Validation of the Children's OMNI-Resistance Exercise Scale of Perceived Exertion

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ABSTRACT

ROBERTSON, R. J., F. L. GOSS, J. L. ANDREACCI, J. J. DUBÉ, J. J. RUTKOWSKI, K. M. FRAZEE, D. J. AARON, K. F. METZ, R. A. KOWALLIS, and B. M. SNEE. Validation of the Children's OMNI-Resistance Exercise Scale of Perceived Exertion. *Med. Sci. Sports Exerc.*, Vol. 37, No. 5, pp. 819–826, 2005. **Purpose:** This investigation examined concurrent validity of the Children's OMNI-Resistance Exercise Scale (OMNI-RES) of perceived exertion for 10- to 14-yr-old females ($N = 25$) and males ($N = 25$) performing unilateral biceps curl (BC) and knee extension (KE) isotonic exercises. **Methods:** The criterion variable was total weight lifted (Wt_{tot}), determined separately for females and males during BC and KE. Subjects performed three separate sets of 6, 10, and 14 repetitions for BC and KE at 50% 1-RM. Ratings of perceived exertion for the active muscles (RPE-AM) and overall body (RPE-Overall) were measured during the final repetition. **Results**: For both female and male groups across the three sets: (a) RPE-AM ranged from 2.9 to 8.3 for BC and 4.5 to 9.6 for KE, and (b) RPE-O ranged from 1.9 to 7.0 for BC and 3.6 to 7.7 for KE. Positive linear regression coefficients ranged from r = 0.72 to 0.88 ($P < 0.01$) between Wt_{tot} and RPE-AM and RPE-Overall for BC and KE in both gender groupings. RPE did not differ between females and males at any measurement point within each set for BC and KE. RPE-AM was greater ($P < 0.01$) than RPE-Overall in the three sets of BC and KE. **Conclusion:** Findings provided concurrent validation of the Children's OMNI-RES to measure RPE for the active muscle and overall body in 10- to 14-yr-old females and males performing upper and lower body resistance exercise. **Key Words:** CHILDREN, DIFFERENTIATED RPE, GENDER EFFECT, RESISTANCE EXERCISE

Investigations involving single- and mixed-gender adult samples indicate that ratings of perceived exertion (RPE) can be assessed during concentric and eccentric resistance exercise paradigms that vary the total volume of weight lifted (Wt_{tot}; i.e., volume loading), percent of one repetition maximum muscular action (%1-RM; i.e., intensity loading), and rest periods between separate sets and exercises (4,9,11,15,17–19,26). These resistance exercise paradigms established force–effort psychophysical functions (8,19,21), examined physiological mediators of the effort sense (4,7,9,11,12,14,17–19,26,27), and used RPE to prescribe strength-training programs and to track conditioning progress (4–6,10). Evidence supporting similar applications of exertional perceptions for children performing resistance exercise is limited (3). An initial step for such applications is to validate a category metric of perceived exertion that is developmentally suited for use by children and adolescents. Accordingly, the present investigation examined concurrent validity of the newly developed children's format of the OMNI-Resistance Exercise Scale (OMNI-RES) for use during upper and lower body isotonic exercise. The scale (Fig. 1) has both verbal and mode specific pictorial descriptors distributed along a comparatively narrow numerical response range (0–10), and is presented in a visually discernible exertional intensity gradient. Pictorial descriptors depicting a child "weight lifter" are positioned along the intensity gradient, consonant with corresponding verbal descriptors. The term OMNI is a contemporary contraction of the word *omnibus.* When used in the context of a perceived exertion metric, OMNI means a RPE scale having broadly generalizable properties (24).

A recent investigation by Robertson et al. (24) established concurrent validity of the adult format of the OMNI-RES for young females and males performing volume-incremented biceps curl (BC) and knee extension (KE) resistance exercise protocols. Linear regression coefficients for the relation between Wt_{tot} and RPE for the active muscle (RPE AM) and overall body (RPE-Overall) ranged from r = 0.79 to 0.91. In addition, a positive linear regression was found between blood lactic acid concentration and RPE-AM (r = 0.87) during BC exercise. The paradigm used in this previous investigation involving adults was essentially replicated in

