes were instructed to perform 3–5 reps with resistance increased by 10–20%. After an RI of 2 min, the athletes were instructed to perform 2–3 reps with resistance increased by 10–20%. After an RI of 3 min, the same resistance was added, and the athletes were ordered to perform one repetition. If the athletes were successful, there was a 3-min RI and a new attempt was made with a resistance that was 10–20% higher. If the athletes were unsuccessful, a new attempt was made after a 3-min RI with a resistance that was 5–10% lower. Load increasing or decreasing was continued until the athlete was able to perform one repetition with the proper exercise technique. An athlete's personal 1RM should be reached within five attempts.

In the girls, 1RM testing was not performed with the 1RM test; rather, it was performed at the 5RM level. The 5RM level was used although the 1RM test has been shown to be safe and appropriate for healthy children (Faigenbaum et al., 2003). The 5RM level was chosen based on the high technical demands of the selected exercise and because the girls had no previous experience with RT (except 4 months of proper technique practice and RT training used in this study). The test was performed according to the following protocol. The warm-up started with 10 reps with a light load (about 50% of the expected maximum). The 1-min pause was used, and 10 reps with a resistance of 10–20% higher were performed. After 1 min, the load was again increased by 10–20% and the girls were instructed to perform five reps. If the athletes were able to perform the repetition with the proper form, there was a 2-min pause, and a new attempt was made with resistance that was 5–10% higher. If the athletes were unsuccessful, a new attempt was made after a 2-min pause with resistance that was 3–5% lower. If the proper technique was violated, the attempt was considered unsuccessful. A strength and conditioning specialist supervised all the testing procedures and an instructor-to-subject ratio of 1:1 was maintained. Each instructor had previous experience in children's strength training and understood the physical and psychological uniqueness of children. Relative strength was calculated as 1RM/weight.

All the participants were asked not to perform any strenuous RT three days before each measurement day. The adult athletes performed the 1RM test or the 5RM test in two sessions. The test always took place on the same day of the week and at the same time, with a 1-week interval due to familiarization according to the test protocol presented below. During this time, the participants' height was measured using a wall-mounted stadiometer, and body weight and body composition were measured using InBody 720.

QS Protocol

After the second maximal strength testing session a 10RM load value was determined for each athlete, based on the formula in Baechle et al. (Baechle et al., 2008). Previous experience with the calculation of 10RM (especially in girls and women who were not strength athletes, such as weightlifters, etc.) has shown that the calculated load is not accurate for some athletes. Furthermore, the value of 10RM in some young athletes appeared to be unstable on various occasions, so a control 10RM re-test was included in the present study.

All the subjects completed three protocol sessions, always in the evening with each session separated by at least 72 hours. Each protocol consisted of a general warm-up and three series with 50%, 60%, and 70% 1RM and a 10RM load control re-test (a re-test was included to achieve maximum accuracy of the 10RM load). The athletes were instructed to perform as many repetitions as possible with resistance, which should correspond to the 10RM load, according to the formula in Baechle et al. (Baechle et al., 2008). The current value of 10RM was corrected according to the number of repetitions each athlete was able to perform. A 5-min pause and three series of QS followed. The RI length was different for each session. The athletes performed each protocol using 1-min (1RI), 2-min (2RI), or 3-min (3RI) RIs (in a randomized order). The subjects were encouraged to target 10 repetitions per set. If the repetition was not performed in the full range of motion or was completed via assistance from a spotter, the repetition was not calculated.

Average Power and Speed Evaluation, Fatigue Index

The average power (AP) and average speed (AS) value for concentric phase of QS repetition was measured with a FitroDyne device (Fitronic, Bratislava, Slovakia). The AP and AS values of all the completed repetitions from the first, second, and third sets was subsequently used for statistical analysis and was directly compared. The fatigue index (FI) was calculated according to the following formula: FI (%) = $[(AP_{max}-AP_{min})/AP_{max}*100]$. AP_{max} and AP_{min} represented the highest and lowest mean AP value of the group within a single set with the same RI. This was used to determine the percent decrease in performance within one set. While AP_{max} and AP_{min} did not always represent performance in the first and last repetition during the sets, the FI represents the intra-individual difference in performance within one set (for all completed repetitions).

