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Exercise enjoyment does not predict change in maximal aerobic power during a strenuous 10-week endurance exercise intervention

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Abstract

Study aim: Although exercise enjoyment is well studied in behavioral context, its associations to aerobic fitness adaptations during exercise interventions have received less attention.
Material and methods: Untrained participants ($n = 37$, 21 females), cycled either at low intensity (LIT) ($n = 18$, mean training time 6.7 ± 0.7 h/week) or high intensity (HIT) with 3–7 min working intervals ($n = 19$, 1.6 ± 0.2 h /week) for 10 weeks. Aerobic capacity, defined as the power associated with maximal oxygen uptake, was the performance outcome. Exercise enjoyment was measured after all exercise sessions during the first and the last week of the intervention.
Results: Exercise enjoyment did not predict the change of aerobic capacity ($p = 0.93$) and was not associated to the weekly perceived exertion ($p > 0.20$). Mean (95% CI) enjoyment decreased equally (time × group difference $p = 0.98$, $\eta_p^2 < 0.001$) in both groups [LIT: -7 (-13– -1); HIT: -7 (-14–0)].
Conclusions: Overall, enjoyment does not seem to be a suitable method to individualize training for improving aerobic capacity. Further, exercise enjoyment decreased during strenuous exercise intervention, and it is not a variable that affects how participants rate their overall weekly perceived exertion.

Keywords: Low intensity training – High intensity training – Exercise enjoyment – PACES – Responder

Introduction

Exercise enjoyment has been used to predict and explain exercise behavior, for example minutes of moderate to strenuous physical activity of children [42] and adults [56], adherence to physical activity [16], intention to continue to exercise [50], and buffering against the age-related decline in physical activity in youth [15]. While baseline exercise enjoyment as a predictive marker has been studied well in behavioral context, its ability to predict changes in physical performance has not received much attention. One of the rare occurrences is a study in which baseline exercise enjoyment at the beginning of the intervention did not predict walking performance in a general weight loss program [3]. Further, the change in exercise enjoyment during an intervention has been linked to an increased competence caused by change in aerobic capacity [17]. This suggests a link between improved aerobic capacity and increased exercise enjoyment of high intensity training (HIT), as has also been suggested elsewhere [18, 27]. However, even these studies do not address whether exercise enjoyment can predict future increases in aerobic capacity, even though they might change in parallel.

As adaptations to training are highly individual, some being high and some low responders [39], there is a growing interest in finding individualized optimal training programs. Typically, the predictive factors for increased aerobic fitness have been physiological ones, for example, cardiac autonomic function measured by heart rate variability [20] or genetic factors [26]. The use of psychological predictive factors, apart from stress [45], has been negligible.

Increased intensity also increases the exercise enjoyment, and HIT sessions are in many instances seen to be more enjoyable than low intensity (LIT) ones [37], although not always [8]. The reason might be that after a high intensity endurance exercise bout, one may experience

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competence, sense of accomplishment, and pride [36]. However, a number of variables influence the experienced enjoyment of a HIT session, as insufficiently active men report lower affective values during a long interval session compared to active ones [13], and the long duration of the work interval decreases the exercise enjoyment compared to short one [32].

Exercise enjoyment has typically improved or been unchanged during exercise intervention [1, 17, 18, 22, 27, 40, 41, 46, 48, 52, 53] with one exception [12] in which progressively declining enjoyment was reported in LIT and HIT across the course of the intervention. However, most of these studies used quite conservative total training loads both for LIT and HIT and short work interval lengths in their HIT group (<1 min). Further, these indoor conducted studies might be biased favoring HIT, as variable stimulus such as alternating high and low intensities as in interval training [19] increases enjoyability of an exercise.

