Original Research

Exertional Observation in Adults Performing Intermittent Treadmill Walking and Running

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ABSTRACT

International Journal of Exercise Science 10(8): 1130-1144, 2017. The present investigation examined the Adult OMNI Walk-Run Scale for use by an independent observer to rate an individual's perception of exertion during intermittent treadmill walking and running. Forty (22.4 ± 2.9 yrs) recreationally active males (n = 18) and females (n = 22) completed three 5-min intermittent bouts of treadmill exercise. The exercise bouts were a level walk (LW; 4.0 km·hr-1, 0% grade), hill walk (HW; 5.6 km·hr-1, 5% grade), and run (R; 8 km·hr-1, 2.5% grade). Each bout was separated by a 5-min recovery period. RPE responses were simultaneously estimated by an observer and self-estimated by the participant during each bout using the Adult OMNI Walk-Run Scale. Session RPE responses were simultaneously estimated by the same observer and self-estimated by the participant 5-min post-exercise session. Analysis of variance indicated no significant mean differences between observer RPE and participant RPE ($p > 0.05$) except for males during the running bout ($p < 0.05$). Additionally, there were no significant mean differences between the observer RPE and the participant RPE for the session ratings ($p > 0.05$). Finally, strong positive correlations were found between observer and participant RPE ranging from 0.79-0.84 for exercise bouts and moderate-strong positive correlations ranging from 0.58-0.64 for the exercise session. Results support the use of the OMNI RPE Scale in a direct observation procedure to estimate exertion in female and male young adults performing intermittent treadmill walking and running. This observation-based procedure provides the practitioner with an opportunity to independently evaluate the perceptual intensity of individuals involved in aerobic exercise.

KEY WORDS: Perceived exertion, intermittent treadmill exercise, session RPE, differentiated ratings, physical activity intensity

INTRODUCTION

Exercise specialists, health and fitness professionals, rehabilitation therapists, public health advocates, personal trainers and coaches are always looking to ensure clients are performing the appropriate intensity of exercise. Technology has led to advances in biometric monitoring and reporting. However, technology comes at a cost and may not be applicable for large

groups of athletes or clients performing exercise at the same time, children engaged in physical education, and clientele unable to financially support the use of technology. One potential procedure that could be used in a variety of settings is the use of exertional observation.

Exertional observation is a direct visual kinematic procedure wherein an independent observer estimates ratings of perceived exertion for an individual performing physical activity. Direct kinematic observation of perceived exertion has been validated in children performing load-incremented treadmill exercise (13). A trained observer is capable of estimating the participant's ratings of perceived exertion for the overall body (RPE-O), legs (RPE-L; peripheral signals such as acidosis, blood glucose levels, and blood flow to the muscles), and chest (RPE-C; respiratory metabolic signals such as pulmonary ventilation) using the Children's OMNI Walk-Run Perceived Exertion Scale (16). Furthermore, the exertional observation procedure is unobtrusive, inexpensive, and places a low burden on both the participant and the investigator.

The basic assumptions underlying visual exertional kinematics are that an observer can (a) identify movement patterns, (b) detect divergence from normal movement, (c) discriminate between non-fatiguing and fatiguing movements, and (d) recognize exertional signs and symptoms (4, 6).

Previous investigations that examined exertional observation kinematics used female and male children who performed continuous aerobic exercise (13), and female and male adults who performed intermittent aerobic (5). In the investigation by Robertson et al. (13) using the Children's OMNI Perceived Exertion Scale, the exertional observation procedure demonstrated strong positive correlations (r = 0.80 to 0.91) between RPE and oxygen consumption (VO_2) and heart rate (HR) for female and male children performing load-incremented treadmill exercise.

Additionally, a global rating of perceived exertion associated with an entire exercise session (i.e. session RPE), as a component of the exertional observation procedure, may provide insight on the "total" perceptual-physiological strain linked to the intensity of an entire exercise period. The observed session RPE may result in its use as part of physical activity surveys where exercise intensity is difficult to measure directly. Foster and colleagues (2, 14) demonstrated that session RPE is valid across various intensities of aerobic and resistance exercise. Session RPE and measures of exercise intensity (%HRR, $\%VO_{2max}$, and %1-RM) observed moderate-to-strong correlations (r = 0.50 to 0.90) (2, 14).