Ethics
All the adult participants signed an informed consent in accordance with the Declaration of Helsinki and the study was approved by the research ethics committee of Masaryk University. For the children that participated in the study, informed consent was signed by their parents.

Statistical Analysis
Normality was checked using Shapiro-Wilk's test ($\alpha=0.05$). Standard statistical methods were used to calculate the mean and standard deviation (SD). Friedman's test was used to analyze the effects of RI length on the number of repetitions per set, mean AP, and AS within the groups. Subsequent post hoc tests were used for pairwise comparison.

Statistical significance was set at $p \leq .05$ for the Friedman test, and pairwise comparisons were performed with a Bonferroni correction for multiple comparisons. Effect size was assessed by r (Fritz et al., 2012). All analyses were performed using SPSS statistical package (Version 25, SPSS, Inc, Chicago, IL, USA). Excel 365 software (Microsoft Corp., Redmond, WA, USA) was used for graph processing.

RESULTS

The data of completed repetition, AP and AS data during the QS sets were not normally distributed, as assessed by the Shapiro-Wilk's test ($p \leq .05$). QS repetition data for both groups are presented in Table 2 and the mean values of AP and AS for both groups (women and girls) are presented in Table 3.

Table 2. QS Repetitions in the Groups of Women and Girls with Different Types of RI.

	Set 1	Set 2	Set 3	Total	p
3-min RI					
Women	10.0 ± 0.0	10.0 ± 0.0	9.94 ± 0.25	29.94 ± 0.14	1.000
Girls	10.0 ± 0.0	10.0 ± 0.0	10.0 ± 0.0	30.0 ± 0.0	1.000
2-min RI					
Women	10.0 ± 0.0	10.0 ± 0.0	9.38 ± 1.54	29.38 ± 0.92	0.050
Girls	10.0 ± 0.0	10.0 ± 0.0	10.0 ± 0.0	30.0 ± 0.0	1.000
1-min RI					
Women	10.0 ± 0.0	9.19 ± 1.64	8.44 ± 2.42	27.63 ± 1.77	0.003
Girls	10.0 ± 0.0	10.0 ± 0.0	10.0 ± 0.0	30.0 ± 0.0	1.000

Values represent mean ± SD

The numbers of completed repetitions were statistically significantly different between sets in testing session with 2-min and 1-min RIs in the group of women. Post hoc analysis did not reveal statistical differences among the sets. Statistically significant difference for AP and AS was found in the group of women in testing session with 3-min and 1-min RIs. Regarding AP performance, post hoc analysis revealed statistically significant differences between the first set (Mdn = 276.02) and the second set (Mdn = 249.22) ($p = .008$, $r = -0.53$) in testing session with 3-min RI and between the first set (Mdn = 244.99) and the third set (Mdn = 221.46) ($p = .014$, $r = -0.50$) in testing session with 1-min RI. Further, there was a significant difference in AS performance between the first set (Mdn = 0.329) and the second set (Mdn = 0.303) ($p = .014$, $r = -0.50$) in testing session with the 3-min RI and between the first set (Mdn = 0.304) and the third set (Mdn = 0.287) ($p = .040$, $r = -0.44$) in testing session with1-min RI.

Table 3. QS Average Power and Speed in the Groups of Women and Girls with Different Types of RI