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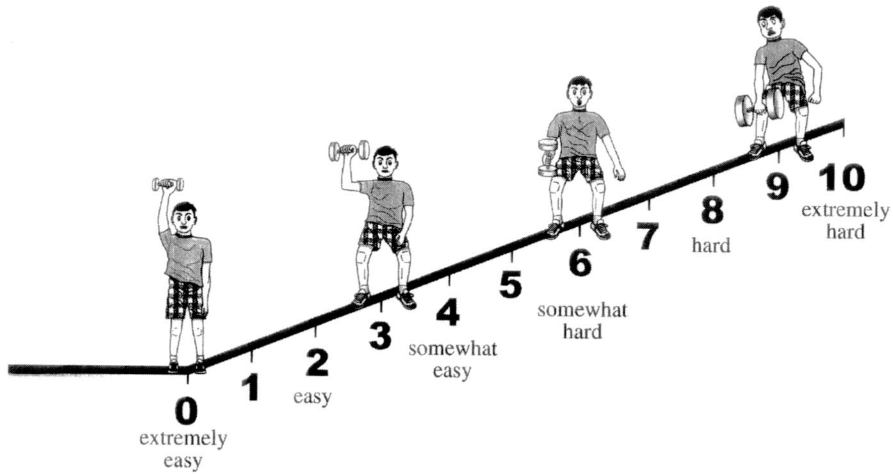

FIGURE 1—Children's OMNI Resistance Exercise Scale (OMNI-RES) of perceived exertion.

the present experiment to establish concurrent OMNI-RES validity for children.

Previous research using adult samples has examined the possible influence of gender on the effort sense during resistance-type muscle actions (7,16,20,22,28). The findings of these investigations generally indicated that exertional perceptions were independent of gender when the comparison weight was relativized to maximal voluntary muscle action (i.e., isometric or isotonic). As an example, in a recent investigation involving exertional estimates derived from the OMNI-RES, Robertson et al. (24) reported that RPE-AM and RPE-Overall did not differ between young adult females and males when resistance exercise was performed at 65% 1-RM for upper and lower body exercises. Given that a gender main effect can also be of interest in perceived exertion research involving children, it is important to establish that the metric employed in such experimentation is valid for use by both female and male subjects performing upper and lower body resistance exercise. In the present investigation, it was expected that the OMNI-RES would be valid for separate samples of female and male children.

A number of previous investigations involving adult female and male samples have differentiated RPE to active muscles (RPE-AM) during resistance exercise (5–8,12,13,18,20–22) providing anatomic specificity to the perceptual response. The intensity of the differentiated RPE-AM was usually higher than that of the undifferentiated RPE-Overall across repetitions and/or exercise time points. Using such a differentiated paradigm, Robertson et al. (24) employed the OMNI-RES to assess exertional perceptions in adult recreationally active weight lifters performing both upper and lower body isotonic resistance exercise. They reported that RPE-AM was significantly higher than RPE-Overall when Wt_{tot} was systematically increased across separate sets of BC and KE exercise. Similar evidence of differentiated perceived exertion responsiveness during resistance exercise is not available for children. As such, the present investigation examined the sensitivity of the Children's OMNI-RES to differentially measure RPE arising from active muscle groups as well as the overall body where Wt_{tot} increased across sequential sets of upper and lower body isotonic exercise.

Two hypotheses were tested: (a) it was expected that for both female and male children, RPE-AM and RPE-Overall would demonstrate a positive correlation with Wt_{tot}, establishing concurrent validity of the children's pictorial format of the OMNI-RES; and (b) it was expected that RPE-AM would be more intense than RPE-Overall during each set of upper and lower body isotonic resistance exercise for both gender groupings.

METHODS

Characteristics (mean ± SD) of the female ($N = 25$) and male ($N = 25$) subjects were, respectively: age, 12.2 ± 1.4 and 12.3 ± 1.3 yr; height, 154.0 ± 11.6 and 158.7 ± 13.5 cm; weight, 55.0 ± 16.5 and 60.0 ± 23.2 kg; BMI, 22.9 ± 5.6 and 23.3 ± 6.6 kg·m^2; 1-RM BC, 7.6 ± 2.3 and 9.8 ± 3.3 kg; and 1-RM KE, 13.2 ± 5.6 and 16.5 ± 7.7 kg. The age range (10–14 yr) of the subjects was chosen because it is consistent with previously endorsed chronological ages of children who can safely participate in resistance exercise training (31). None of the subjects had resistance exercise training experience. Sample size was determined for the statistical power required to demonstrate a three-factor interaction effect within the repeated measures comparisons of RPE. This power requirement was the most stringent among any of the statistical models employed in the analysis of variance, and as such required the greatest number of subjects for each contrast cell. Using a power of 0.80, an α of 0.05, and an effect size of 0.9, it was determined that a minimum of 16 female and 16 male subjects were required to test both the main and interaction effects (29). The within-subject factor in the power calculation assumed an intraclass correlation of $r = 0.70$ over the repeated measures.

