

Introduction

33 Exercise has been defined as planned and structured activity (Caspersen et al.,
34 1985) that induces several benefits on the human body, and it has been considered an
35 important tool to improve health (Pedersen & Saltin, 2015; Sallis, 2009). There are
36 various exercise classification options such as aerobic continuous, aerobic interval and
37 resistance exercise. Aerobic exercise has been defined as any activity that uses large
38 muscle groups, can be maintained continuously, is rhythmic in nature (e.g. cycling,
39 walking jogging/ running, and swimming), and, as the name implies, relies upon aerobic
40 metabolism (Pescatello et al., 2014). In resistance exercise, muscles are required to work
41 or hold against an applied force or weight and primarily utilize anaerobic metabolism
42 (Pescatello et al., 2014). Interval training involves short bouts of exercise with distinct
43 intensity and short periods of rest between bouts with the contribution of aerobic to
44 anaerobic metabolism dependent on the variables manipulated (Pescatello et al., 2014). It
45 has been well established that exercise decreases the risk of all-cause mortality (Lee et
46 al., 2018) and can be a protective factor against various diseases (Schuch et al., 2019;
47 Zachariah & Alex, 2017).

48 The American College of Sport Medicine and the World Health Organization
49 have recommended that most adults engage in physical exercise of at least 150-300
50 minutes per week at moderate intensity (64-76% HR_{max} and 46-63% VO_{2max}), 75-100
51 minutes per week at vigorous-intensity (77-95 % HR_{max} and 64-90% VO_{2max}) or a
52 combination of moderate and vigorous exercise totaling a targeted energy expenditure
53 (i.e. 500-1000 MET·min·wk) (Bull et al., 2020; Garber et al., 2011). Additionally, healthy
54 adults should perform 2-3 days of resistance training (on non-consecutive days) per week
55 (Garber et al., 2011). Resistance training sessions should include 8-10 exercises targeting
56 major muscle groups involving at least one set of 15-25 repetitions with light loads (<50%
57 1RM) or 8-12 repetitions with moderate-heavy loads (60-80% 1RM). Despite the plethora
58 of evidence surrounding the health benefits associated with exercise and these
59 recommendations, most recent studies have shown that the general adult population
60 spends considerable time being sedentary and little time engaged in exercise (Koyanagi
61 et al., 2018; Werneck et al., 2019). While there has been extensive research into individual
62 and environmental factors that may contribute to a sedentary lifestyle (Buck et al., 2019),
63 it remains alarming that a large number of people (approximately 50%) who commence
64 an exercise program cease it within six months (Linke et al., 2011). Feelings of pleasure

65 and enjoyment associated with exercise have been linked to exercise adherence (Focht,
66 2009; Rhodes & Kates, 2015), making it prudent to consider prescribing exercise sessions
67 that are associated with positive affective and enjoyment responses. Thus, affective
68 responses negatively or positively influence individual goals and/or well-being and affect
69 (e.g., pleasure or displeasure) (Hardy & Rejeski, 1989). In this same way, enjoyment
70 responses promote acceptance or rejection of the exercise protocol (Kendzierski &
71 DeCarlo, 1991).

72 Traditionally moderate intensity aerobic exercise has been prescribed to the
73 general population, despite evidence that people find it challenging to accumulate the
74 recommended exercise volume due to lack of time (Trost et al., 2002). As such, high
75 intensity interval training (HIIT) was designed as an option for achieving a high energetic
76 expenditure in short exercise bouts. Some evidence has suggested that HIIT leads to
77 greater clinical and physiological benefits (e.g. cardiac function, exercise capacity,
78 inflammation, quality of life, VO_{2peak} , and endothelial function) when compared to
79 continuous aerobic exercise (Ito, 2019). However, studies have suggested that high
80 intensity exercises may result in poorer exercise adherence, due to the more negative
81 affective responses and enjoyment associated with them, compared to lower intensity
82 exercise (Ekkekakis, 2009; Nasuti & Rhodes, 2013; Tavares et al., 2020).

83 A previous systematic review and meta-analysis investigated affective and
84 enjoyment responses to high intensity interval training and continuous training (Oliveira
85 et al., 2018). The Oliveira et al. (2018) review concluded that HIIT exercise may be a
86 viable strategy for obtaining positive psychological responses. However, data gathered
87 during and after exercise were combined in this review, perhaps leading to an
88 oversimplified impression of nuances within data characteristics. This possibility is
89 supported by other evidence that intensity manipulation has a differential effect for
90 responses measured either during exercise or post-exercise (Ekkekakis et al., 2018). In
91 present review we attempted to update and more precisely describe participants' affective
92 responses to HIIT and CT when measured both during and post-exercise. Additionally,
93 we sought to include a more comprehensive range of exercises (i.e., aerobic continuous,
94 interval exercise and resistance exercise) using both meta-analytical and meta-regression
95 approaches. The aim of this review was to examine the acute and chronic effects of
96 exercise on healthy adults' affective and enjoyment responses. Information gathered from
97 this meta-analysis and meta-regression was expected to be useful to exercise specialists

98 and clinicians devising and prescribing exercise programs that might promote greater
99 **exercise** adherence.

