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Abstract

Background: Adults are not meeting the physical activity recommendations that are associated with health benefits. Affective valence is stated to play a large role in an adults exercise behavior. It is important to determine what variables motivate physical activity and determine exercise intensity. The purpose of this study was to determine what predicts self-selected exercise intensity in adults. **Methods:** Participants were young adults aged 18 to 35 involved at the University of Tennessee. An orientation, baseline exercise testing was conducted. This test was followed about by a self-selected exercise in which the participant was responsible for blinding selecting the speed and grade of the treadmill in five minute increments. Data from the exercise test and pre-exercise survey were compiled for analysis. **Results:** Significant correlations were found between BMI, age, FAS, exertion, intensity, and enjoyment. No correlations were found for readiness, POMS, PANAS, and BRUMS questionnaires and exercise intensity. **Conclusion:** BMI and age towards the end of a physical activity bout, as well as FAS, perceived exertion, tolerance and preference of exercise intensity, and exercise enjoyment can all predict adult self-selected exercise intensity.

Introduction:

Current physical activity guidelines suggested that adults, aged 18 to 65 years, need a minimum of 30 minutes of moderate aerobic physical activity on five days every week or vigorous aerobic physical activity for a minimum of 20 minutes on three days during the week. A combination of these intensities can be accomplished by performing 150 minutes of moderate-to-vigorous physical activity (MVPA) each week [1]. Meeting these recommendations has significant health benefits for adults and children of all ages. Increasing evidence continually supports the impact appropriate physical activity has on decreases in the risks of premature mortality, cardiovascular disease, stroke, diabetes, obesity, and psychological disorders [2].

Despite the health benefits associated with regular physical activity, the majority of American adults are not meeting the recommended levels of physical activity needed to promote improved health [3]. According to a study by the Centers for Disease Control and Prevention (CDC), less than half of American adults participated in recommended levels of physical activity in 2005 [4]. It has also been reported that 31 percent of the world's population is not meeting the appropriate recommendations [5]. While numerous factors contribute to this low percentage of physical activity in adults, it is important to understand what factors influence an individual's ability to meet the physical activity recommendations and select at what intensity they are willing to work.

One factor that correlates with how vigorously an adult is willing to work in order to reach a healthy level of physical activity is affective valence, or positive or negative emotions. Williams et al. examined the effect of affective valence during and after physical activity on the individual's behavior during future physical activity bouts [6]. Results from this study indicate that affective valence during exercise has a positive cross-sectional and longitudinal correlation with future physical activity behavior [6]. Another study by Schneider et al. found similar results in concluding that individuals who experienced positive affective valence during moderate intensity exercise participate in almost 15 additional minutes of physical activity each day than individuals who experienced negative affective valence [7]. The impact of affective valence on physical activity behavior is evident during moderate intensity physical activity.

While the affective valence affects moderate intensity physical activity, its effect on vigorous intensity physical activity is less apparent [7]. Thus, it is of interest whether self-selection of exercise can lead to positive affective valence and increased MVPA. By allowing for adults to self-select their intensity of exercise based on current affective valence, it is hoped that there will be a positive affective valence throughout the physical activity bout which will lead to increases in future physical activity behavior. The benefits of self-selected exercise on affective valence, however, are understudied. Therefore, the purpose of this study was to determine what predicts self-selected exercise intensity.

Methods:

Participants: The study consisted of 44 participants who were University of Tennessee students and faculty and classified as healthy, yet insufficiently active young adults. Their ages ranged from 18 to 35 years and they were required to have a body mass index (BMI) score of 18.5 to 34.9 kg/m^2. This placed all individuals partaking in the study in the range from normal to class I obesity according to the BMI score. Oh the 44 participants, only 33 individuals successfully completed the study and provided useful data for analysis. Exclusion criteria included the participant being underweight ($BMI<18.5\ kg/m^2$) or class II obesity or higher ($BMI \geq 35\ kg/m^2$).

Pregnancy or risk of becoming pregnant, participation in exercise on 3 or more days per week for a duration of 30 minutes per session, and one or more contraindications to beginning an exercise program as according to the Physical Activity Readiness Questionnaire (PAR-Q), and failure to complete the self-selected segment of the study were also reasons for exclusion.

Equipment: This study required access to a treadmill, Polar heart rate monitors, digital scale, and a stadiometer.