This study has two aims. First, we tested a hypothesis that baseline exercise enjoyment at the beginning of the intervention would predict the change in maximal aerobic power and weekly rating of perceived exertion during strenuous 10-week HIT vs. LIT setting, where LIT was done outdoors. Second, possible changes in exercise enjoyment were studied, and it was hypothesized that outdoor LIT would be as effective to increase enjoyment as indoor HIT.

Materials and methods

A comprehensive description of the methods used in the research project can be found in our previously published study [34].

Participants

The study was done on healthy untrained 23–40-year-old adults (Table 1). Only participants who were sedentary or recreationally active were included. Totally 37 participants of 44 fulfilled the exercise intervention (Figure 1). Sixteen identified themselves as males, 21 as females, and none as other. All participants provided a written informed consent, and the study was approved by the Ethical Committee of the Central Finland Health Care District (8U/2020) compiled with the Declaration of Helsinki.

Exercise intervention

LIT and HIT exercises. Participants were randomly divided into LIT (n = 18) or HIT (n = 19) cycling groups for 10 weeks. Weekly training load progressed individually, emphasizing volume progression, based on self-reported weekly rating of perceived exertion (wRPE) using Borg RPE Scale® [4]. After each training week, participants were asked, in Finnish, 'How much the training has strained your week in the scale 0–10?'. The prescribed training load progression was individualized based on wRPE, and progression was greater with lower wRPE. Training realization is shown in Table 2.

Endurance training in the LIT group was below the power corresponding the first lactate threshold (LT_1) with 3–6 weekly sessions, each lasting 45–240 min. Participants cycled with their own bikes mostly outdoors. They were given possibility to ride indoors. Three (out from 18) participants did their training completely indoors, and the others did 3% of their training indoors. The HIT group cycled 2–3 weekly indoor sessions. They had long work intervals (3–7 min) above the power corresponding the second lactate threshold (LT_2) with at least 15 min worth of cumulative work time in a session. Participants started intervention either in mid-

Table 1. Basic characteristics (mean and standard deviation) of the participants at the beginning of the study

		Aerobic capacity				
		Maximal oxygen uptake		Maximal aerobic power	Body mass index	Age
		[l/min]	[kg/min/min]	[W]	[kg/m²]	[year]
Low intensity training group	Female (n = 11)	2.55 (0.12)	34.5 (3.8)	189 (23)	26.5 (4.4)	32.0 (5.4)
	Male (n = 7)	3.62 (0.14)	40.9 (5.5)	272 (25)	27.7 (2.8)	34.0 (6.2)
	Combined (n = 18)	2.97 (0.66)	36.7 (5.4)	221 (47)	27.0 (3.8)	32.8 (5.7)
High intensity training group	Female (n = 10)	2.33 (0.04)	37.6 (5.0)	176 (11)	23.5 (3.4)	29.8 (4.8)
	Male (n = 9)	3.25 (0.13)	37.2 (6.4)	251 (43)	27.0 (2.6)	34.2 (4.7)
	Combined (n = 19)	2.77 (0.55)	37.4 (5.5)	212 (48)	25.1 (3.5)	31.9 (5.2)