100 **Method**

101 This systematic review and meta-analysis was conducted in accordance with the
102 recommendations outlined in the Preferred Reporting Items for Systematic Reviews and
103 Meta-Analyses (PRISMA) statement (Moher et al., 2009), registered on Prospero:
104 CRD42020167507.

105 **Search Strategy and Study Selection**

106 We first conducted a literature search from the earliest record up to July 9, 2020
107 using the following electronic databases: PubMed, PsycINFO, SPORTDiscus, and Web
108 of Science. Our search strategy in PubMed combined the terms ‘walking’, ‘jogging’,
109 ‘running’, ‘cycling’, ‘swimming’, ‘endurance training’, ‘aerobic exercise’, ‘aerobic
110 training’, ‘resistance training’, ‘resistance exercise’, ‘strength training’, ‘weight training’,
111 ‘weight lifting’, ‘high intensity interval training’, ‘interval training’, ‘interval exercise’,
112 ‘high intensity intermittent training’, ‘high intensity intermittent exercise’, and ‘sprint
113 interval training’, with ‘enjoyment’, ‘pleasure’, ‘emotion’, and ‘mood’. Search strategies
114 for other databases were slightly adapted. One reviewer (V.T.) then individually
115 evaluated the titles and abstracts of retrieved articles to assess their eligibility for review
116 and meta-analysis (see eligibility criteria below). Studies to be included were checked
117 again by a second reviewer (D.H.). These two reviewers were not blinded to the studies’
118 authors, institutions or journals of publication. Study abstracts that did not provide
119 sufficient information according to the inclusion criteria (see below) were retrieved for
120 full-text evaluation by the same two reviewers.

121

122 **Eligibility Criteria**

123 Articles were eligible for inclusion if they met the following criteria: (a)
124 randomized and non-randomized comparative studies; (b) published in English; (c)
125 included adult participants (≥ 18 years of age); (d) included participants with no known
126 medical condition or injury; (e) compared continuous aerobic versus HIIT; (f) compared
127 of intensities for resistance exercise/training; (g) involved either a single exercise session
128 (acute response) or ≥ 3 exercise sessions (chronic adaptation); and (h) measured at least

129 one outcome of enjoyment or affective response during and post exercise, using only two
130 valid scales (Physical Activity Enjoyment Scale (PACES) and the Feeling Scale (FS),
131 respectively). Briefly, the PACES is a measure with 18 items and is enjoyment-specific
132 for physical activity. This scale assesses enjoyment for physical activity by asking
133 participants to rate their immediate feeling about the physical activity they have just
134 performed, using a 7-point bipolar Likert scale. Higher scores reflect greater enjoyment
135 levels (Kendzierski & DeCarlo, 1991). This scale demonstrated internal consistency,
136 with coefficient $\alpha = .90$, and item-total correlations = $.38 - .76$ (Crocker & Gessaroli,
137 1995). The FS is an 11-point, single item, bipolar rating scale used to measure the
138 affective dimension of pleasure - displeasure during exercise. The scale ranges from -5 to
139 +5, with verbal descriptors, positioned on all odd integers and at zero point ("neutral")
140 (Hardy & Rejeski, 1989). Previous research (Van Landuyt et al., 2000) found the FS to
141 correlate between 0.51 and 0.88 with the valence scale of the Self-Assessment Manikin
142 (Lang, 1980).

143

144 **Data Extraction**

145 One reviewer (V.T.) extracted data and compiled it into an Excel spreadsheet,
146 recording such relevant data as participant characteristics [age, body mass index (BMI),
147 VO_{2Peak}], study characteristics (type of exercise, intensity, frequency, study duration) and
148 enjoyment and affective responses (during and post of exercise). Data presented in figures
149 for seven studies (Decker & Ekkekakis, 2017; Hoekstra et al., 2017; Niven et al., 2018;
150 Olney et al., 2018; Poon et al., 2018; Stork et al., 2018; Thum et al., 2017) were estimated
151 using an online data extraction tool (WebPlotDigitizer <https://apps.automeris.io/wpd/>).
152 For all enjoyment and affective responses, this researcher extracted absolute data [means
153 (M) and standard deviations (SD)] and relative changes from baseline (percentage change
154 and SD).