Subjects were clinically normal volunteers who demonstrated cognitive ability to read out loud each verbal descriptor on the Children's OMNI-RES. Medical clearance to undertake exercise testing was required before participation. Risks and benefits were explained and the subject and her/his parent (guardian) gave written consent to participate. Subjects did not have cardiovascular, neuromotor, or metabolic contraindications to exercise testing, as determined by preparticipation medical examination. Both the experimental paradigm and the use of children as research subjects were approved by the University of Pittsburgh institutional review board.

Experimental Design

The investigation used a cross-sectional, perceptual estimation design consisting of one orientation and three experimental trials. This experimental design was employed previously to establish concurrent validity of the Adult OMNI-RES (24).

All subjects undertook the orientation trial first followed by the three experimental trials. One set of single-arm BC exercise and one set of single-leg KE exercise was performed during each of the three experimental trials. Therefore, two sets were performed during a trial, with one trial administered for a given laboratory session. Using a counterbalanced assignment, one half of the female group and one half of the male group performed the BC and then the KE exercise. The remaining half of each group performed the opposite order within a given trial, that is, KE before BC. Three sets consisting separately of 6, 10, and 14 repetitions were performed for both the BC and KE exercises. The three sets (i.e., 6, 10, and 14 repetitions) for the BC and the three sets for the KE exercise were presented in counterbalanced order across the three experimental trials. This was done using an inclusive counterbalanced schedule for the three repetitions/sets within a given exercise (i.e., BC or KE) and then assigning a separate subject to each sequence.

Correlations between RPE and Wt_{tot} during BC and KE exercise were calculated to establish concurrent scale validity using a volume-loading resistance protocol. In this protocol, relative exercise intensity (i.e., 50% 1-RM) was the same for the three separate exercise sets, whereas exercise repetitions increased over sets. As such, Wt_{tot} increased with accumulating repetitions within each set, and also varied across the three successive sets for a given exercise. A volume-loading protocol at a fixed relative intensity was used because it has been shown to produce a wide range of Wt_{tot} within and between sets for both upper and lower body exercise (24). Large response ranges of Wt_{tot} were requisite for correlational analysis of the type used presently to establish concurrent scale validity (24).

Orientation Trial

During the orientation trial, the experimental purpose was explained, limb dominance established, and descriptive characteristics determined. Body height (cm) and weight (kg) were measured with a Detecto-Medic Scale and an attached stadiometer (Detecto Scales, Inc., Brooklyn, NY). Limb dominance was established as the writing hand and kicking leg. Instructions and anchoring procedures for the Children's OMNI-RES were then given to the subject. The techniques and equipment for the single-limb BC and KE exercise were explained, and a 1-RM was determined for both exercises using procedures described by Gearhart et al. (6). Finally, a supervised practice session to standardize "lifting technique" was undertaken. During this practice session, the weights equivalent to 50% of the separately determined 1-RM for the single-limb BC and KE exercise were calculated and recorded for each subject. Appropriate seat and knee bar settings on the KE exercise machine were also determined and recorded for each subject.

Experimental Trials

Unilateral BC. The isotonic BC exercise was performed with the dominant arm using a barbell weight equivalent to 50% 1-RM for that exercise. Magnetic Plate Mates (Bodytrend, Carpenteria, CA) were used to adjust the weight to the nearest 0.57 kg. The subject was seated on a flat/incline bench (Nautilus Fitness Products, Boulder, CO) with adjustable seat height and back support. Both feet were completely in contact with the floor, with the knees and hips positioned in 45° flexion and the back placed firmly against the vertical back support. The nondominant (i.e., inactive) arm was maintained in 180° extension throughout the exercise. The exercise began with the barbell positioned at the closest point to the floor. At the end of the concentric phase, the elbow (dominant arm) was in maximum flexion. During the eccentric phase, the barbell was lowered until the elbow was again in 180° extension, marking completion of one full repetition. The concentric–eccentric muscle action was performed in a vertical plane perpendicular to the horizontal plane of the shoulders. The concentric and eccentric phases were each completed in 2 s, with this sequence signaled by an electronic metronome. A set was finished when the required repetitions for that exercise were completed.