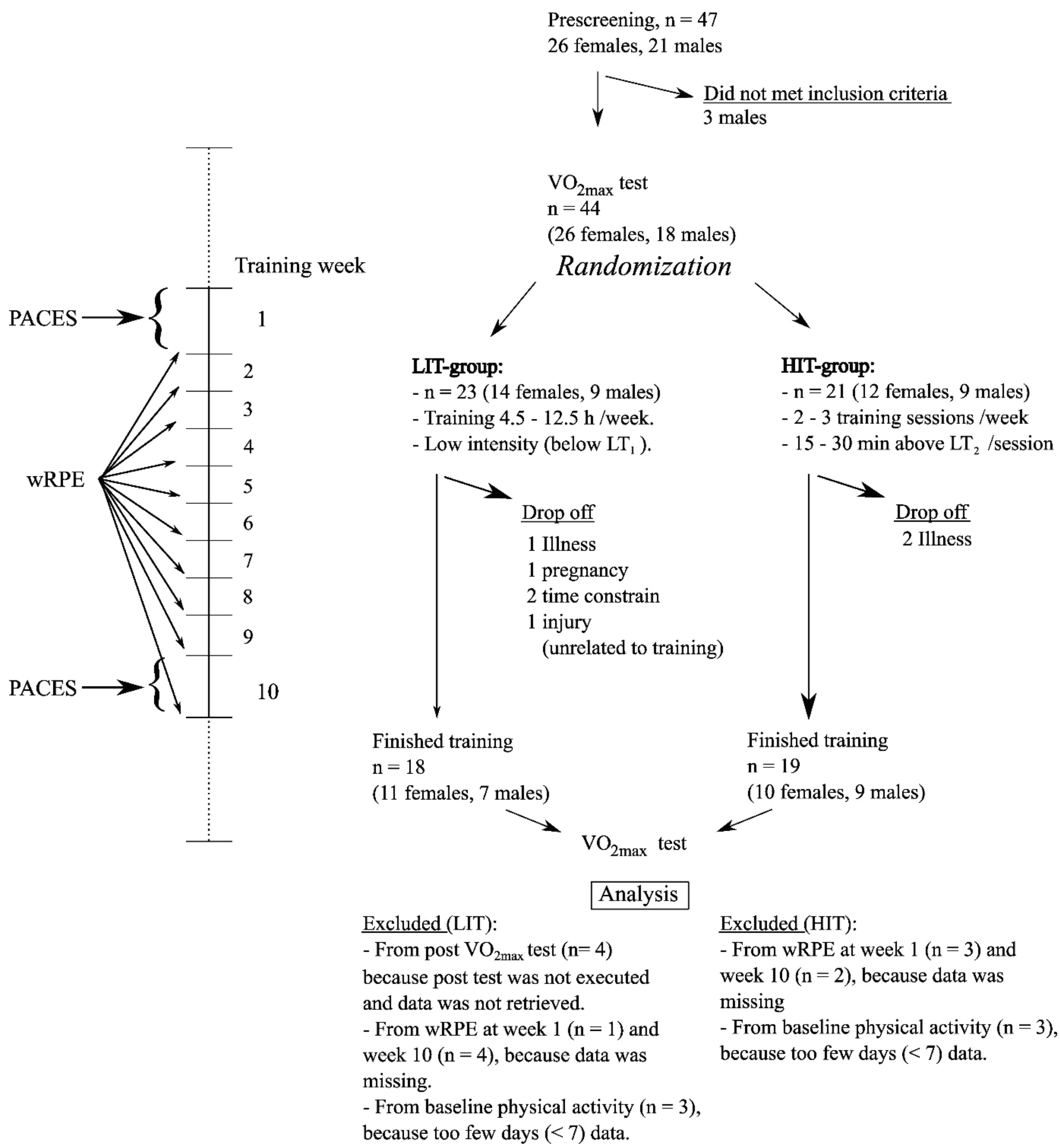

Figure 1. Flow chart of the study. *LIT* Low Intensity training group. *HIT* High Intensity Training group. *PACES* Physical activity enjoyment scale. VO_{2max} *test* Maximum oxygen uptake test. *wRPE* weekly rating of perceived exertion

Table 2. Total training realization (mean and standard deviation), in the LIT and HIT groups during 10-week exercise intervention

	Total training time [h]	Training volume [h/week]	Training frequency/week	Training session rating of perceived exertion	Time at power zones [%]					Total training load (a.u)
					Z1	Z2	Z3	Z4	Z5	
Low intensity training group (n = 18)	67.4 (7.6)	6.7 (0.8)	4.8 (0.3)	2.7 (1.3)	76 (12)	20 (12)	3 (2)	0 (0)	0 (0)	86 (13)
High intensity training group (n = 19)	15.6 (1.8)	1.6 (0.2)	2.4 (0.1)	7.2 (1.9)	53 (5)	1 (1)	2 (2)	11 (6)	33 (9)	55 (8)