155

156 **Study Quality Assessment**

157 We assessed the risk of within-study bias using the Tool for the assEssment of
158 Study qualiTy and reporting in EXercise (TESTEX) (Smart et al., 2015). The TESTEX
159 tool is a 15-point scale (5 points for study quality and 10 points for reporting) that assesses
160 study quality and reporting in exercise training studies. When using this tool, if a criterion
161 is met, a score of '1' is awarded and if not a score of '0' is awarded. For study quality,

162 the criteria included: (a) randomization (e.g., coin-tossing); (b) allocation concealment
163 (concealment before randomization); (c) groups similar at baseline; and (d) blinding of
164 assessor. For reporting, the criteria included: (a) percentage of participants completing
165 the study in both groups (1 point – if adherence >85%; intervention group; 1 point – if
166 adverse events are reported; 1 point – if exercise attendance is reported); (b) intention-to-
167 treat analysis; (c) between-group statistical comparisons reported; (d) point measures and
168 measures of variability; (e) activity monitoring in control; (f) relative exercise intensity
169 remained constant; exercise volume and energy expenditure. To interpret the assessment
170 scores for both study quality and reporting the maximum total of 15 was divided into four
171 classifications. A score of <4 was considered “poor”, 4 - 7 as “moderate”, 8 - 11 as “good”
172 and >11 as “excellent” study quality and reporting.

173

174 **Statistical Analysis**

175 Analyses were conducted for acute and chronic exercise interventions (e.g., HIIT
176 versus continuous training, separately). For the acute studies, participant affect and
177 enjoyment were reported immediately following exercise, using the Feeling Scale or
178 Physical Activity Enjoyment Scales, respectively, and analyzed, separately. For the
179 chronic studies the change in enjoyment (using the Physical Activity Enjoyment Scales)
180 during and after the exercise interventions were analyzed. All analyses were conducted
181 using Comprehensive Meta-Analysis version 3 software (Biostat Inc., Englewood, NJ,
182 USA), with the level of significance set at $p \leq 0.05$. Effect size (ES) values were calculated
183 as standardized differences in the means and expressed as Hedges’ g , which corrects for
184 parameter bias due to small sample sizes (Ugille et al., 2014). Hedges’ g were classified
185 as trivial or small (0.20 to 0.49), moderate (0.50 to 0.79), and large (>0.80) (Hedges,
186 1981). We examined between-study variability for heterogeneity, using the I^2 statistic for
187 quantifying inconsistency (Higgins et al., 2003). Heterogeneity thresholds were set at I^2
188 = 25% (low), I^2 = 50% (moderate) and I^2 = 75% (high) (Higgins et al., 2003). In the
189 presence of significant heterogeneity, the heterogeneity was further examined through:
190 (a) subgroup analysis, exploring the role of intensity; or (b) meta- regression on age, BMI
191 and gender. We applied a random-effects model meta-analysis to pool the data for each
192 analysis. For adequate statistical power, we included a minimum of five studies in the
193 pooled random-effects analysis (Jackson & Turner, 2017). We analyzed publication bias
194 using funnel plots and Egger’s test of effect size (mean difference) against its standard

195 error. We applied the Trim and Fill procedure (Duval & Tweedie, 2000) if evidence of
196 publication bias was noted. Additionally, we removed potential outlier studies, such as
197 those with substantially larger effects, and we recalculated pooled ES as a part of the
198 sensitivity analysis.

199

200

Results

201 Our initial search yielded 3,311 studies. After removing duplicates and excluding
202 studies based on title and abstract, 77 studies remained. After the full-text review, there
203 were 48 studies, and 20 unique studies (17 acute and 3 chronic) that met the eligibility
204 criteria for inclusion (Alicea et al., 2020; Bartlett et al., 2011; Decker & Ekkekakis, 2017;
205 Focht et al., 2015a; Heisz et al., 2016; Hoekstra et al., 2017; Mary E. Jung et al., 2014;
206 Kilpatrick et al., 2015; Kong et al., 2016; Kriel et al., 2019; Martinez et al., 2015; Niven
207 et al., 2018; Bruno R.R. Oliveira et al., 2013; Olney et al., 2018; Poon et al., 2018;
208 Portugal et al., 2015; Sagelv et al., 2019; Stork et al., 2018; Thum et al., 2017; Vella et
209 al., 2017) (see Figure 1).

210

[Insert here. Figure 1 – Flow Chart of Study Selection]

211

Acute Studies

212

213
214 The 17 acute studies were comprised of 310 participants (39% women). Further
215 description of these participant characteristics is provided in Table 1. Fifteen of these
216 studies analyzed the effects of HIIT versus CT. Twelve studies of this subset measured
217 affective responses during and post exercise using the FS (Alicea et al., 2020; Decker &
218 Ekkekakis, 2017; Hoekstra et al., 2017; Jung et al., 2014; Kilpatrick et al., 2015; Martinez
219 et al., 2015; Niven et al., 2018; Oliveira et al., 2013; Olney et al., 2018; Poon et al., 2018;
220 Stork et al., 2018; Thum et al., 2017), while ten studies applied the PACES after exercise
221 (Bartlett et al., 2011; Decker & Ekkekakis, 2017; Hoekstra et al., 2017; Jung et al., 2014;
222 Kriel et al., 2019; Martinez et al., 2015; Olney et al., 2018; Sagelv et al., 2019; Stork et
223 al., 2018; Thum et al., 2017). Ten studies involved cycling and five studies involved
224 treadmill exercise. Intensity was expressed as a percentage of peak power output in Watts
225 in six studies, VO^2 peak in five studies, ventilatory threshold in three studies, and
226 maximum heart rate in one study. The duration of the HIIT ranged from six seconds to
227 four minutes compared to 20-50 minutes for CT (see Table 1).