Unilateral KE. The isotonic KE was performed with the dominant leg using a weight equivalent to 50% 1-RM for that exercise. The exercise was performed on a rotary leg-extension curl machine (Nautilus Fitness Products, Boulder, CO). Magnetic Plate Mates were used to adjust the weight to the nearest 0.57 kg. The back was positioned firmly against the back support of the exercise machine. The hands gripped stabilizing points on the seat. The seat position and back support were adjusted for each subject so that both knees were in 90° flexion. The knee of the nondominant (i.e., inactive) leg remained in 90° flexion throughout the exercise. The foot of the dominant leg was at the closest position to the floor at the start of the concentric phase of the muscle action. The weight bar of the exercise machine was positioned at the midpoint of the frontal aspect of the tibia. At the end of the concentric phase, the knee was in 180° extension, and the leg was parallel to the floor. During the eccentric phase, the weight bar was lowered until the knee was again in 90° flexion, marking completion of one full repetition. The concentric and eccentric phases were each completed in 2 s, with the sequence signaled by an electronic metronome. A set was finished when the required repetitions for that exercise were completed.

Exercise was observed by an investigator to ensure that the concentric and eccentric phases were complete for each repetition. Subjects were instructed to exhale during the concentric phase and inhale during the eccentric phase. The two exercises were separated by a 5-min seated recovery period.

RPE Scaling Procedures

Ratings of perceived exertion were estimated during each exercise set using the child format of the OMNI-RES. A differentiated rating for the active muscles (RPE-AM) was estimated during the concentric phase of the final repetition of each set. An undifferentiated rating for the overall body (RPE-Overall) was estimated immediately after the RPE-AM during the final repetition. Subjects were reminded during the next to the last repetition of each set to "think about your feelings of exertion." The OMNI-RES was in clear view of the subject during the entire exercise set. Standard instructions for the OMNI-RES were read to the subject immediately before each trial. These scaling instructions were adapted from those previously published for the adult format of the OMNI-RES (24). The scaling instructions explained: (a) perceived exertion, (b) how to use the OMNI-RES, and (c) the low and high perceptual anchor points.

Instructions: We would like you to use these pictures to describe how your body feels during weightlifting exercise (show subject the OMNI-RES). You are going to perform weightlifting exercise using your upper and lower body. Please look at the person at the bottom of the picture who is lifting a light weight. (Investigator: point to the lower left pictorial). If you feel like this person when you are lifting a weight, the effort will be EXTREMELY EASY. You should give the number zero. Now look at the person at the top of the picture who is barely able to lift a very heavy weight. (Investigator: point to the top right pictorial). If you feel like this person when you are lifting weights, the effort will be EXTREMELY HARD. You should give the number 10. If you feel somewhere in between extremely easy (0) and extremely hard (10), then give a number between 0 and 10.

We will ask you to give a number that tells how your arm/leg muscles feel and then a number that describes how your whole body feels.

Remember, there are no right or wrong numbers. Use both the pictures and the words to help select the numbers. Use any of the numbers to describe how you feel when lifting weights.

The low and high perceptual anchors for the OMNI-RES were established using a visual-cognitive procedure (24). This procedure instructs the subject to cognitively establish a perceived intensity of exertion that is consonant with that depicted visually by the weight lifter at the bottom (i.e., low anchor, rating 0) and top (i.e., high anchor, rating 10) of the incline as presented in the OMNI-RES. Subjects were instructed to use their memory of the least and greatest effort that they had experienced while lifting a weight or an object to help in establishing the visual-cognitive link. The OMNI-RES was in full view of the subject at all times during the experimental protocol.

Data Analysis

Descriptive data for perceptual and physiological variables were calculated as mean ± SD. Evidence for response validity was determined using regression analysis with repeated measures over exercise sets (SPSS 11.0 for Windows, Chicago, IL). The analysis separately regressed Wt_{tot} against RPE-AM and RPE-Overall using data from the three exercise sets performed during the BC and KE exercise. Separate regression coefficients were calculated for the female and male groups.