Therefore, the purpose of the present investigation was expand upon the previous research and to examine exertional observation in young adults performing intermittent treadmill walking and running. In the present investigation, validity of exertional observation was accepted according to the following hypotheses for separate groups of female and male adults. (a) Observer's momentary RPE would be positively correlated with the participant's submaximal VO_2 and HR, establishing concurrent validity. (b) Observer's estimated RPE (both momentary and session) would be positively correlated with participant's estimated RPE,

establishing construct validity. (c) The exertional observation procedure could be used to differentiate the intensity the perceptual signals from the legs and chest during intermittent bouts of treadmill walking and running.

METHODS

Participants
Twenty-two female and eighteen male healthy, recreationally active, non-obese adults participated in this investigation. Recreationally active was defined as participation in 30 to 60 minutes of aerobic and/or resistance exercise 2-3 times per week with activities not involving collegiate or professional sport participation. Participants were recruited through recruitment flyers posted around campus and in recreation centers. The mean characteristics of the female and male participants were, respectively (± SD); age 22.1 (± 2.5) and 22.7 (± 3.4) yr; height 164.4 (± 6.4) and 178.2 (± 8.4) cm; body mass 64.4 (± 12.3) and 79.4 (± 11.0) kg; and maximal oxygen consumption 39.36 (± 5.72) and 49.17 (± 6.49) $mL \cdot kg^{-1} \cdot min^{-1}$. Risks and benefits of the investigation were explained and written voluntary consent to participate was collected. Participants did not have clinical, neuromotor, or cognitive contraindications to exercise testing as determined during pre-participation screening using the Physical Activity Readiness Questionnaire (PARQ). The experimental procedures were approved by the University of Pittsburgh's Institutional Review Board.

Protocol
A cross-sectional, multiple observation design measured exertional perceptions during an intermittent treadmill protocol consisting of three intensities each lasting 5 minutes. Participants were assessed in a 3-h postprandial state and were requested to refrain from vigorous physical activity 24-h prior to their test.

Concurrent validation used the participant's oxygen consumption (VO_2) and heart rate (HR) responses to treadmill exercise as the criterion variables and the observer-estimated ratings of perceived exertion as the concurrent variables.

Evidence of concurrent validity was accepted as a positive correlation between the criterion and concurrent variables during the three treadmill bouts. The construct validation procedure was based on the previous validation procedure for an exertional observation procedure in children using the OMNI-RPE scale (12, 13). The construct variables were RPE-O, -L, and -C measured during the three intermittent treadmill exercise bouts. The participant's self-rated exertional perception served as the criterion procedure and exertional observation was the conditional procedure. Evidence of construct validity was examined by correlating the participant's self-rated RPE with the observer estimated RPE. A high validity coefficient was taken as an indication that the observation procedure measured the same perceptual construct (i.e. RPE) as the criterion procedure.

Treadmill Test Protocol: Prior to performing the treadmill exercise, height and body mass were determined with a Detect-Medic Scale and attached stadiometer (Detecto Scales, Inc. Brooklyn,

NY). During a pre-test orientation period, participants were familiarized with the OMNI Walk/Run RPE Scale (17). Walking and running exercise were performed on a Trackmaster TMX425Cx treadmill (Newton, KS). The intermittent treadmill protocol consisted of three, 5 minute exercise bouts with a 5 minute seated recovery between each bout. The exercise bouts included a level walk at 4.0 km·hr^{-1}, 0% grade; a hill walk at 5.6 km·hr^{-1}, 5% grade; and a run at 8 km·hr^{-1}, 2.5% grade. Pilot work indicated these exercise bouts were approximately equivalent to 30%, 55%, and 80% of VO$_{2max}$ for participants of similar age, physical, and exercise characteristics. The three bouts were presented in a counterbalanced order. The speed and grade for the exercise bouts were set by the investigator. A load-incremented Bruce treadmill protocol was used to determine the maximal oxygen consumption (VO$_{2max}$) for each participant was performed one week following the walking and running exercise bouts as to not confound the exertional observation procedure with a possible demand bias to the graded protocol.

Heart Rate and Oxygen Consumption: For both the walking and running intermittent bouts and the maximal test, HR (beats·min^{-1}) was measured during the last fifteen seconds of each minute during treadmill exercise using a Polar Telemetry System (Polar Electro, Finland). An open circuit respiratory-metabolic system (TrueMax 2400 Parvo Medics, Sandy, UT) was used to measure total body oxygen consumption (VO$_2$; ml·kg^{-1}·min^{-1}) each minute of treadmill exercise.