228

262 subgroup analysis of HIIT versus high intensity CT on affective responses during exercise
263 there was no significant effect [-0.15 (-1.08 – 0.78); $p = 0.755$]. Egger's regression did
264 not indicate publication bias (intercept = -3.79, SE = 11.57, $p = 0.75$). Heterogeneity was
265 found to be high ($I^2 = 94.06$), but there was no significant *Kendall's rank* correlation
266 coefficient ($\tau = -0.25$, $p = 0.34$).

267

268 ***Acute HIIT vs. CT Post-Exercise.*** We found a significant moderate effect of
269 affective response post-exercise favoring CT, compared to HIIT [-0.61 (-1.11 – -0.10); p
270 = 0.018] (Supplementary Figure, SF2). Again, heterogeneity among participant responses
271 was high ($I^2 = 92.90$). We found a significant Kendall's rank correlation coefficient for
272 this analysis ($\tau = -0.31$, $p = 0.02$), indicating significant funnel plot asymmetry. Egger's
273 regression indicated publication bias (intercept = - 7.21, SE = 4.21, $p = 0.05$). Trim and
274 fill analyses changed the overall effect (ES = -0.96; 95% CI= -1.52 – -0.40) suggesting
275 that the asymmetrical funnel plot for acute HIIT versus CT on affective responses was
276 influenced by publication bias. The meta regression for the FS showed no significant
277 effect for any of the covariates including age [coefficient= 0.019 (-0.002 – 0.041); $p =$
278 0.077], BMI [coefficient= 0.006 (-0.009 – 0.0021); $p = 0.451$], and gender [coefficient=
279 -0.003 (-0.008 – 0.001); $p = 0.149$].

280

281 The subgroup analysis of HIIT versus moderate intensity CT revealed a significant
282 large effect in favor of moderate intensity CT for a positive affective response post-
283 exercise [-1.09 (-1.88 – -0.30); $p = 0.006$]. Egger's regression did not indicate publication
284 bias (intercept = - 3.90, SE = 8.83, $p = 0.66$). High heterogeneity was also found for this
285 analysis ($I^2 = 92.34$), and there was no significant Kendall's rank correlation coefficient (τ
286 = -0.26, $p = 0.28$) (Supplementary Figure, SF3). The meta regression for the FS showed
287 no effect for any of the covariates including age [coefficient= -0.009 (-0.037 – 0.017); p
288 = 0.486], BMI [coefficient= 0.017 (-0.037 – 0.003); $p = 0.095$], and gender [coefficient=
289 -0.011 (-0.018 – -0.005); $p = 0.002$].

290 There was a small but still non-significant effect for the subgroup analysis of HIIT
291 versus high intensity CT on affective responses post exercise [0.27 (-0.27 – 0.82); $p =$
292 0.332]. Egger's regression did not indicate publication bias (intercept = - 3.68, SE = 4.74,
293 $p = 0.45$). Heterogeneity was high ($I^2 = 86.12$), and there was no significant Kendall's rank
294 correlation coefficient ($\tau = -0.26$, $p = 0.24$).

295 ***Enjoyment Response***

296 ***Acute HIIT vs. CT post-exercise.*** We observed a significant small effect favoring
297 HIIT compared to CT for enjoyment post-exercise [0.31 (0.05 – 0.57); $p = 0.017$]
298 (Supplementary Figure, SF4). Participant heterogeneity for enjoyment was high ($I^2 =$
299 63.54). Egger's regression did not indicate publication bias (intercept = 2.37, SE = 1.46,
300 $p = 0.12$). We found no significant Kendall's rank correlation coefficient ($\tau = 0.30$, $p =$
301 0.09). The meta regression found no significant effects for the following covariates: age
302 [coefficient= -0.004 (-0.030 – 0.021); $p = 0.733$], BMI [coefficient= 0.000 (-0.021 –
303 0.020); $p = 0.950$], and gender [coefficient= -0.009 (-0.016 – -0.002); $p = 0.009$].