Ratings of perceived exertion were examined with a three-factor (site × set × gender) analysis of variance (ANOVA; SPSS 11.0 for Windows, Chicago, IL) with repeated measures on the within factor of set. The analyses determined differences between REP-AM and RPE-Overall for each set of the BC and KE exercise for both the female and male groups. The analyses also examined differences in RPE-AM and RPE-Overall between females and males for each set. Separate ANOVAs were calculated for the BC and KE exercises. Mauchly's test of sphericity was not significant for either the BC or KE analyses. Significant main and interaction effects were examined with a simple effects *post hoc* analysis.

RESULTS

RPE and Wt_{tot} responses. Presented in Figures 2 and 3 are means (±SD) of RPE measured during the three sets of BC and KE resistance exercise. Each figure presents data separately for the female and male subject groups. Table 1 lists the means (±SD) of Wt_{tot} lifted by the female and male groups during the three sets of BC and KE exercise. These data were used in the regression analysis to examine concurrent validity of the children's OMNI-RES and in the factorial analysis to examine gender influences and differentiated perceptual responsiveness. The results of these analyses are described below.

Concurrent validity. Table 2 lists the results of the linear regression analyses that expressed RPE as a function of increasing Wt_{tot} for both the BC and KE exercises. For the female subjects, positive linear regression coefficients ($P < 0.01$) were found between Wt_{tot} and RPE-AM (BC: r = 0.88; KE: r = 0.72) and RPE-O (BC: r = 0.87; KE: r = 0.80). Similarly, for the male subjects, positive linear coefficients ($P < 0.01$) were found between Wt_{tot} and RPE-AM (BC: r = 0.81; KE: 0.75), and RPE-O (BC: r = 0.80; KE: r = 0.88).

Effect of gender and measurement site. The ANOVA of the RPE responses indicated that the main effects for site (BC: $F_{1,11}$ = 58.41; KE: $F_{1,11}$ = 113.79) and set (BC: $F_{2,11}$ = 263.90; KE: $F_{2,11}$ = 199.71) were significant ($P < 0.01$), whereas the main effect for gender (BC: $F_{1,11}$ = 5.03; KE: $F_{1,11}$ = 1.00) was not significant ($P \geq 0.05$). Neither the two-factor nor three-factor interaction effects were significant for the BC and KE responses. The nonsignificant gender main effect for both the BC and KE data indicated that RPE-AM and RPE-O did not differ

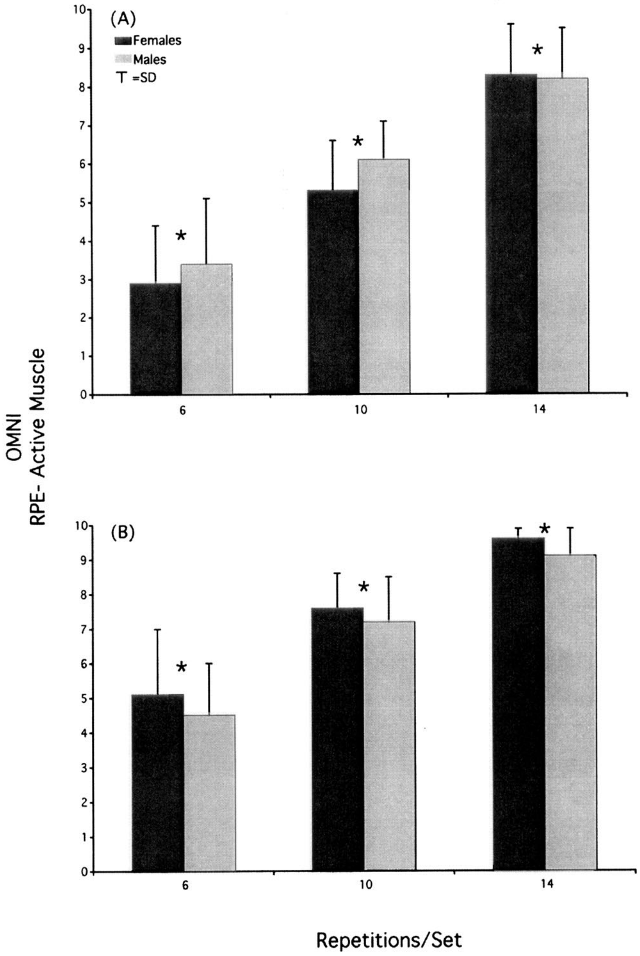

FIGURE 2—Ratings of perceived exertion (OMNI Scale) for the active muscles (RPE-AM) during the final repetition for female ($N = 25$) and male ($N = 25$) children performing three sets of biceps curl (A) and knee extension (B) resistance exercise at 50% 1-RM. * Indicates that RPE increased ($P < 0.01$) from the 6- to 10- and 10- to 14-repetition sets in both the female and male groups.