Ratings of Perceived Exertion - Self-Rating Procedure: Perceived exertion was self-rated by the participant during the last fifteen seconds of each exercise bout. The participant estimated the undifferentiated RPE for the overall body (RPE-O), and differentiated RPE in the legs (RPE-L), and in the chest (RPE-C). Additionally, session ratings of perceived exertion (overall, legs, and chest) were estimated by the seated participant 5-min following completion of the entire treadmill exercise. For this investigation, a session rating of perceived exertion was defined as a post-exercise measure of the global exertion experienced during the entire exercise sequence.

The procedure to estimate RPE was explained before the exercise session and included a definition, scaling instructions, and scale anchoring (11). Perceived exertion was defined as the subjective intensity of effort, strain, discomfort and/or fatigue that was felt during exercise. The standardized instructions and scale anchoring procedures for the Adult OMNI Walk/Run RPE Scale have been published previously (12). The Adult OMNI Walk/Run RPE Scale was in full view of the participant when the instructions were read and the perceptual scale anchors were established. During the exercise bouts, participants self-rated their perceptions by pointing to the RPE on the OMNI Walk/Run RPE Scale as the respiratory valve prohibited a verbal response.

Ratings of Perceived Exertion - Observation Procedure: The observers were female and male members of the research team whom had extensive experience with self-rating perceived exertion. In addition the research team underwent a series of observation orientation sessions prior to data collection to ensure inner-rater and intra-rater reliability greater than 0.80. One observer was assigned to each treadmill test based on research team availability and

participant scheduling. During the exercise sessions, the observers were positioned floor level and 45 degrees left-frontal angle to the participant. In this way, the observer could not see the RPE response on the scale that was pointed to by the participant. Both the observer's position and the treadmill's position were standardized with markings on the floor throughout the investigation.

Additionally, the observers were acoustically isolated (ear/hearing protectors) to ensure that they did not hear the investigator confirming the participant's responses and background noise associated with treadmill operation. The observer was not informed of the participant's RPE, VO_2, and HR responses. Observers used an identical Adult OMNI Walk/Run RPE Scale to estimate the participant's RPE-O, -L, and –C during the last fifteen seconds of each minute for each five minute exercise bout. The observer also estimated the session RPE 5-min following completion of treadmill exercise. The observers used the same instructional sets for the Adult OMNI RPE Scale as the participants. The participant was not made aware of the observer's RPE estimates. The Adult OMNI Walk/Run RPE Scale was in full view of the observer when making the RPE estimates.

Observers underwent standardized orientation that included the definition of perceived exertion, scale instructions, and the procedures for memory anchoring (13), which were specific to the Adult OMNI Walk/Run RPE Scale. Observers employed contextual categories and observation keys that provided a frame of reference which to estimate the participant's exertion. Each observer practiced using momentary time sampling to rate both undifferentiated and differentiated RPE for young female and male adults performing intermittent bouts of treadmill walking and running. The coding system used in the exertional observation procedure included two contextual categories; the participant and the environment. Each contextual category contained observation keys that filtered excess visual noise and provided a calibration of exertional observation for the participant contextual category. The investigation focused on observation keys of 1) limb, torso, and head movement rate/amount, 2) appearance of sweat, redness, and grimacing, and 3) breathing rate and depth (4, 6). Treadmill grade was employed as an environmental category intended to simulate terrestrial variations in surface incline to be traversed. The observer used these categories and keys to estimate RPE for each participant.

Statistical Analysis
Descriptive data for the perceptual and physiological variables were calculated as mean ± SD. Evidence of both concurrent and construct validity was first determined using linear least squares regression analysis for data derived from the three exercise bouts (IBM SPSS Statistics 22.0 for Windows, Chicago, IL). Separate analyses were performed for both momentary and session RPE responses.

When determining concurrent validity, the analysis separately regressed the participant's VO_2 and HR against the observer-estimated RPE-O, -L, and –C using data from the last minute of the three treadmill exercise bouts. Regression coefficients were calculated for female and male groups. When determining construct validity, the analysis regressed observer-estimated RPE

against the participant's self-rated RPE using data from the last minute of the three treadmill exercise bouts. Regression coefficients were calculated separately for RPE-O, -L, and –C within each of the sex groups. Due to the sex differences in VO_{2max} and the intent to examine validity over as wide a perceptual-physiological range as possible, data were analyzed for the three treadmill exercise bouts using sex as a categorical, not independent variable.

Validity evidence was also examined using repeated measures analysis of variance (ANOVA). A 2x3x3 mixed model ANOVA was performed on momentary RPE responses with main effects for procedure (self-rating, observation), site (overall, legs, and chest), and bout (LW, HW, and R). For the session RPE, a 2x3 mixed model analysis of variance was performed with main effects for procedure (self-rating, observation) and site (overall, legs, and chest). Separate analysis was performed for the female and male groups. Significant main and a priori selected interaction effects were further assessed with a simple-effects *post hoc* analysis.