304
305 For the subgroup analysis we found no significant effects for HIIT versus
306 moderate intensity CT on enjoyment [0.36 (-0.10 – 0.84); $p = 0.130$]. Egger's regression
307 did not indicate publication bias (intercept = 2.95, SE = 2.01, $p = 0.18$). This subgroup
308 analysis presented with high heterogeneity ($I^2 = 76.6$) and no significant Kendall's rank
309 correlation coefficient ($\tau = 0.25$, $p = 0.34$). There were too few studies ($n=3$) to run this
310 sub-analysis.

311 312 ***Chronic Studies***

313 A total three chronic studies were included in this review, representing 79
314 participants (72% women). A further description of these participant characteristics is
315 provided in Table 2. All three studies examined the effects of HIIT versus CT using the
316 PACES (Heisz et al., 2016; Kong et al., 2016; Vella et al., 2017). Due to the low number
317 of these studies (<5) no meta-analysis was conducted.

318 Kong et al., (2016) compared HIIT to moderate to vigorous intensity CT (five
319 week intervention) in a group of sedentary adults with obesity and found stronger positive
320 affective responses to be associated with HIIT ($p < 0.05$). Cardiorespiratory fitness
321 improvement was similar for both groups, but HIIT was a more time-efficient strategy.
322 Heisz et al., (2016) evaluated sedentary adults who undertook six weeks of either HIIT
323 or moderate intensity CT, and found that HIIT compared to moderate intensity CT had
324 more positive affect at week 4, and was associated with significantly more positive affect
325 at week 5 ($p < 0.05$) and 6 ($p < 0.01$). There were no differences in reported enjoyment
326 between HIIT and moderate intensity CT between weeks 1 to 3. Changes in enjoyment

327 were predicted by changes in workload ($p < 0.05$) but not by aerobic fitness (VO_2 peak),
328 suggesting that workload predicted changes in exercise favouring strength adaptations
329 may be a major contributor to enjoyment with exercise training. Finally, Vella et al.
330 (2017) compared three weeks of either HIIT or moderate intensity CT in seventeen
331 sedentary adults who were either overweight or obese. Mean enjoyment across the
332 intervention was high for both groups ($p > 0.05$), however enjoyment did not change over
333 time, nor were there any differences in enjoyment observed between groups. Therefore,
334 two of the three chronic studies showed that HIIT resulted in greater enjoyment compared
335 to CT.

336

337 **[Insert Table 2. Descriptions of Chronic Studies.]**

338

339 *Study Quality Analysis*

340 Using the TESTEX scale, the mean total score for acute study quality was 2.5
341 (median 2.0) of a possible 5 points, and the mean total score for reporting was 3.9 (median
342 4.0) of a possible 10 points (see Supplementary Table, ST1). The mean overall score out
343 of a possible 15 points (5 points for study quality and 10 points for reporting) was 6.4
344 (median 6.0). Overall, study quality and reporting were considered a moderate level,
345 acceptable for all studies achieving this threshold. Most studies met the following criteria:
346 (a) randomization specified; (b) groups similar at baseline; (c) between-group statistical
347 comparisons reported; (d) point measures and measures of variability for all reported
348 outcome measures; and (e) exercise volume and energy expenditure. Most studies did not
349 meet the following criteria: (a) eligibility criteria specified, (b) allocation concealed, and
350 (c) blinding of assessor. Regarding the few chronic studies, the mean score for study
351 quality was 3.7 (median 3.0) of 5 points and the mean total score for reporting was 5.7
352 (median 6.0) of 10 points (see Supplementary Table ST2), while the mean overall score
353 was 9.3 (median 9.0) (5 points for study quality and 10 points for reporting).

354

355

355 **Discussion**

356 In this systematic review with meta-analysis and meta-regression we examined
357 the research literature on the acute and chronic effects of exercise on affective and
358 enjoyment responses in healthy adults. This review indicated a greater positive affective

359 response post-exercise for CT compared to HIIT. In particular, a greater positive affective
360 response appeared to occur following acute exercise of moderate intensity CT compared
361 to HIIT. In contrast, enjoyment measured post-exercise was greater following acute HIIT
362 compared to CT.

363 Based on a small number of studies of chronic exercise, enjoyment seemed to
364 progressively increase following HIIT compared to CT, although no meta-analysis could
365 be performed. Studies were methodologically sound (categorized as “moderate”);
366 however, there was high heterogeneity among respondents, and publication bias against
367 publishing non-significant findings, while evident, did not appear to influence the results
368 of the meta-analyses regarding effect sizes.

369 Affective responses measured with the FS (during and post-exercise) (Hardy &
370 Rejeski, 1989) assessed how respondents were feeling on a bipolar scale from very bad
371 (-5) to very good (+5). Most studies in this meta-analysis reported a positive effect of
372 exercise on affective responses measured post-exercise, but this might be expected in
373 light of classic opponent process theory which predicts a rebound effect after a negative
374 stimulus (Solomon, 1980). Therefore, it is important to mention that both types of acute
375 exercise (CT and HIIT) were associated with this positive affective response. Moreover,
376 our meta-analysis showed a positive effect of acute exercise on affective response
377 measured post exercise. However, only moderate, and not high intensity, CT was found
378 to be more pleasurable compared to HIIT post-exercise.