Recruitment: To recruit participants, flyers containing information describing the study and contact information were posted throughout the University of Tennessee campus. Class announcements were made, emails were sent out through student list serves, and participants could sign up through the SONA system (an online research management program that allows students to easily earn research participation credit). Interested participants then emailed Dr. Kelley Strohacker, the primary investigator, and then interacted in a series of three emails.
The first email contained the PAR-Q, and BMI chart, instructions for determining BMI, and a question regarding physical activity habits. Participants were asked to only reply to the email if they met the requirements and were eligible to partake in the study, but they were not to include any confidential information (PAR-Q answers, BMI, activity level). A second email was then sent to the participant to set up an in-person orientation session based on a list of available times. Once a time was selected, a third email was sent that confirmed the appointment time and gave the participant necessary instructions before arriving for the orientation session. All participants in the study were voluntary and had the option to discontinue at any point during the study.

Study: The orientation consisted of a one-on-one meeting between the participant and the primary instructor (PI) or designated research assistant. Height and weight of each individual were measured to the nearest millimeter and 0.1 kg, respectively, using a digital scale and stadiometer. From these values the BMI score was calculated. Following these measurements, a Polar heart rate monitor was fitted to the participant and a resting heart rate was taken every minute over a 5 minute span and an age-predicted maximal heart rate was calculated. Participants then performed an incremental treadmill test that followed a modified Balke protocol. The test was terminated when participants reached volitional exhaustion or other signs and symptoms indicated a premature stop. The heart rate was measured every minute, and time on the treadmill test was used to estimate VO_{2max} according to the formula: $VO_{2max} = 1.44$ x (minutes on treadmill) + 14.99 [8].

Following orientation, another meeting was set up in which the individual participated in a self-selected exercise program. Prior to exercise, each participant completed a pre-exercise questionnaire packet that consisted of the Profile of Mood States (POMS) including the Energy Index (EI), the Brunel Mood Scale (BRUMS), the Feeling Scale (FS), the Felt Arousal Scale (FAS), and the Positive and Negative Affective Schedule (PANAS). Once fitted with a Polar heart rate monitor, the test consisted of a 30 minute bout where participants were allowed to self-select treadmill speed and grade throughout the test. The participant was blinded from the selected values by a cardboard barrier and required to adjust the speed and grade by controls on the hand bars. Every 5 minutes, speed and grade were selected and recorded. Heart rate, Rating of Perceived Exertion (RPE), Feeling Scale (FS), and Felt Arousal Scale (FAS) were also recorded every 5 minutes. In the end, each 5 minute heart rate was divided by the age-predicted maximal heart rate to determine the intensity as $\%HR_{max}$. The same was done with each 5 minute heart rate averaged across the 30 minute bout and divided by the age-predicted maximal heart rate to determine the average bout intensity.

Pre-Exercise Questionnaires:

Profile of Mood States (POMS): Participants will be asked to describe how they feel right now in order to assess six mood factors (tension-anxiety, depression-dejection, anger-hostility, vigor-activity, fatigue-inertia, confusion-bewilderment). 65 items will be rated on a 5-point Likert Scale (0= not at all, 1= a little, 2= moderately, 3= quite a bit, 4= extremely) based on the extent to which each is felt.

Positive and Negative Affect Schedule (PANAS): PANAS is a 20-iten scale that has been validated for use in determining acute affective valence [9]. Overlap exists between the items on both the POMS and PANAS questionnaires, so PANAS will be scored against the same 5-point Likert Scale.

Brunel Mood Scale (BRUMS): BRUMS is a 24-item scale that is used for determining mood state in sport populations [10]. BRUMS experiences overlap with the POMS questionnaire, so the same 5-point Likert Scale will be used.

Feeling Scale (FS): FS is an 11-point scale that assesses immediate affective feelings of pleasure and displeasure [11, 12]. Scores range from -5 (very bad) to 5 (very good) with 0 (neutral) as the midpoint. This scale is used as a measure of affective valence in response to acute exercise [13, 14]. FS responses have been related to other measures of affective valence, as well as past and future physical activity participation [11, 12, 13, 15].

Felt Arousal Scale (FAS): FAS is a single item indicator of perceived activation scored on a six point scale (1= low arousal to 6= high arousal). The FS and FAS will be combined for separate assessments of activation and affective valence. This approach is beneficial for studies of acute exercise because it provides the broad perspective needed to capture the diverse and multi-faceted affective valence experiences associated with exercise [16].

Statistical Analysis- Data was collected from each of the questionnaires, pre-exercise baseline values, initial testing, and self-selected exercise bout. Once compiled, correlations were run comparing various variables to percent heart rate at each five minute increment and average percent heart rate in order to determine if there were any significant associations to report.