Average power (W)						
	3-min RI	p	2-min RI	p	1-min RI	p
Women						
Set 1	264.23 ± 62.99	0.100	262.81 ± 69.78	0.214	251.52 ± 64.54	0.015
Set 2	248.23 ± 64.49		256.57 ± 69.29		242.90 ± 68.52	
Set 3	253.03 ± 65.96		252.21 ± 76.34		244.39 ± 72.00	
Mean	255.17 ± 64.83		257.30 ± 71.92		246.48 ± 68.31	
Girls						
Set 1	144.57± 39.98	0.646	154.02 ± 56.11	0.068	160.47 ± 49.81	0.229
Set 2	148.89 ± 38.32		154.77 ± 52.43		159.84 ± 50.49	
Set 3	144.33± 35.88		145.74 ± 50.97		163.29 ± 50.13	
Mean	145.93 ± 38.16		151.51 ± 53.37		161.20 ± 50.17	
Average velocity (m.s^{-1})						
	3-min RI	p	2-min RI	p	1-min RI	P
Women						
Set 1	0.322 ± 0.050	0.018	0.320 ± 0.059	0.129	0.303 ± 0.057	0.024
Set 2	0.302 ± 0.053		0.313 ± 0.065		0.288 ± 0.066	
Set 3	0.307 ± 0.054		0.310 ± 0.077		0.285 ± 0.065	
Mean	0.310 ± 0.053		0.315 ± 0.067		0.293 ± 0.063	
Girl						
Set 1	0.305 ± 0.059	0.444	0.332 ± 0.066	0.022	0.342 ± 0.058	0.229
Set 2	0.316 ± 0.064		0.312 ± 0.060		0.340 ± 0.057	
Set 3	0.303 ± 0.059		0.314 ± 0.060		0.348 ± 0.061	
Mean	0.308 ± 0.061		0.321 ± 0.062		0.343 ± 0.059	

Values represent mean ± SD

No significant differences in numbers of completed repetitions and AP were found in girls. AS results indicated significant different values between the first set (Mdn = 0.326) and the second set (Mdn = 0.307) ($p = .040$, $r = –0.44$) in testing session with 2-min RI. The changes in AP during all three sets at different RI lengths in the girls and women is shown in Figures 1–3. While the AP is relatively balanced in all sets for all 10 repetitions for the girls, there is a visible decrease in the women.

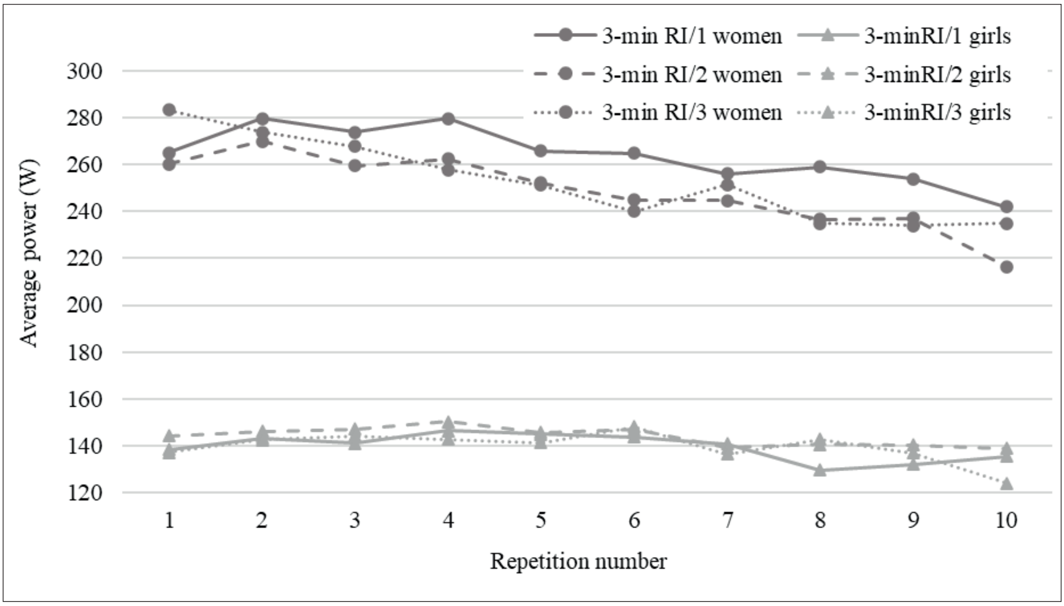

Figure 1. The mean AP data during the 3-min RI for both groups. Data depict the mean group power for each repetition.