379

380 Although HIIT and moderate CT protocols have been shown to improve
381 cardiorespiratory fitness (Jung et al., 2020; Martland et al., 2020), cardiovascular and
382 brain health (Myers et al., 2015; Zhu et al., 2015), these benefits have been associated
383 with long-term engagement in exercise programs (Pedersen & Saltin, 2015). Having a
384 greater positive experience during or post exercise may be important for improving
385 adherence to exercise programs. This idea is largely based on hedonic theory which holds
386 that individuals are likely to repeat experiences that make them feel good (Kahneman et
387 al., 1999). During exercise, if a novice trainer experiences high levels of displeasure,
388 discomfort, pain or a feeling of exhaustion the chances of them repeating the activity or
389 long-term adherence is reduced (Ekkekakis et al., 2000). For these reasons, a robust body
390 of evidence has shown that the affective response to exercise should be considered when

391 prescribing exercise intensity in order to ensure each individual feels good enough to
392 facilitate future exercise (Ekkekakis et al., 2008; Rhodes & Kates, 2015). Some evidence
393 has suggested that the affective or pleasure response during, as compared to post-exercise,
394 is of greater importance to exercise adherence (Ekkekakis & Brand, 2019; Williams et
395 al., 2016). Thus, affective responses during exercise may be particularly predictive of
396 future exercise participation (Kwan & Bryan, 2010; Schneider et al., 2009; Williams,
397 2008). On the other hand, it is not clear what effect post exercise perceptions may have
398 on future exercise behavior (Rhodes & Kates, 2015; Williams et al., 2016).

399 The present meta-analysis indicated that high intensity exercise may be associated
400 with a less positive affective response (when measured post-exercise) than moderate
401 continuous training, regardless of age, BMI and gender. Thus, CT may improve the rate
402 of adherence to physical exercise more than HIIT (Ekkekakis & Lind, 2006; Elsangedy
403 et al., 2018). Our meta-analysis showed a small significant positive effect of enjoyment
404 measured post-exercise favoring HIIT over moderate CT. For the sub-analysis HIIT vs
405 Moderate Intensity Continuous Training (MICT) and HIIT vs High Intensity Continuous
406 Training (HICT), we found no significant difference. Interestingly, across this meta-
407 analysis, we also found no effect from participant gender, despite a prior report that men
408 and women have different affective responses that may be attributable to their different
409 thermoregulation and possibly the menstrual cycle (Rocheleau et al., 2004). Our finding
410 of an enjoyment advantage for HIIT, when measured post-exercise, may be explained by
411 post-exercise reflections or comparisons with expectations in participant involvement in
412 physical activity. Arguably, high intensity exercise has the ability to promote a sense of
413 accomplishment and competence contributing to enjoyment (Burn & Niven, 2019),
414 perhaps related to strategies with HIIT to optimize enjoyment responses and improve the
415 exercise experience. In addition, some motivational factors were evident. Generally, a
416 preference of intense exercise may be related to its contribution to enhancing the
417 efficiency of achieving personal health goals such as changes in body composition (e.g.,
418 decreased fat mass and increased lean mass). Otherwise, in choosing exercise of a
419 moderate or light intensity, if there is a noticeable delay of benefits for health and fitness,
420 there may be frustration and possibly dropout (Ekkekakis et al., 2005).

421 Fitness and health benefits from performing resistance training (RT) have been
422 well established (Cavarretta et al., 2018; Gordon et al., 2017; Grgic et al., 2019), with 2-
423 3 sessions per week recommended (Garber et al., 2011). Therefore, it is imperative to

424 examine factors that may influence adults' adherence to RT. A previous systematic
425 review found numerous factors were associated with participation in RT, some of which
426 included education, perceived health status, quality of life, affective judgements, self-
427 efficacy, intention, and self-regulation behaviors (Rhodes et al., 2017). The authors
428 concluded that when promoting RT, there should be focus on creating an enjoyable
429 experience along with self-efficacy, planning and self-monitoring behaviors. Therefore,
430 the present study attempted to extend beyond prior findings (Rhodes et al., 2017) and was
431 is the first systematic review of the impact of RT variables on affective and enjoyment
432 responses. This is highly relevant, considering the dose–response relationships generally
433 observed for key RT variables (i.e., volume, intensity, rest) for achieving fitness and
434 health outcomes (Borde et al., 2015; Schoenfeld et al., 2017). Unfortunately, very few RT
435 studies were identified in the present systematic review (n = 2), and this prevents any
436 conclusions concerning the effect of RT on affective and enjoyment responses. However,
437 the present review highlighted the need for future studies to examine how to optimize RT
438 variables to enhance affective and enjoyment responses, in an attempt to positively
439 influence RT adherence.