Results:

Demographics, VO_{2max}, and body composition correlations against each five minute percent heart rate increment and average percent heart rate are revealed in Table 1. Significant correlations were found between BMI and percent heart rate at 25 minutes ($P<0.01$), age at percent heart rate at 20 minutes ($P<0.01$), and age at percent heart rate 25 minutes ($P<0.05$). Therefore the greatest significance came from BMI towards the end of the exercise bout and from age during mid- to end exercise. This reveals how effective these measurements were in predicting the intensity of the exercise bout as revealed by the percent heart rate. All other correlations for these variables were insignificant.

It was also found that there were positive correlations between mean FAS at the 20 ($P<0.05$) and 25 minute marks ($P<0.01$). Pre-exercise to minute 30 change in FS had a significant correlation with heart rate percentage at 5 minutes ($P<0.05$), but no significant correlations from pre-exercise to mean change in FS or mean FS. Several measurable correlations were found with pre-exercise to minute 30 change in FAS. At minutes 10, 15, and 20, these values were statistically significant at $P<0.05$, and they were significant to $P<0.01$ at minutes 25 and 30. Pre-exercise to mean change in FAS also revealed significance at 15 minutes ($P<0.05$) and 25 minutes ($P<0.01$), as seen in Table 2.

When comparing the data from POMS, PANAS, and BRUMS to percent heart rate at five minute increments and overall average, there were no significant relationships discovered (Table 3). This reveals that these measurements are not good indicators of the intensity and effort adults contribute to physical activity. When percent heart rates were compared to exertion, intensity, and enjoyment, however, there were several significant correlations present. When comparing percent heart rate max to each increment and average, all but minute five showed significance to the 0.01 level. Mean rating of perceived exertion also had overwhelming correlations with all but the five minute measurement and average being significant. Of these significant values, only the 30 minute correlation was significant to the 0.05 level with all others being significant to the 0.01 level. Tolerance of intensity and preference of intensity were also very strong indicators of the percent heart rates and, thus, the amount of work put into the exercise. General exercise enjoyment only correlated at the 15 minute measurement to the 0.01 level of significance.

Discussion: Based on the data, it can be determined that several factors are capable of predicting the intensity, affective valence, and participation in current and future physical activity. BMI played a significant role at 25 minutes, which can be expected due to the fact that more fit and healthy individuals would have a higher tolerance increased intensity and duration exercise. Age was also predictive at the 20 and 25 minute increments which can be explained do to the fact that younger individuals are expected to have more energy and be able to perform higher intensity activities for longer durations of time than older populations.

It is also not surprising that the majority of the correlations involving FAS were very significant. Since FAS involves the perceived activation during the exercise bout, it would be expected that their felt arousal would decrease with lower intensities (lower percent heart rate) and become increase with higher exercise intensities (higher percent heart rate). It is unusual, however, that the FS correlations did not follow a similar trend. It was expected that FS would increase with decreased percent heart rate and decrease with increased percent heart rate to a significant statistical value. A lack of correlation could be the result of participants not fully understanding the FS scale or incorrect participant report.

When considering the readiness, POMS, PANAS, and BRUMS values, it was unexpected to see no significant correlations. It was anticipated that that these variables would have significant associations with percent heart rate. For example, an increased level of energy and more rest were expected to lead to increase exercise intensities and, thus, higher percent heart rates. The same increase in percent heart rate was also expected with higher POMS and BRAMS energy indexes. High PANAS positive affect was thought to lead to increased percent heart rates while large PANAS negative affect and POMS total mood disturbance were predicted to lead to lower percent heart rates. Future studies are necessary to determine why these correlations were not present as expected.

Finally, it was reasonable to assume that increased levels of tolerance and preference for exercise intensity, as well as general exercise enjoyment would lead to higher percent heart rates and higher intensity physical activity bouts. Negative levels would lead to lower intensity. The percent heart rate max achieved would also be dependent on the bout intensity and thus strongly correlate with the heart rate percentages at each five minute bout. These data were very conclusive in determining what predicts self-selected exercise intensity.

Some weaknesses in the study involve the demographics of the study population. In addition to being a small sample size, most of the participants involved were first year college students. This limits the applicability of the study. In future analysis, it is important to recruit a larger, more diverse study population.