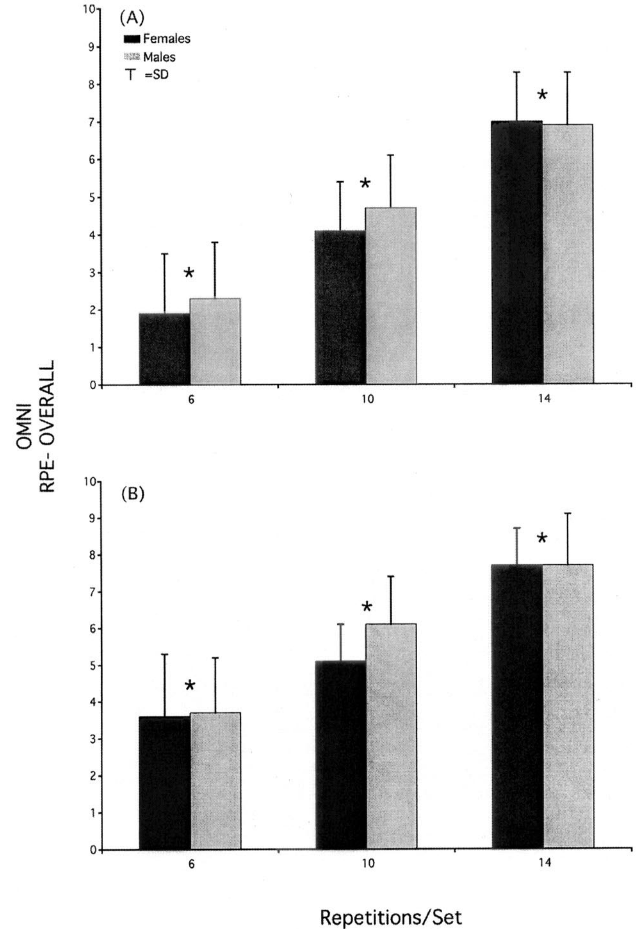

FIGURE 3—Ratings of perceived exertion (OMNI Scale) for the overall body (RPE-Overall) during the final repetition for female ($N = 25$) and male ($N = 25$) children performing three sets of biceps curl (A) and knee extension (B) resistance exercise at 50% 1-RM. *Indicates that RPE increased ($P < 0.01$) from the 6- to 10- and 10- to 14 repetition sets in both the female and male groups.

between females and males within each of the three exercise sets. Selected *post hoc* analyses indicated that: (a) when averaged over the sets and gender main effects, RPE-AM was higher ($P < 0.01$) than RPE-O during both the BC and KE exercises; and (b) when averaged over the site and gender main effects, RPE increased ($P < 0.01$) from the 6- to 10-repetition set and the 10- to 14-repetition set for both the BC and KE exercises (Figs. 2 and 3).

DISCUSSION

This investigation examined concurrent validity of the newly developed children's weightlifting format for the OMNI Scale of Perceived Exertion. Validity was established for 10- to 14-yr-old female and male children performing unilateral isotonic BC and KE exercise. Validation criteria stipulated that: (a) for separate groups of female and male children, RPE-AM and RPE-Overall would distribute as a positive function of Wt_{tot} during both upper and lower body resistance exercise; and (b) the OMNI-RES could be used by children to separately rate the intensity of the differentiated perceptual signal arising from the active muscles and the undifferentiated signal for the overall body during both upper and lower body resistance exercise. The findings of this investigation were consistent with these hypotheses.