Sample size was determined using a power of 0.80, and α of 0.05, and an effect size of 0.90. A minimum of 16 males and 16 females were required to test both the main and the interaction effects (15). The within-subject factor assumed an intra-class correlation of r = 0.70.

RESULTS

Descriptive Information: Table 1 lists the means (±SD) for the male and female participant's physiological responses during each treadmill exercise bout.

Table 1. Physiological responses during intermittent bouts of treadmill exercise listed by sex and exercise bout.

Sex	Bout	VO_2 $(ml \cdot kg^{-1} \cdot min^{-1})$ Mean (±SD)	HR $(b \cdot min^{-1})$ Mean (±SD)
Male	LW	13.65 (1.66)	97.3 (12.3)
	HW	24.23 (2.23)	123.2 (15.3)
	Run	35.56 (3.28)	156.3 (17.1)
Female	LW	13.25 (1.54)	111.9 (14.8)
	HW	23.78 (1.73)	142.5 (18.0)
	Run	34.41 (2.84)	170.5 (16.9)

Figures 1 and 2 present the mean (±SD) RPE determined using self-rated and observer procedures for each treadmill exercise bout. Data are presented separately for females and males.

Concurrent Validity: Regression analyses indicated that observer-estimated RPE-O, RPE-L, and RPE-C distributed positively with VO_2 in both males (Table 2) and females (Table 3).

Regression analyses indicated that observer-estimated RPE-O, RPE-L, and RPE-C distributed positively with HR in both males (Table 4) and females (Table 5).

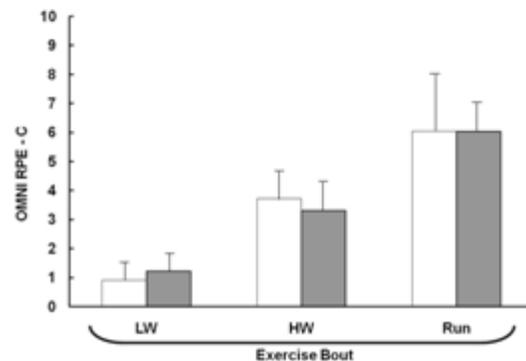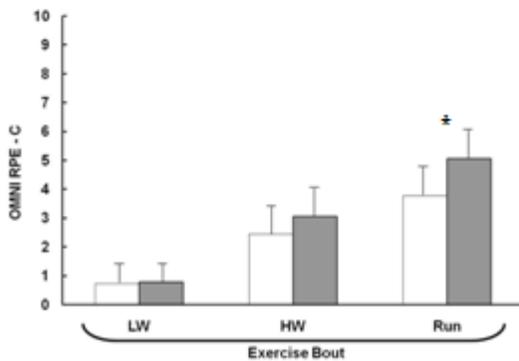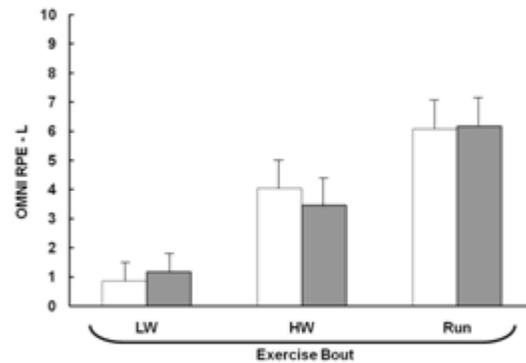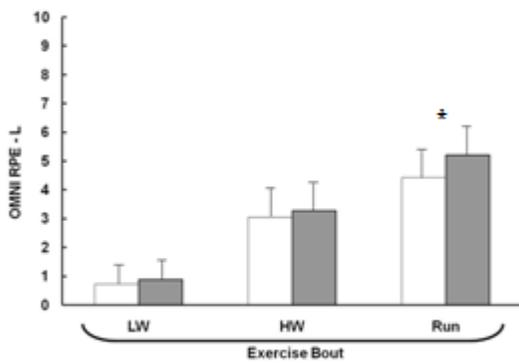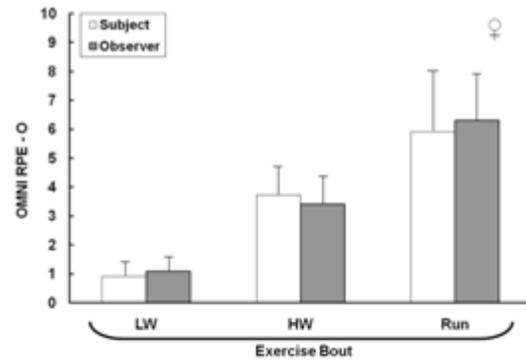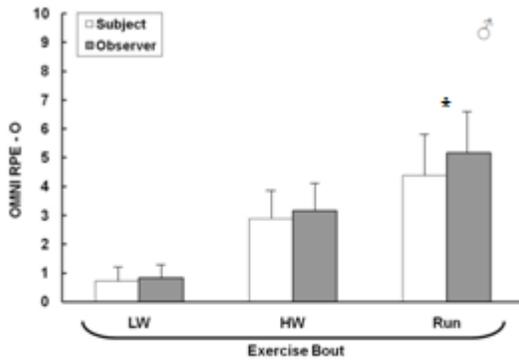All regression functions were statistically significant (p < 0.05).