Power Zones Z1 (below LT_1 – 10 W); Z2 (between LT_1 – 10 W to LT_1 + 10 W); Z3 (between LT_1 + 10 W to LT_2 – 10 W); Z4 (between LT_2 – 10 W to LT_2 + 10 W); Z5 (above LT_2 + 10 W). *LT_1* First lactate threshold. *LT_2* Second lactate threshold. *a.u.* arbitrary unit.

summer (June or July, 9 participants in the LIT and 12 in the HIT group), or in autumn (September or October, 9 in the LIT and 7 in the HIT group). A more detailed training description can be found elsewhere [34].

Measurements

Maximal oxygen uptake (VO_{2max}) was measured by maximal incremental cycling test with 3 min stages and 25–30 W increments in the week preceding the intervention and after the last training week. The measurements included breathing gases (Jaeger Vyntus TM CPX, CareFusion Germany 234 GmbH, Hoechberg, Germany) and blood lactate (analyzed with EKF-diagnostic GmbH, Ebendorfer Chaussee 3, Germany) from the last minute of each stage. LT_1 was defined as the lowest value of the lactate/VO_2 ratio, and LT_2 as a sudden and sustained increase in blood lactate concentration [11]. LT_1 and LT_2 were used to prescribe training, and maximal aerobic power (P_{max}) as the primary marker of aerobic capacity, calculated by the weighted mean of the last 3 min of the test: power of last completed stage (W) + [time (s) of unfinished state]/(180 s) × increment (W). Four participants from the LIT group did not execute post VO_{2max} test.

Training load. Training power output were distributed to five zones [6]: Z1 (below LT_1 – 10 W); Z2 (LT_1 – 10 W to LT_1 + 10 W); Z3 LT_1 + 10 W to LT_2 – 10 W); Z4 (LT_2 – 10 W to LT_2 + 10 W); Z5 (above LT_2 + 10 W). For each zone, a weighting factor was linked (in an ascending order: 1, 2, 3, 4, 7.5) and training load was calculated multiplying the factor by the time spend in the zone [6]. Realized weekly training loads are in Figure 2.

Exercise enjoyment was measured, in Finnish, by the 18-item Physical Activity Enjoyment Scale (PACES; Kendzierski & DeCarlo, 1991*).* Participants responded to "How do you feel at the moment about the physical activity you have been doing" on the 7-point bipolar scale (e.g. "1 = it is not very refreshing…. 7 = It is very refreshing" and "1 = it is not at all stimulating…. 7 = it is very stimulating"). The score was the summation of all the items, running between 18–126. Participants filled the PACES after each training session in the first and the last week of the intervention through mobile phone application (AthleteMonitoring, FITSTATS Technologies, Inc., Moncton, Canada). Weekly mean values were used for the final exercise enjoyment scores. In this study Cronbach's α for PACES was 0.95.

Physical activity. The participants were instructed to continue their daily physical activities (commuting, nonphysical hobbies, etc.), but all strenuous exercise in addition to LIT or HIT was not allowed. To estimate baseline physical activity before the training intervention, daily heart rate from wrist was measured continuously (Garmin Forerunner 945, Garmin Ltd., Taiwan). Heart rate was divided into three zones using LT_1 and LT_2. Only participants with more than 7 days of data were considered. For a more comprehensive analysis of baseline physical activity, see [34].