Concurrent validity. In the present investigation, validity coefficients derived from linear regression analyses ranged from r = 0.72 to 0.88 for the BC and KE exercises, and were significant for both female and male children. These findings are in agreement with the only previous investigation that employed the OMNI Scale to assess exertional perceptions during resistance exercise (24). In this previous investigation, Robertson et al. (24) determined that for female and male adults, RPE increased linearly with Wt_{tot} (r = 0.79–0.91) during upper and lower body isotonic resistance exercise. When examined in juxtaposition, the present and previous findings indicate that both the child and adult formats of the OMNI-RES evidence strong, positive, and linear validity coefficients for upper and lower body exercise when a volume-loading paradigm is employed. Such response concurrence provides rating consistency across OMNI scale formats independent of gender and

TABLE 1. Total weight (kg) lifted during three sets of unilateral biceps curl (BC) and knee extension (KE) resistance exercise at 50% of one repetition maximum.

			Repetitions per Set					
			6		10		14	
Gender	N	Exercise	Mean	(+SD)	Mean	(+SD)	Mean	(+SD)
Female	25	BC	23.13	6.97	38.00	11.49	53.19	16.09
		KE	39.34	16.81	65.57	28.02	91.83	39.23
Male	25	BC	29.67	9.93	49.05	16.39	68.69	22.96
		KE	48.89	23.27	81.49	38.79	114.10	54.30

age. In addition, the present findings are also generally consistent with previous investigations employing Borg scales (i.e., 6–20, CR-10) that demonstrated RPE increased as a function of increasing Wt_{tot} (6,11,17,22,26).

The present paradigm is the first to employ a Children's OMNI scale format that presents developmentally specific pictorial-verbal categories to rate perceived exertion during resistance exercise. Responses indicated that both gender groupings were able to use the pictorial-verbal format of the OMNI-RES to translate into numbers (i.e., RPE) their perceptions of physical exertion during repeated isotonic muscle actions involving single-arm and single-leg resistance exercise. The strong positive and linear relation observed between Wt_{tot} and both RPE-AM and RPE-Overall provides concurrent validity evidence for use of the OMNI-RES by young female and male children.

Gender-specific validation. A number of previous investigations involving adult samples have examined the possibility that gender systematically influences perceptual responses during resistance exercise (7,16,20,22,24,28). To date, information regarding the effect of gender on children's exertional perceptions when performing resistance exercise is not available. As such, the present investigation examined concurrent validity of the OMNI-RES for separate groups of female and male children performing upper and lower body resistance exercise. Regression coefficients between RPE (AM and Overall) and Wt_{tot} across three exercise sets ranged from $r = 0.72$ to 0.88 for female subjects and $r = 0.75$ to 0.88 for male subjects. These validity coefficients are very similar to those reported previously for separate groups of young adult females and males performing volume-loading upper and lower body resistance protocols where RPE was estimated with the adult format of the OMNI-RES (24). When the present and previous findings are examined together, the perceptual responses indicate that the age-specific OMNI-RES pictorial-verbal formats are valid for both female and male children and adults performing upper and lower body isotonic resistance exercise.

For the children studied presently, neither the differentiated nor the undifferentiated RPE differed between females and males during the upper and lower body resistance exercises. In a similar manner, Robertson et al. (24) reported that RPE determined with the OMNI-RES did not differ between female and male adults when performing BC and KE isotonic muscle actions. The absence of a gender effect in the adult sample was attributed to the use of a resistance exercise paradigm where the relative intensity (i.e., 65% 1-RM) was the same for the female and male groups. This relativized response mechanism is consistent with most (7,20,22) but not all (16) previous reports involving RPE comparisons between female and male adults. It is proposed that a mechanism involving relative isotonic force production could also be used to explain the similarity in perceptual responses between the present samples of female and male children when performing both upper and lower body resistance exercise. That is, the volume-loading paradigm employed the same relative intensity (i.e., 50% 1-RM) for both gender groupings. Assuming that the percent of maximal voluntary muscle action plays a mediating role in setting the intensity of effort sensation, it would be expected that gender would not systematically affect RPE in young children when a relative resistance exercise load is performed. This hypothesis requires further investigation.

Differentiated RPE. The RPE-AM was higher than the RPE-Overall for both the female and male children when performing BC and KE exercise. These findings held across the low-, moderate-, and high-volume sets. Robertson et al. also reported that the differentiated perceptual signal arising from the active muscle was significantly more intense than the global perceptual report for the overall body when RPE was estimated with the adult format of the OMNI-RES during a volume-loading resistance exercise protocol (24). The findings of the present investigation involving children

TABLE 2. Regression analysis of RPE expressed as a function of total weight (kg) lifted during unilateral biceps curl (BC) and knee extension (KE) resistance exercise.