Figure 1. Observer's and Participant's RPE for the overall body (RPE-O), legs (RPE-L), and chest (RPE-C) for males (♂). * p < 0.05

Figure 2. Observer's and Participant's RPE for the overall body (RPE-O), legs (RPE-L), and chest (RPE-C) for females (♀).

Table 2. Regression analysis for observer's RPE expressed as a function of male participant's VO_2 during intermittent bouts of treadmill exercise listed by the differentiated RPE.

Criterion	VO_2		
Concurrent RPE	O	L	C
Slope	3.82	3.84	3.59
SEE	0.37	0.37	0.39
Intercept	12.75	12.38	13.70
SEE	1.37	1.38	1.42
r*	0.82	0.82	0.79
r^2	0.67	0.68	0.63

Table 3. Regression analysis for observer's RPE expressed as a function of female participant's VO_2 during intermittent bouts of treadmill exercise listed by the differentiated RPE.

Criterion	VO2		
Concurrent RPE	O	L	C
Slope	3.40	3.32	3.43
SEE	0.21	0.25	0.25
Intercept	11.54	11.84	11.69
SEE	0.90	1.05	1.04
r*	0.89	0.86	0.86
r^2	0.80	0.74	0.74

Table 4. Regression analysis for observer's RPE expressed as a function of male participant's HR during intermittent bouts of treadmill exercise listed by the differentiated RPE.

Criterion	HR		
Concurrent RPE	O	L	C
Slope	11.19	11.31	11.09
SEE	1.20	1.18	1.12
Intercept	93.39	90.19	92.73
SEE	4.38	4.39	4.05
r*	0.79	0.80	0.81
r^2	0.63	0.64	0.66

Table 5. Regression analysis for observer's RPE expressed as a function of female participant's HR during intermittent bouts of treadmill exercise listed by the differentiated RPE.

Criterion	HR		
Concurrent RPE	O	L	C
Slope	10.60	10.79	10.97
SEE	0.79	0.81	0.88
Intercept	103.41	102.73	102.91
SEE	3.42	3.45	3.58
r*	0.86	0.86	0.85
r^2	0.74	0.74	0.72

Construct Validity: Regression analyses also indicated that observer-estimated RPE was positively related to participant self-rated RPE over the three treadmill bouts. The correlation coefficients and regression analyses are presented for males (Table 6) and females (Table 7). All analyses were statistically significant ($p < 0.05$) for RPE-O, RPE-L, and RPE-C.

Table 6. Regression analysis of observer's RPE expressed as a function of male participant's RPE during intermittent bouts of treadmill exercises listed by the differentiated RPE.

Criterion	O	L	C
Slope	0.74	0.81	0.65
SEE	0.08	0.07	0.08
Intercept	0.48	0.36	0.40
SEE	0.28	0.25	0.30
r*	0.80	0.85	0.74
r²	0.64	0.72	0.54

Table 7. Regression analysis of observer's RPE expressed as a function of female participant's RPE during intermittent bouts of treadmill exercises listed by differentiated RPE.

Criterion	O	L	C
Slope	0.97	0.99	0.99
SEE	0.08	0.08	0.08
Intercept	0.09	0.16	0.05
SEE	0.33	0.35	0.35
r*	0.84	0.83	0.83
r²	0.70	0.69	0.69

Analysis of Variance: For males, ANOVA of the RPE responses indicated that a procedure main effect ($F_{1,17}$ = 7.592, p = 0.014, partial η^2 = 0.309), a site main effect ($F_{2,34}$ = 5.012, p = 0.012, partial η^2 = 0.228), and a bout main effect ($F_{2,34}$ = 189.595, p < 0.001, partial η^2 = 0.918) were significant.