Statistical analyses

Although the study question was included in the original study plan, the original sample size was calculated for the primary outcome of the study (increase in energy expenditure during prolonged cycling test) [34] making the current study more retrospective in nature. No sample size calculation was performed on the outcome measures of this study. Description data is presented as means and standard deviations (SD). Statistical tests were calculated by SPSS 26.0 and 28.0 (SPSS Inc, Chicago, IL, USA) and by Mathematica 13.0 (Wolfram Research, USA). The Shapiro-Wilk test was used to examine the normality together with visual inspection. Cronbach's α was calculated with all 44 participants taking part in the first exercise intervention week. Before performing the final analysis, it was determined if the magnitude of changes in the main variables differed between genders with Kruskal-Wallis test. No differences were detected in VO_{2max}, P_{max}, enjoyment, training load, or weekly rating of perceived exertion, and thus females and males were analyzed in combined groups.

Between-group differences were tested with 2 × 2 split plot ANOVA, and its effect size partial eta squared

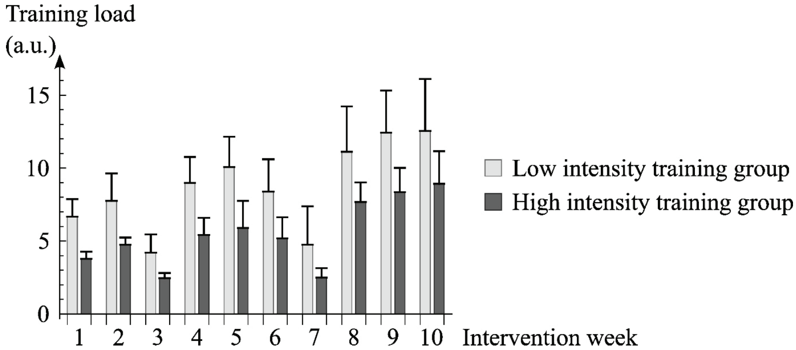

Figure 2. Mean (SD) training load during the intervention in the LIT and HIT groups. From the first to the last week of the training, the training load increased by a factor 1.9 ± 0.5 and 2.4 ± 0.9 in the LIT and HIT groups, respectively. In each week the load of the LIT group was higher than that of the HIT group ($p < 0.001$). *a.u.* arbitrary unit

(η_p^2) was calculated. Small, moderate, and large effect size magnitudes for η_p^2 were categorized as 0.01, 0.06, and 0.14 [44]. If sphericity assumption failed, Greenhouse-Geisser correction was used. In the paired comparison, 95% CI was calculated and t-test was used, except with physical activity in which Mann-Whitney was used. A hierarchical multiple linear regression was used to explore to which extent enjoyment predicted outcomes. In the first step of the model, age, gender, and group were entered as independent variables. The change in wRPE from the first to the last week was interpolated from a regression line. The analyses were run separately for summer and autumn participants, and the only difference was detected in the LIT group in change in VO_{2max} ($p = 0.04$), so it was decided to analyze summer and autumn participants in a combined group. Correlations were done using Spearman correlations.

Results

Prediction of the change in maximal aerobic power and training load by exercise enjoyment

Exercise enjoyment at week 1 did not predict the absolute change in P_{max} or the total training load (Table 3, Figure 3). Moreover, change in exercise enjoyment was not associated with the weekly rating of perceived exertion or absolute change in P_{max} (Table 3). The results were unaffected if the change in P_{max} was inspected in a relative rather than in an absolute value.

Development of exercise enjoyment

Exercise enjoyment at the first week was 90.4 (13.1) in the LIT and 97.6 (11.4) in the HIT group (between group $p = 0.08$) and at the end of the intervention 83.5 (13.4) in the LIT and 90.6 (14.3) in the HIT group (between group $p = 0.13$). Exercise enjoyment decreased in both training groups [LIT: –6.8 (-13.0–-0.8); HIT: –7.0 (-13.7–-0.2)] during the exercise intervention. ANOVA did not reveal time x group difference between the groups ($p = 0.98$, $\eta_p^2 < 0.001$).