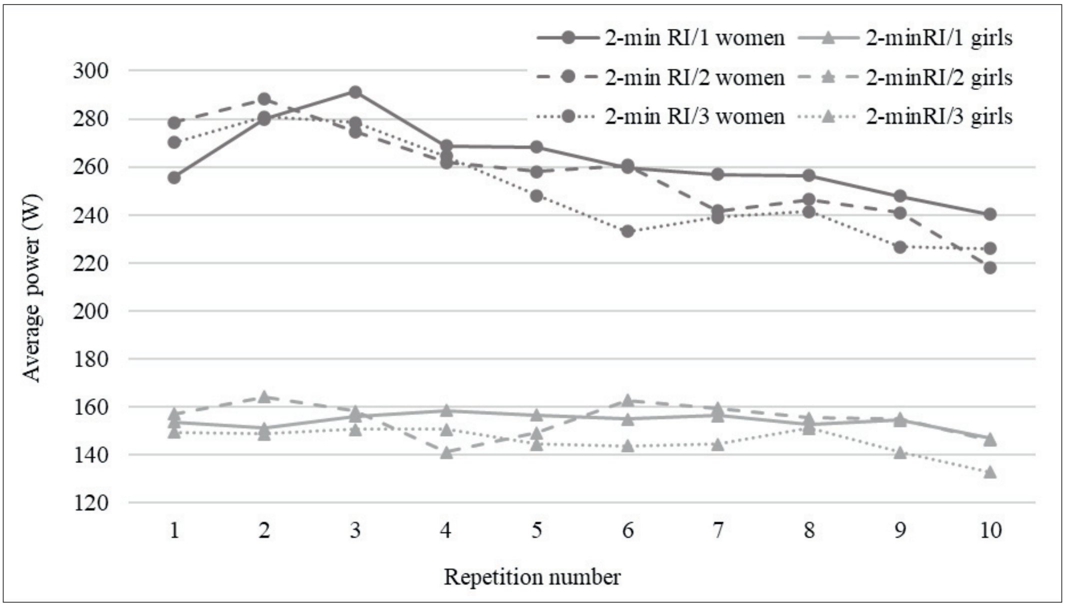

Figure 2. The mean AP data during the 2-min RI for both groups. Data depict the mean group power for each repetition.

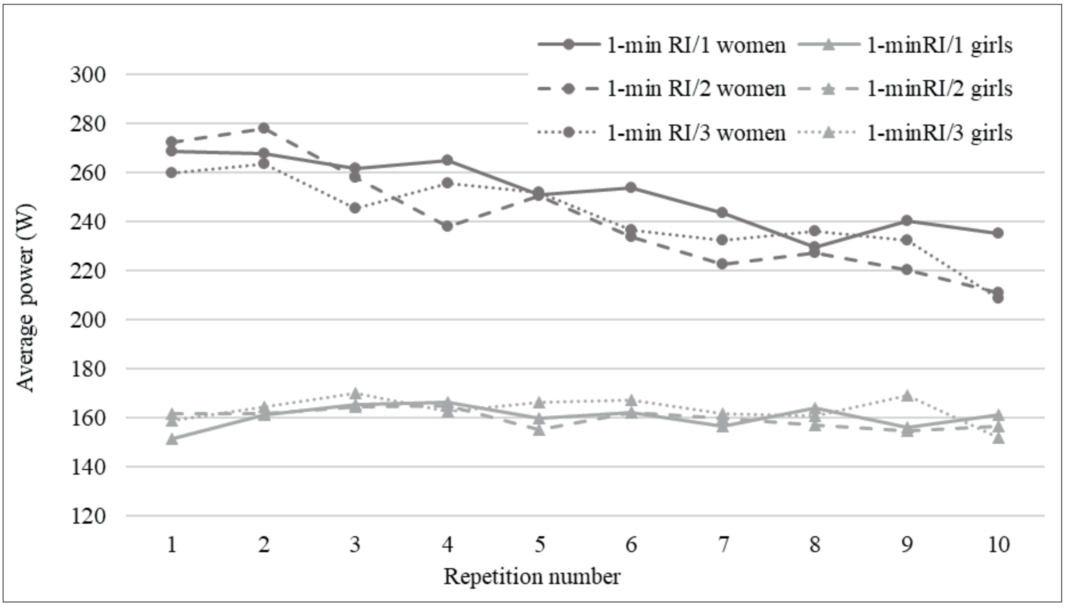

Figure 3. The mean AP data during the 1-min RI for both groups. Data depict the mean group power for each repetition.