440

441 ***Limitations and Directions for Further Research***

442 Limitations of the present study included the wide variety of exercise application
443 methods within the category of HIIT, perhaps interfering with an attempt to summarize
444 them collectively. Second, most studies had small participant sample sizes with high
445 heterogeneity, perhaps influencing these meta-analytic results. For instance, greater effect
446 sizes are generally reported in smaller as compared to larger studies, and this may result
447 in reporting bias (Sterne et al., 2000). Additionally, biases can occur from methodological
448 flaws in studies with small sample sizes or may result from differences in the underlying
449 effects of studies with smaller and larger sample sizes (Kjaergard et al., 2001; Turner et
450 al., 2013). Finally, there were few studies that examined the effects of chronic exercise,
451 limiting the ability to fully explore responses to long-term exercise. Future research on
452 this topic should carefully consider (a) participant sample size, (b) length of training, (c)
453 what exercise characteristics differentiate perceived pleasure from perceived enjoyment,
454 and (d) whether pleasure or enjoyment is more important for exercise adherence.

455 Promoting physical exercise to the general population is a priority, however 63%
456 of exercisers abandon new activities within 12 weeks (Sperandei et al., 2016). Therefore,
457 the general population has not been engaging in physical exercise programs that in the
458 long term can provide improvement to general health. Thus, different exercise programs
459 are required to optimize affective and pleasure responses, both during and after exercise.
460 Our results suggest that exercise selection and intensity may play important roles towards
461 developing an exercise habit for people with a limited exercise history. Therefore,
462 exercise programs should be individualized to match the fitness levels and goals of the
463 individual to assist with adherence to an exercise program.

464 **Conclusion**

465 The present review of past research found that a greater positive affective response
466 post-exercise occurs following CT compared to HIIT. This finding was present regardless
467 of the influence of age, BMI and gender. Moderate, and not high intensity CT, appeared
468 to promote a more positive affective response post-exercise, compared to HIIT. However,
469 enjoyment tended to be greater following HIIT compared to CT. The disparity between
470 the affective and enjoyment responses following CT and HIIT may be due to an
471 interaction between effort, discomfort, and task accomplishment.

472 **Funding sources**

473 This research did not receive any specific grant from funding agencies in the public,
474 commercial, or not-for-profit sectors.

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Table 1. Descriptions of Acute Studies

Author	Participants (n)	BMI	VO2	Age	Women %	Condition	Intensity Variable	Configuration	Type	Outcome
Bartlett et al., 2011	8	24.2	57	25	-	HIIT	% Vo2peak	7min-70% + 6x (3min-90%)/(3min-50%) + 7min-70%	Treadmill	PACES
						MCT	% Vo2peak	50min - 70%		
Oliveira et al., 2013	15	24.2	47.9	24	0	HIIT	% Vo2peak	6.6x (120s-100%)/(57s-0%)	Treadmill	FS
						MCT	% RCP	20min - 85%		
Jung et al., 2014	44	24.1	36.3	33.1	63	HIIT	% Wpeak	10x (60s-100%)/(60s-20%)	Cycle Ergometer	PACES and FS
						CVI	% Wpeak	20min - 80%		
						CMI	% Wpeak	40min - 80%		
Martinez et al., 2015	20	29	28.5	22	45	HIIT30-s	% Vo2peak	24x (30s-SI)/	Cycle Ergometer	PACES and FS
						HIIT60-s	% Vo2peak	12x (60s-SI)/		
						HIIT120-s	% Vo2peak	6x (120s-SI)/		
						HC	% Vo2peak	20min - HC		
Kilpatrick et al., 2015	24	23	41	22	50	HI	% VT	10x (60s-0% VT)/ 60s -< 20% VT	Cycle Ergometer	FS

						SI	% VT	10x (60s-20% > VT)/ (60s -at %VO2Peak)		
						HC	% VT	20min - < 20% VT		
						MC	% VT	20min – at %VT		
Thum et al., 2017	12	23.1	41.4	29.5	35	HIIT	% Wpeak	8x (60s-85%)/(60s-25%)	Cycle Ergometer	PACES and FS
						MCT	% Wpeak	20min - 45%		
Decker & Ekkekakis, 2017	24	34.9	19.5	39.2	100	HIIT	% VT	3min-20W + 4x (3min-115%)/(2min-85%) + 5min-20W	Cycle Ergometer	PACES and FS
						MCT	% VT	25min 85%		
Hoekstra et al., 2017	12	-	35.5	22.5	-	HIIT	% Wpeak	10x (60s - 200%) / (60s - 40%) 20 min	Cycle Ergometer	PACES and FS
						MCT	% Wpeak	30 min - 80%		
Poon et al., 2018	12	23.5	44.9	24.3	-	HIIT	% Vo2peak	10x (60s - 100%) / (60s 50%)	Treadmill	FS
	12	23.4	39.5	46.8	-	MICE	% Vo2peak	40 min - 65%		
						VICE	% Vo2peak	20 min - 80%		