			Variable							
			Criterion	Concurrent						
Exercise	Gender	N	(X)	(Y)	Intercept	SE	Slope	SE	r*	r^2
BC	F	25	Wt_{tot}	RPE-AM	1.129	0.333	0.124	0.008	0.88	0.77
				RPE-Overall	0.123	0.331	0.119	0.008	0.87	0.76
BC	M	25	Wt_{tot}	RPE-AM	2.475	0.364	0.077	0.007	0.81	0.66
				RPE-Overall	1.248	0.362	0.076	0.007	0.80	0.64
KE	F	25	Wt_{tot}	RPE-AM	5.126	0.348	0.041	0.005	0.72	0.51
				RPE-Overall	2.954	0.292	0.043	0.004	0.80	0.64
KE	M	25	Wt_{tot}	RPE-AM	4.613	0.314	0.033	0.003	0.75	0.57
				RPE-Overall	3.050	0.222	0.036	0.002	0.88	0.77

RPE, rating of perceived exertion (OMNI-RES) for the active muscle (RPE-AM) and overall body (RPE-Overall); Wt_{tot}, total weight; F, female; M, male; * $P < 0.01$.

and the previous report involving an adult sample where both experiments assessed RPE using the OMNI-RES are consistent with a number of previous reports that used the Borg 15-category scale. In these previous experiments, differentiated perceptual signal strength was assessed for adult samples during or immediately following a single isotonic repetition of upper and lower body resistance exercise (5,12,13). The intensity of the perceptual signal that was differentiated to the predominantly active muscle groups was always greater than that for the overall body.

One indication of the utility of a category RPE scale is its precision in distinguishing between an anatomically regionalized perceptual signal and a total body signal when both assessments are made within a comparatively narrow time frame (i.e., 4 s) (24). The present findings demonstrated that reasonably rapid assessment of both the differentiated and undifferentiated RPE is possible in young children undertaking multiple set protocols that activate different muscle groups according to the body regions involved.

Pediatric considerations. An important component of health-fitness programming for children is the development of muscle strength (2,25,30). Mounting evidence indicates that assessment of muscle strength in children is both safe and effective (1). When the results of such tests are used as prescriptive baselines, appropriately designed and supervised training programs can improve children's muscle strength, motor skills, bone density, body composition, and, to a measured extent, cardiorespiratory fitness (1). Recommendations for children's strength-training programs stipulate that the overload dosage should: (a) involve comparatively higher repetitions and lower absolute weight per set, (b) use multijoint exercises, and (c) activate major muscle groups in both the upper and lower body (31). Based on the present findings that established concurrent validity for the Children's OMNI-RES, it is suggested that a perceptually self-selected and self-regulated training dosage be included with these conditioning recommendations for children. Applying this concept, the training weight and, as such, the total repetitions per exercise set are selected by the child according to a predetermined target-RPE training zone (23). It is proposed that under appropriately supervised conditions, a self-selected and regulated resistance exercise program will make training more enjoyable, promote regular participation, and help ensure that the total training load (repetition × weight) remains within a safe and effective overload zone to improve muscle strength. Validation of the OMNI-RES, a pictorial-verbal category metric developmentally formatted for use by children to scale exertional perceptions, is the first step in such a perceptually based, self-regulated strength-training system.

CONCLUSION

This investigation is the first to use a pictorial-verbal category metric to measure differentiated and undifferentiated RPE in young (10- to 14-yr-old) children performing upper and lower body isotonic resistance exercise. RPE (AM and Overall) derived from the Children's OMNI-RES distributed as positive linear functions of Wt_{tot} across low-, moderate-, and high-volume sets. These findings were consistent for both the female and male subject groups when performing unilateral BC and KE isotonic exercise at 50% 1-RM. Gender differences in perceived exertion responses were not observed, suggesting that in 10- to 14-yr-old children, the relative contraction intensity may mediate exertional signal strength using a common neurophysiologic pathway for both female and male children. By combining the present and previous findings, it can be concluded that the OMNI-RES is valid for use by female and male children and young adults performing upper and lower body isotonic weightlifting exercise.

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