Table 4 represents the highest and lowest mean AP values and percentage FI for the groups of women and girls during three sets with same RI lengths. As seen in Table 4, for the women, the FI (%) increases over time from the first to the third sets (except for 1-min RI between 2nd and 3rd set). The smallest increase is visible in the 3-min RI. The largest difference between the first set and the second set was achieved in the 1-min RI, but there was a decrease in the third set. This is due to the inability of some women to complete all 10 repetitions. This also affected the AP_{min} in the third set, the value of which was not as low as it was in the second set. In the third set of the 1-min RI, the initial level of AP_{max} was not restored in comparison to the previous two sets; this can be explained by the insufficient time needed to restore energy supplies. No clear trend in the decrease of AP_{max} and AP_{min} was visible in the girls, as the highest performance was sometimes achieved in the second set or the third set. Moreover, no significant decrease was visible in the FI percentage, which was lowest in the 1-min RI.

Table 4. The highest and lowest mean AP value within a single set with the same RI

	Women			Girls		
	P_{max} (W)	P_{min} (W)	Fatigue Index (%)	P_{max} (W)	P_{min} (W)	Fatigue Index (%)
3-min RI						
Set 1	297.07	228.25	23.46	162.06	115.40	29.12
Set 2	287.82	203.79	29.44	169.78	113.29	33.04
Set 3	294.68	205.51	30.78	160.58	108.61	32.69
2-min RI						
Set 1	302.36	217.91	27.53	174.20	130.04	25.79
Set 2	299.51	200.83	32.59	178.15	124.18	30.97
Set 3	297.33	190.89	36.00	170.56	118.03	31.43
1-min RI						
Set 1	288.34	203.58	29.47	179.14	132.54	25.37
Set 2	284.07	170.48	40.22	180.38	135.64	25.55
Set 3	271.48	180.33	33.02	185.11	136.12	27.84

DISCUSSION

The main finding of the study is that while the results for the women show a decrease in strength production and QS performance in connection with a change of RI length, the girls were able to produce a relatively constant performance independent of the RI lengths. In some of the parameters, changes were evident in the girls' performance between the sets. However, these changes represent unsystematic performance fluctuations without a significant decreasing trend. These results suggest that girls are able to recover faster than women from moderate-intensity resistance exercise; this finding is similar to the results in Faigenbaum et al.'s (Faigenbaum et al., 2008)) study on men and boys, which can be beneficial to all coaches and health professionals designing strength programs for children and youth (Tibana et al., 2012).

Determining a sufficient RI length is important in children not only in terms of sufficient regeneration, as seen in adults (Faigenbaum et al., 2008), but also from a training planning perspective. According to our own experience, many coaches working with youth report that the high amount of time required for RT does not allow them to include a RT program in the regular training plans of young athletes due to the low hourly allowance for training. The possibility of using a shorter RI length could save time and enable coaches to include a RT program even in sports disciplines with a low training-hours capacity.

The results of the present investigation showed that the total number of repetitions performed during three sets of the QS were significantly different in the group of women with the 2-min RI and the 1-min RI. However, the decrease in the number of completed repetitions was not as significant as that reported in previous studies (Faigenbaum et al., 2008; Miranda et al., 2007; Ratamess et al., 2007; Richmond & Godard, 2004; Willardson & Burkett, 2006). A possible explanation for this can be found in Ratemmes et al' study, which points to a lower decrease in performance in women in comparison to men (e.g., 1-min RI men: 1 set: 10.0 ± 0.0 reps, second set: 7.1 ± 2.3 reps, third set: 4.0 ± 1.7 reps; e.g., 1-min RI women: 1 set: 10.0 ± 0.0 reps, second set: 9.3 ± 1.4 reps, third set: 7.7 ± 3.0 reps) (Ratamess et al., 2012).