Stork et al., 2018	30	22.4	31.3	21.2	60	HIIT	All out	10x (60s -70%)/ 60s - rest	Cycle Ergometer	PACES and FS
						SIT	All out	3x20-s / 2 min - rest		
						MCT	% Wpeak	50 min - 35%		
Niven et al., 2018	20	-	48.2	25.7	-	HIIT	All out	10 × 6 s - all out / 60s - rest	Cycle Ergometer	FS
						MCT	% VT	30 min - 85%		
Olney et al., 2018	19	23.1	40.3	24	48	HIIT HIGH	% Wpeak	8x (60s-85%)/75s - 20%)	Cycle Ergometer	PACES and FS
						HIIT LOW	% Wpeak	6x (2min 70%)/60s - 20%)		
						SIT	% Wpeak	6x (“all-out” 20s - 140% Wpeak) - (140s at 20% Wpeak)		
						MCT	% Wpeak	25 min - 40%		
Kriel et al., 2019	11	-	40.7	23	-	SIT	All out	4 x 30 s - all out / 120s - rest	Cycle Ergometer	PACES
						MCT	% Weak	38 min - 50%		
Sagelv et al., 2019	7	23.9	52.1	23.4	60	HIIT	HRmax	4x 4 min - >90% / 4x 3 min - 70%	Treadmill	PACES

						MCT	HRmax	45 min - 70%		
Alicea et al., 2020	12	-	44.7	22.3	100	HIIT	%Vo2peak	14 x (60s - 100%) / (60s - 50%)	Treadmill	FS
						MCT	%Vo2peak	28 min - 80%		
Portugal et al., 2015	16	-	-	25.1	0	RT	80% 1RM (vgs)	3 x (8 rep) – 20 min	RE	FS
							40% 1RM (lgt)	3 x (8 rep) – 20 min		
Focht et al., 2015	20	-	-	23.1	100	RT	80% 1RM (vgs)	3 x (10 rep) - 45 min	RE	FS
							40% 1RM (lgt)	3 x (10 rep) - 45 min		

Note: HIIT: High intensity interval training; HI: Heavy intensity; SI: Severe intensity; MCT: Moderate continuous training; W: watts; CVI: continuous vigorous intensity; CMI: continuous moderate intensity; HC: heavy continuous; RCP: respiratory compensation point; %VO2peak: Percentage peak of oxygen consumption; VT: ventilatory threshold; SIT: Sprint interval training; MICE: Moderate intensity continuous exercise; VICE: Vigorous intensity continuous exercise; HRmax: Heart rate maximal; HRR: Heart rate reserve; RM: Repetition maximal; HIIT#: High impact intensity training; VGS: Vigorous; LGT: Light; RT: Resistance Training; RE: Resistance Exercise; PACES: Physical Activity Enjoyment Scale; FS: Feeling Scale.

Table 2. Descriptions of Chronic Studies

Author	Participants (n)	BMI	VO2	Age	Women %	Training Frequency and Duration	Condition	Intensity Variable	Configuration	Type	Outcome
Heisz et al., 2016	17 (T)	21.1 ± 0.5	31.8 ± 1.6	21.4 ± 2.9	70	3/wk, 6 wk	HIIT	HRmax	10 x (60s - 95%) / (30% Wpeak)	Cycle ergometer	FS
	19 (T)	23.0 ± 1.0	30.2 ± 1.5	20.4 ± 1.3	68.5		MCT	HRmax	27 min - 70-75%		
Kong et al., 2016	13 (S)	25.8 ± 2.6	32.0 ± 6.6	21.5 ± 4.0	100	3/wk, 5 wk	HIIT	% Vo2peak	60 x (8s - 80%) / (12s - 50w)	Cycle ergometer	FS
	13 (S)	25.5 ± 2.1	32.0 ± 5.0	20.5 ± 1.9	100		MVCT	% Vo2peak	40 min - 71%		
Vella et al., 2017	8 (S)	29.9 ± 29.9	34.8 ± 2.9	23.1 ± 6.6	40	4/wk, 5 wk	HIIT	HRR	10 x (60s - 75-80%) / (60s 35-40%)	Cycle ergometer/ Treadmil	FS
	9 (S)	33.1 ± 6.0	34.5 ± 2.1	28.9 ± 8.1	40		MVCT	HRR	20 min - 55-59%		

Note: HIIT: High intensity interval training; MCT: Moderate continuous training; MVCT: Moderate to vigorous continuous training; HRmax: Heart rate maximal; HRR: Heart rate reserve; %VO2peak: Percentage peak of oxygen consumption. T = trained; S = sedentary; FS: Feeling Scale; WK: week.