The procedure X site interaction ($F_{2,34}$ = 1.063, p = 0.357, partial η^2 = 0.059) was not significant while the procedure X bout interaction ($F_{2,34}$ = 4.386, p = 0.020, partial η^2 = 0.205) and the bout X site interaction ($F_{2,34}$ = 2.785, p = 0.033, partial η^2 = 0.141) were significant. The procedure X site X bout interaction ($F_{4,68}$ = 1.825, p = 0.134, partial η^2 = 0.097) was not significant. *Post-hoc* analyses of the procedure main effect ($F_{1,17}$ = 10.387, p = 0.005, partial η^2 = 0.379) demonstrated that the observed RPE averaged across site was significantly (p < 0.05) greater than the self-rated RPE during the running bout.

For females, ANOVA of the RPE responses indicated that the procedure main effect ($F_{1,21}$ = 0.000, p = 1.00, partial η^2 < 0.001) and the site main effect ($F_{2,42}$ = 0.787, p = 0.435, partial η^2 = 0.175) were not significant while the bout main effect ($F_{2,42}$ = 225.145, p < 0.001, partial η^2 = 0.915) was significant. The procedure X site interaction ($F_{2,42}$ = 0.702, p = 0.501, partial η^2 = 0.032), procedure X bout interaction ($F_{2,42}$ = 2.801, p = 0.072, partial η^2 = 0.118), and the bout X site interaction ($F_{2,42}$ = 1.169, p = 0.330, partial η^2 = 0.053) were not significant. The procedure X site X bout interaction ($F_{4,84}$ = 1.760, p = 0.145, partial η^2 = 0.077) was not significant for females.

The assumption of sphericity was met for RPE measures over procedure (Mauchly's W = 1.00) for both females and males. Mauchly's tests of sphericity for RPE measures over bout (W = 0.519, χ^2 (2) = 13.099, p = 0.001) and over site (W = 0.719, χ^2 (2) = 6.598, p = .037) were significant for females but not for males (over bout: W = 0.746, χ^2 (2) = 4.698, p = .095; over site: W = 0.837, χ^2 (2) = 2.843, p = 0.241). However, Mauchly's tests of sphericity for the interaction

effects were not significant. In the event of violating the assumption of sphericity, the Greenhouse-Geisser correction was used.

A priori contrast comparisons of the site x bout interactions examined differentiated perceptual responsiveness across procedure for a given bout. The site x bout interaction was not significant in females suggesting both the participant and the observer rated the intensity of the differentiated leg and chest signals to be similar across bout. Comparisons between the observer-estimated RPE-L and RPE-C at each exercise bout were determined with a *post-hoc* analysis in males. In males, *post-hoc* analysis indicated that the bout main effect was significant ($F_{2,34}$ = 171.24, p < 0.001, partial η^2 = 0.910). The site main effect ($F_{1,17}$ = 2.096, p = 0.166, partial η^2 = 0.110) and the bout X site interaction effect ($F_{2,34}$ = 0.262, p = 0.771, partial η^2 = 0.015) were not significant. The assumption of sphericity was met for RPE measures over bout (Mauchly's W = 0.865, χ^2 (2) = 2.324, p = 0.313). Main effect of site and the bout X site interaction effect also met the assumption of sphericity.

The factorial analyses indicated that (a) in females, observer-estimated RPE were not significantly different than the self-estimated RPE for the overall body, legs, and chest/breathing for each of the three exercise bouts, (b) in males, observer-estimated RPE was significantly higher than the self-estimated RPE during the running bout but were not significantly different during the level and hill walks, and (c) when averaged over measurement site, observer- and self-estimated RPE progressively increased from lowest to highest exercise bout for both females and males.

ANOVA of the Session RPE responses (Table 8) indicated that the procedure main effect was not significant for both females ($F_{1,19}$ = 0.723, p = 0.406, partial η^2 = 0.037) and males ($F_{1,17}$ = 0.006, p = 0.939, partial η^2 < 0.001). The site main effect was not significant for females ($F_{2,38}$ = 0.000, p = 1.000, partial η^2 < 0.001) but was significant for males ($F_{2,34}$ = 8.543, p = 0.001, partial η^2 = 0.425). The procedure X site interaction ($F_{2,38}$ = 1.046, p = 0.361, partial η^2 = 0.052; $F_{2,38}$ = 0.176, p = 0.840, partial η^2 = 0.028) was not significant for both females and males, respectively.