Change in aerobic capacity

There were large time x group differences in improvement of P_{max} ($p < 0.001$, $\eta_p^2 = 0.28$) and VO_{2max} ($p = 0.003$, $\eta_p^2 = 0.26$). P_{max} improved in both groups [LIT: n = 14, ΔP_{max} = 11 W (3–19 W); HIT: ΔP_{max} = 27 W (21–33 W)], while VO_{2max} improved only after HIT [LIT: n = 14, ΔVO_{2max} = 0.4 ml/kg/min (-1.3–2.1 ml/kg/min); HIT: ΔVO_{2max} = 3.5 ml/kg/min (2.3–4.6 ml/kg/min)].

Table 3. Hierarchical multiple regression analyses on how much change in P_{max} and wRPE, and total training load were predicted by initial exercise enjoyment, and how much change in exercise enjoyment was associated with total training load and change in P_{max}

		Pre exercise enjoyment	Δ Exercise enjoyment
ΔP_{max} (n = 33)	Beta (p-value)	0.02 (p = 0.93)	0.02 (p = 0.94)
	Partial correlation	0.02	0.01
Total training load (n = 37)	Beta (p-value)	–0.07 (p = 0.53)	–0.40 (p = 0.20)
	Partial correlation	–0.11	–0.23
Δ Weekly rating of perceived exertion (n = 37)	Beta (p-value)	–0.21 (p = 0.26)	0.10 (p = 0.57)
	Partial correlation	–0.20	0.10

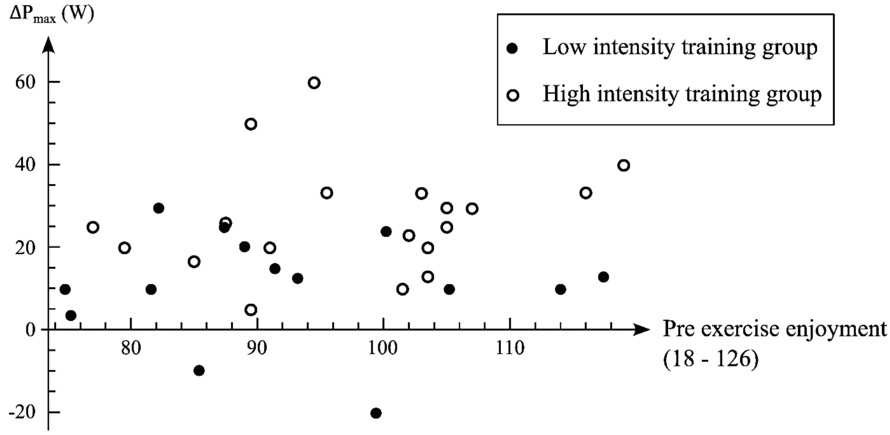

Figure 3. Scatterplot of pre exercise enjoyment scores and absolute change in P_{max} in the LIT and HIT groups

Associations of wRPE, enjoyment and training load

Exercise enjoyment did not correlate with wRPE at week 1 (LIT: n = 17, ρ = 0.13, p = 0.62; HIT: n = 16, ρ = 0.34, p = 0.20) nor at week 10 (LIT: n = 13, ρ = 0.16, p = 0.61; HIT: n = 18, ρ = 0.09, p = 0.73). Total training load correlated with average wRPE (LIT: ρ = – 0.55, p = 0.02; HIT: ρ = –0.65, p = 0.003).

Physical activity

Daily minutes above the first lactate threshold at the baseline before the intervention were 6.6 (7.3) min in the LIT group and 6.2 (8.6) min in the HIT group with no difference between the groups (p = 0.80). The post-hoc correlations showed no differences between the time above LT_1 at the baseline and the baseline enjoyment in the LIT (n = 15, ρ = –0.03, p = 0.93) or the HIT (n = 16, ρ = –0.22, p = 0.42) group.

Discussion

The main findings of this study were that exercise enjoyment did not predict improvement in maximal aerobic power nor the individualized training load progression based on weekly rating of perceived exertion. Moreover, endurance exercise intervention with heavy load and progression decreased exercise enjoyment. Exercise enjoyment decreased even when participants were able to affect the progression themselves and train outdoors (LIT).