While there were significant correlations to indicate positive predictors of self-selected exercise intensity, many of the variables where not as significant as expected. Going forward, the intent is to compare the percent heart rate trends for each five minute increment between each participant. This will provide a general idea of the pattern of intensity that the adults in the study are selecting, as well as what factors motivate their activity patterns. This will provide more details regarding the current correlations and introduce more opportunities to discover other variables useful in predicting self-selected exercise intensity.

Conclusion: Adult participation in the recommended amount of physical activity is not at a healthy level. Therefore, it is important to determine ways in which to improve adults' interest in and adherence to regular physical activity that is associated with health benefits. Numerous correlations were found between self-selected exercise intensities at BMI and age towards the end of exercise, FAS variables, perceived exertion, and tolerance and preference of exercise intensity. These factors are beneficial in understanding what motivates adults to select certain exercise intensities and motivating them to participate in more consistent, healthy levels of physical activity.

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Appendices

Table 1. Demographics, VO_{2max}, and Body Composition correlations to exercise intensity (percent heart rate).

	BMI	Estimated Relative VO2 Max	Age in Years	Race	Ethnicity	Highest Education Achieved
Percent HR at 5 min	-0.027	-0.061	-0.105	0.075	0.029	0.068
Percent HR at 10 min	0.196	0.102	0.289	0.020	0.010	0.086
Percent HR at 15 min	0.211	0.276	0.307	0.117	0.021	-0.008
Percent HR at 20 min	0.253	0.203	**0.406***	0.180	-0.059	0.005
Percent HR at 25 min	**0.392***	0.263	**0.522****	0.317	-0.003	0.109
Percent HR at 30 min	0.210	0.212	0.291	0.112	0.221	-0.209
Average Percent HR	0.154	0.095	0.175	0.170	0.051	0.053

Table 2. FS and FAS correlations to exercise intensity.

	Mean FS	Mean FAS	Pre Exercise to Minute 30 Change in FS	Pre Exercise to Mean Change in FS	Pre Exercise to Minute 30 Change in FAS	Pre Exercise to Mean Change in FAS
Percent HR at 5 min	-0.111	-0.096	**0.416***	0.249	-0.038	-0.075
Percent HR at 10 min	-0.319	0.357*	-0.155	-0.197	**0.360***	0.285
Percent HR at 15 min	-0.272	0.422*	-0.197	-0.236	**0.410***	**0.354***
Percent HR at 20 min	-0.180	**0.432***	-0.198	-0.165	**0.404***	0.316
Percent HR at 25 min	-0.127	**0.625****	-0.210	-0.194	**0.522****	**0.550****
Percent HR at 30 min	-0.252	0.311	-0.124	-0.060	**0.471****	0.117
Average Percent HR	-0.254	0.229	0.214	0.082	0.279	0.180

Table 3. Readiness, POMS, PANAS, and BRUMS correlations to exercise intensity.

	Readiness Energy	Readiness Rested	POMS Energy Index	POMS Total Mood Disturbance	PANAS-Positive Affect	PANAS-Negative Affect	BRUMS Energy Index
Percent HR at 5 min	0.118	-0.023	-0.283	0.330	0.035	0.302	-0.274
Percent HR at 10 min	-0.337	-0.058	-0.156	0.149	-0.232	-0.146	-0.104
Percent HR at 15 min	-0.042	0.062	0.153	-0.007	0.129	-0.026	0.171
Percent HR at 20 min	-0.125	0.034	-0.021	0.076	-0.044	-0.159	0.008
Percent HR at 25 min	0.076	0.194	0.164	-0.035	0.229	-0.155	0.159
Percent HR at 30 min	0.094	0.080	0.002	0.141	0.050	-0.034	-0.004
Average Percent HR	0.051	0.028	-0.209	0.316	0.051	0.174	-0.190

Table 4. Exertion, Intensity, and Enjoyment correlations to exercise intensity.

	Mean Rating of Perceived Exertion	Tolerance for Exercise Intensity	Preference of Exercise Intensity	General Exercise Enjoyment
Percent HR at 5 min	-0.051	0.149	**-0.435***	0.033
Percent HR at 10 min	**0.487****	**0.421***	**0.403***	0.240
Percent HR at 15 min	**0.505****	0.3	0.272	**0.353***
Percent HR at 20 min	**0.552****	**0.358***	**0.434***	0.239
Percent HR at 25 min	**0.694****	0.210	**0.378***	0.329
Percent HR at 30 min	**0.411***	**0.464****	**0.455****	0.092
Average Percent HR	0.337	**0.371***	-0.079	0.205

** Correlation is significant at the 0.01 level (2-tailed)

* Correlation is significant at the 0.05 level (2-tailed)