Table 8. Self-estimated and the observer estimated Session RPE responses listed by sex and site mode.

Sex	Site	Session RPE (Mean ±SD)	
		Participant	Observer
Male	Overall	3.22 (1.40)	3.11 (0.90)
	Legs	3.28 (1.49)	3.28 (0.96)
	Chest	2.72 (1.27)	2.78 (1.00)
Female	Overall	4.43 (1.47)	4.15 (1.39)
	Legs	4.38 (1.36)	4.25 (1.68)
	Chest	4.48 (1.66)	4.05 (1.73)

DISCUSSION

The purpose of the present investigation was to examine exertional observation in young adults performing intermittent treadmill walking and running. Concurrent and construct validity were accepted for the exertional observation procedure in separate groups of female

and male adults, and among the three sites (O, L, and C). The examination of exertional observation in treadmill exercise is an initial step leading to ecological application of the assessment procedures for common physical activity modes.

Concurrent Validation. The physiological criteria in the concurrent validation were VO_2 and HR, which generally increase concurrently with an increase in metabolic demand. In the present investigation, observer's RPE distributed as a positive function of the participant's VO_2 and HR during the walking and running treadmill exercise bouts. Concurrent validity coefficients derived from the various regression models ranged from r = 0.82 to 0.85. A positive trend was observed for the undifferentiated and the differentiated responses when females and males were examined separately. These exertional observation results are similar to those found by Robertson et al. (13) for children performing a load-incremental treadmill protocol (r = 0.80 to 0.91). These findings regarding observed RPE are consistent with Borg's effort continua model that predicts corresponding and inter-dependent perceptual-physiological responses in the presence of increasing exercise intensity (1).

Construct Validation. Construct validation of the exertional observation procedure for adults was based on the paradigm previously used to validate the aerobic and resistance formats of the OMNI-RPE scales (9, 10, and 17) and the exertional observation procedure in children (13). The construct variables were RPE-O, -L, and –C measured during treadmill walking and running. Evidence of construct validity was based on the hypothesis that the participant's self-rated RPE and the observer's RPE would be significantly and positively correlated when measured simultaneously during an intermittent walk-run treadmill protocol. Construct validity coefficients derived from the regression models correlated the participant's self-rated and observer estimated RPE ranged from r = 0.79 to 0.84 for the intermittent treadmill exercise.

ANOVA indicated that, with one exception, observer and participant RPE did not differ for both the female or male groups. The exception was for males where the mean RPE was greater for the observer than participant during the running bout. However, as the mean difference between procedures was less than 1 RPE unit (Δ = 0.944) and the effect size is considered small, the discrepancies may not be of practical significance. The findings from the present investigation indicate that the exertional observation procedure, with the above exception, measured the same perceptual construct (i.e. RPE) as the self-rating procedure. Results supported the experimental hypothesis, establishing construct validity of the exertional observation procedure for young adult females and males

Additionally, construct validation was examined for the observer's rating of the session RPE. Session RPE was taken as the post-exercise measure of the global exertion experienced during the entire intermittent treadmill exercise protocol. The entire exercise protocol required exercise intensities that ranged from low to high levels. The construct validity coefficients for the observer and self-rated RPE-Session ranged from r = 0.58 to 0.64. These moderate but significant correlations suggest that an observer can accurately estimate the global perceptual responses that an individual experiences over the course of an entire exercise comprised of intermittent walking and running bouts indicative of health-fitness physical activity. ANOVA

indicated that observer and participant RPE for the entire exercise sequence did not differ for either the female or the male participant groups.

The present findings support the ability to accurately rate the intensity of exertional perceptions using direct visual kinematics for an entire session of exercise. The use of an observer estimated session RPE has important implications in physical education and public health settings. As the Session RPE involves only a single post-exercise assessment, it is proposed that it provides a dynamic perspective of an exercise session. An application of this measurement is to use the observed RPE as a general estimate of the relative intensity of the entire physical activity session that had just been performed. Such an observation can be combined with traditional survey procedures where the intensity component of physical activity is one of the most difficult to accurately assess.