Exercise enjoyment predicting maximal aerobic power

There was no association between exercise enjoyment and changes in maximal aerobic power. Although exercise enjoyment may predict future physical activity [10, 42], it seems that there are not much studies on predicting change in fitness based on enjoyment.

Endurance runners have been divided into two global running patterns with different biomechanical parameters: aerial runners rely on stretch shortening cycle and return of elastic energy, while terrestrial runners minimize energy expenditure by reducing vertical oscillation [14]. Aerial runners had reported more positive feelings toward higher speed runs than terrestrial runners [28]. It has been speculated that aerial runners would benefit more from high-speed running training and explosive strength training [14]. Endurance coach practitioners have further suggested that, generally speaking, aerial runners would benefit from training intensity, and terrestrial runners from training volume [29], both of which they inherently already have positive feelings about [28]. In this study, we conceptualize this belief into a research question: Can enjoyment be used to predict the change in aerobic capacity?

However, this did not realize in our study, nor when aerial and terrestrial runners trained either explosive or maximal strength training in addition to an endurance training [38]. Further, in general weight loss program enjoyment did not predict change in walking performance [3]. Therefore, although some individuals prefer and enjoy higher intensity exercise and tolerate it better than others [9, 50], it seems that performance improvements cannot be predicted by positive feeling toward exercise alone.

There are confounding factors that may influence the conclusion. HIT has a small beneficial effect over LIT in enhancing VO_{2max} in untrained participants [35]. Combining greater enjoyment of HIT exercise [37] with its slightly beneficial effect on VO_{2max} could, at the group level, lead to a positive connection between baseline enjoyment and change in aerobic capacity. To specifically examine the individual responses without the above mentioned group level connection, we chose to use hierarchical regression, in which the group was added as an independent variable. Further, higher baseline physical activity has been associated with higher enjoyment at high intensity exercise [13], which might cause bias in the prediction of future change in aerobic capacity. However, in our study the amount of baseline physical activity above LT_1 was not associated with baseline exercise enjoyment in either group.

Exercise enjoyment and weekly exertion and total training load

Neither exercise enjoyment, nor its change were associated with the total training load or weekly rating of perceived exertion. Even though exercise enjoyment predicts physical activity [25, 42, 47, 56] and it is related to exercise motivation [21], it seems that exercise enjoyment is not a variable that affects how participants' valued overall weekly exertion or how their training load increased. Acutely, this has been reported in many studies in which enjoyment of HIT has been greater than LIT, despite HIT-session having greater perceived exertion [30, 37], but here we saw that this holds true also in larger picture.

Albeit training load was determined through weekly rating of perceived exertion, their correlation was not as high (|ρ| = 0.55–0.65) as one would have anticipated. That there was not a complete correlation might have emerged from interindividual difference in executing the training program. For example, that in the LIT group Z1 and Z2 zones had different emphasizes in participants' training.

Exercise enjoyment development during the intervention

Exercise enjoyment decreased during our 10-week intervention. In earlier studies, exercise enjoyment has typically improved or been unchanged [1, 17, 18, 22, 27, 40, 46, 48, 53] during an endurance exercise intervention, with one exception [12]. In our HIT group we used long intervals (>2 min) and reached at least 15 minutes of cumulative high intensity time per session as recommended for optimal aerobic fitness improvement [5, 55]. There is not much exercise enjoyment interventions using these recommendations, as only two exercise enjoyment interventions have exploited them [18, 27]. In those, enjoyment increased [27] and varied [18] during the intervention, while in our study exercise enjoyment decreased.

It seems plausible that increased training load caused our decreased enjoyment, as progression in our study was distinctively greater compared to other exercise enjoyment studies. Although not completely examined, it is possible that acutely the duration of an exercise can decrease enjoyment [1, 31]. In our study, the duration of training sessions and thus training load increased toward end of the intervention, which might have triggered decreased exercise enjoyment.