Although previous studies have reported differences in the recovery between children and adults, many of them describe these differences in relation to high- or moderate-intensity exercises not strength performance. For example, Weinstein et al. compared performance in two upper-body Wingate Anaerobic Tests separated by either 2-min or 10-min recovery intervals in boys and men. The results showed that power decrease (mean and peak power) and blood lactate concentration were significantly lower in the boys than the men during the 2-min RI. In the 10-min RI, the differences in the performance between the boys and men in the second round were not statistically significant (Weinstein et al., 2018). Differences are mainly due to children's lower maximal power output, which puts lower demands on regeneration and allows for faster recovery (Falk et al., 2006). This is consistent with the results reported by Faigenbaum et al., who described significant age-related differences in relative strength between boys (55.7%), adolescents (68.9%), and adults (124.3%), and with the results of our research: girls' relative strength (129.73%) and women's relative strength (150.34%) (Faigenbaum et al., 2008). Nevertheless, maturation-related differences (lower relative muscle mass, lower neuro-motor recruitment), size-related factors (smaller muscle-fiber diameter, higher capillary density, shorter perfusion distance, shorter circulation distance, and faster cardio-respiratory kinetics), and metabolic characteristics (faster return of acid-base balance, lower peak of La and H+, faster CrP replenishment, lower glycolytic enzyme activity, and lower energy substrate level) may contribute to children's ability to recover more quickly than adults (Falk et al., 2006). Dipla et al. (Dipla et al., 2009) and Ratel et al (Ratel et al., 2006); mentioned similar physiological and neuromotor parameters; however, most of the studies reviewed in these works investigated men and boys. Interestingly, the results of their research suggest that while the ability to resist fatigue in prepubertal girls and boys was the same, the fatigue resistance of adult women was the same as male adolescents.

In addition to the number of repetitions, the present study also evaluated the measurement of bar speed and power during each QS repetition. This allowed us to observe a decrease in performance even in cases where the number of repetitions did not decrease. This phenomenon is also described by Faigenbaum et al. with repeated performance in the bench press exercise (Faigenbaum et al., 2008). However, the AP and AS evaluation results during the QS series showed a similar trend as the decrease in the number of repetitions across the groups. While the women's results showed a statistically significant difference in AP and AS, both for the 3-min RI and the 1-min RI, no statistically significant difference in AP was found in the girls. Interestingly, there was a slight increase in AS in the third set. The only statistically significant difference in the girls was the difference between the AS at the 2-min RI. This increase and a slight fluctuation in both the AP and AS results without a clearly visible trend in all the successive sets indicates the degree of variability in the girls' performance in general rather than the insufficient length of RI for the necessary replenishment of energy reserves.

CONCLUSION

There was no systematic decrease in the ability to produce strength associated with different RIs in the girls, both in terms of reducing the number of repetitions or a significant decrease in the power or speed during QS. Based on our results, we are unable to determine whether the reason for the small decline and fluctuating performance (within a set) is due to the girls' ability to regenerate faster, as suggested by previous research, or their inability to exert their maximum effort (the relative strength of the girls did not reach the same values as found in the women). However, this result indicates that a 1-min RI could be sufficient for RT with a 10RM load for girls that do not engage in strength training. This result may help coaches include an RT program in the athletic preparation of children in sports with a smaller time allowance for the training or in sports that do not have RT as priority conditioning method. This could lead to a reduction in the amount of time required for strength training in children, as it is not necessary to employ the RI that is used for the adults to develop strength in children.

Acknowledgments

The authors report no conflicts of interest. This publication was written at Masaryk University as part of the project number MUNI/A/1325/2018 with the support of the Specific University Research Grant, as provided by the Ministry of Education, Youth and Sports of the Czech Republic in the year 2019.

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