Only a few previous studies have examined the validity of kinematic exertional observation in either adults or children. Holzmann (3) employed videotape observations in which the identification of the participant's exertion was based on the participant's posture, weight to carry, muscular force and tension, vibration, and shock during standardized weightlifting. RPE was estimated with the Borg CR-10 scale and used in the development of a perceptual stress index. In a follow-on investigation by Ljunggren (5), concurrent validation of a kinematic observation technique was determined using RPE (Borg CR-10 Scale) self-rated by participants performing randomized power outputs on a cycle ergometer. The observer's RPE was significantly correlated with participant's HR ($r = 0.98$) and power output ($r = 0.99$). Additionally, the observer and participant RPEs were highly correlated ($r = 0.99$). Robertson et al. (16) examined the concurrent and construct validity of an exertional observation procedure for children performing a load-incremental treadmill protocol. Strong concurrent ($r = 0.80$ to 0.91) and construct ($r = 0.87$ to 0.92) validity coefficients were reported. The results from the present investigation are consistent with the findings of all three of the previous studies and extend the exertional observation knowledge base to adults performing weight bearing locomotor activities. Future research should examine the exertional observation procedure in a) additional modes of exercise, and b) free-living environments outside of the laboratory. Controlled, laboratory settings may not always replicate free-living environments such as adventure, leisure, and lifetime activities.

Differentiated Ratings. The ability to distinguish between regionalized perceptual signals (peripheral perceptions in the legs and the respiratory perceptions in the chest) and a total body signal when both estimates are assessed concurrently adds to the precision of the exertional observation procedure. The findings from the present investigation indicate that a visual kinematic procedure employing the Adult OMNI Walk/Run Scale may be used to separately estimate the intensity of perceived exertion signals arising from the legs, the chest, and the overall body in males but not in females. Although there were no statistically difference in females, the data shows a trend of practically significance with a moderate effect size.

These findings differ from previous investigations that employed various formats of the Children's OMNI Scale and demonstrated that the self-rated perceptual estimate for the legs was higher than the estimate for the chest across a wide range of submaximal intensities for aerobic exercise (7, 8). Such a response has also been noted for adults performing weight bearing (9) and non-weight bearing aerobic exercise (10). Further research is required to assess if observer-estimated RPE specific to anatomical regions during exercise can increase the precision of exertional observation where the muscle mass activation varies among exercise modes.

Additionally, Winchester et al. (18) identified an effect of observer's sex on the self-rated RPE in males performing moderate treadmill exercise. Future research should examine the effect of observer's sex on a) self-rated RPE in females, b) in different modes of exercise, c) during different intensities, and d) among differentiated ratings of perceived exertion.

OMNI RPE Scale. The Adult OMNI RPE Scale was used to rate exertional perceptions by both the observer and the participant. The OMNI RPE Scale is comprised of pictorial, numerical, and verbal descriptors. It was expected that a pictorial category scale would be advantageous to kinematic observations. It has been suggested that observation keys may be more salient at greater workloads where muscle tension, breathing cost, skin redness, and sweating are more pronounced. These previous reports postulated that movement based observation keys may be less sensitive at lower intensities resulting in a decreased observer-self rater concordance (5). However, it was noted that there was strong agreement between the observer and the participant RPE across the full aerobic metabolic range in the female and male participants examined presently. Robertson et al. (13) has noted that the visual intensity gradient of the OMNI Scale may more precisely define the observation keys at both the lower and upper metabolic ranges. Additionally, the pictorial descriptors of the OMNI RPE Scale were specific to the walking and running modes performed by the participants providing a cognitive image of the exertional milieu. The observers in this investigation had extensive experience and training in perceived exertion and the exertional observation procedure. Future research should examine the ability of novice observers to estimate participant self-rated RPE such that the exertional observation procedure may be employed by lay individuals.

It is proposed that exertional observation can have an application in a variety of health and fitness settings as an adjunct to physical activity surveillance. In these settings, exertional observation can be used separately or in conjunction with standardized physical activity monitoring to assess the relative intensity of activities in a free-living environment. In this application, exertional observation would serve as a tool to assess relative exercise intensity instead of using estimated MET values for specific activities. Coaches and trainers could employ exertional observation to perceptually monitor training intensity on a day-to-day basis and make subsequent adjustments in target training zones without the need for biometric monitoring and/or expensive equipment. In an analogous application, physical therapists could apply exertional observation procedures to track rehabilitation progress of their clients.

In conclusion, the exertional observation procedure demonstrated concurrent and construct validity in measuring the undifferentiated RPE for overall body and the differentiated RPE for the legs and chest for young adult females and males performing intermittent bouts of treadmill walking and running. Furthermore, a visual kinematic procedure to assess session RPE may provide greater flexibility in estimating physical activity intensity on a day-to-day basis. The ability to measure a single intensity variable could compliment a more rigid observation system, biometric monitoring, or as an alternative to time-point assessments.

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