Surprisingly few studies have paid close attention to enjoyment development and factors affecting it in the long interventions [43]. After all, exercise enjoyment has been seen to change during weeks lasting interventions even when the sessions have been standardized throughout the intervention [12, 17, 18, 27, 41, 48]. Increased exercise enjoyment is often explained by increased aerobic capacity and the improved self-efficacy followed from increased fitness [17, 18, 27]. However, this cannot be the only affecting factor, as there are numerous studies in which the exercise enjoyment was unchanged [22, 52] or decreased [12] although aerobic capacity was improved. This was the case also in our study where the large change in P_{max} in the HIT group was accompanied by decreased exercise enjoyment. Other offered explanations to enjoyment development have included habituation to training [2, 48], need for an alternating stimulus [12], continuous exposure to exercise and exercise counselling [46], and fulfilled expectations of weight loss [27]. However, these factors were not measured in our study. It might be that quantitative methods alone are not adequate and more qualitative studies would be needed to reveal the whole complexity of exercise enjoyment development spectrum [49].

It seems that exercise enjoyment studies have exclusively compared the HIT and LIT exercises indoors. Indoor LIT has been reported to be felt monotonous [51] and boring [30] compared to HIT. Affective and exercise enjoyment may favorably be influenced by outdoor exercise in the presence of nature [23, 24], as well as autonomy of choosing how to implement the exercise session [33], both of which were present in our study design. We hypothesized that doing LIT outdoors would increase its enjoyment compared to indoor HIT. However, this was not realized even in the first week of the intervention, when the training load was still moderate. It seems that green exercise was not alone enough to lift enjoyment of the LIT compared to indoor HIT. Reasons why enjoyment was not uplifted in the LIT group might be changing weather, unaccustomed to outdoor cycling, and too restricted cycling power at exercises which might have limited the autonomy of choosing how to implement the session.

We acknowledge that the context of LIT and HIT was different, as solely LIT was conducted outdoors. However, this was a desired and intentional feature, and the research setting was equalized with the notion that both training modes encompass variation. HIT inherently includes variability through alternating intensities within a session, whereas variation in LIT needs to be introduced externally. In this study, it was achieved by transferring cycling to outdoor environments.

Limitations

One reason not to detect any associations between exercise enjoyment and maximal aerobic power change could be that due to small sample size, our participants were neither particularly high nor low responders [7]. If individual responding was minimal, a question of how well enjoyment predicts individual adaptation might become too challenging to get definite answer. Further, we did not have a control group, which could have helped to clarify the factors affecting development of exercise enjoyment.

When we studied whether the participants enjoy the type of exercise that is personally the most suitable for them, we understood improvement of maximal aerobic power to be the solely marker for "physiologically most suitable" exercise. However, it is well known that high responder to one variable is not that to another [54]. It follows that results may become different, if a different marker would have been chosen, for example, improvement in time trial performance, recovery ability, or more health related, such as blood pressure or arterial stiffness.

Although body mass index between the females in the LIT and HIT groups were not statistically significant ($p = 0.09$), difference of its mean (95% CI) of 3.0 (-0.6–6.7) indicate potential source of bias. However, it seems that obesity alone is not a substantial factor for exercise enjoyment and change in weight has been reported unclear connection to exercise enjoyment [2, 3].

Conclusions

Exercise enjoyment does not seem to be a suitable method to individualize training for increased maximal aerobic power. Moreover, exercise enjoyment is not a variable that affects how participants rated their overall weekly perceived exertion. Lastly, exercise enjoyment was decreasing during challenging endurance exercise intervention. The facts that participants had chance to affect the amount of progression and that the low intensity training was done outdoors were not enough to revert enjoyment deteriorated processes.

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Conflict of interest: Authors state no conflict of interest.

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