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Original Research

Treadmill Exercise and Indoor Cycling: Self-selected Intensity, Perceived Enjoyment, and Importance of Preference for Activity Mode

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Abstract

International Journal of Exercise Science 18(5): 1344-1354, 2025. https://doi.org/10.70252/NCPI2090 For advancement of public health through exercise, exercise intensity and enjoyment are important. We aimed at testing whether self-selected exercise intensity was higher during treadmill exercise than during indoor cycling. Secondly, the enjoyment associated with the two activities was evaluated. Thirdly, in a person-centered analysis, taking into account the participants' preference for mode of activity, we assessed whether preference for one of the activity modes was accompanied by greater intensity. Healthy adults (n=21) participated in the repeated measures crossover-designed study. They performed 16-min bouts of treadmill exercise and indoor cycling at self-selected intensity. Heart rate was recorded to determine the intensity. Enjoyment associated with the exercise activity was determined by a questionnaire. Intensity in terms of heart rate as percent of maximal heart rate was not different between treadmill exercise and indoor cycling (p=0.148). Enjoyment, on the other hand, was 4.4±7.6 units greater for treadmill exercise than for indoor cycling (p=0.012). Seventeen of the participants had a preferred mode of activity, when asked before any testing. The person-centered analysis, which took into account the participants' preference for the mode of activity, showed that intensity was 4±7 percentage points higher (p=0.029) during the preferred mode of activity as compared to the other activity. In summary, the study showed that the self-selected intensity was not different between treadmill exercise and indoor cycling, while the enjoyment was found to be greater during treadmill exercise. A person-centered analysis showed that intensity was higher during the preferred mode of activity than during the other activity.

Keywords: Biking, exercise adherence, health, preference-based exercise, running, self-selected intensity, training

Introduction

A specific goal of performing aerobic fitness exercise is to maintain or advance the health of individual persons. An overall goal is to advance public health in general. The present study was inspired by practice where aerobic fitness exercise is carried out in diverse municipal, regional, and private settings. In these settings, common modes of aerobic exercise include indoor cycling as well as treadmill exercise. Further, it is a widespread practice that participants

are allowed to self-select the intensity during exercise, which has been suggested to health practitioners as an appropriate option.[1]

To be able to carry out a professional evaluation of performed exercise and provide sensible exercise recommendations, we need to know whether there are differences between the training modes of indoor cycling and treadmill exercise in terms of 1) the self-selected exercise intensity and 2) the perception of the exercise. As for the exercise intensity, we are focused on heart rate since it is simple to measure in the practice and reflects the load on the aerobic energy system. As for the perception, we are focused on enjoyment since enjoyment appears to be a strong predictor of physical activity behavior [2] as well as a factor relevant for increasing adherence to physical exercise, as suggested based on a literature review.[3]

Regarding the aspect of exercise intensity, previous research has indicated that exercise intensity, in terms of heart rate, in young adults, is 15-20 beats per min higher during running than during cycling.[4,5] In these studies, exercise intensity was compared at an equal rate of perceived exertion. In another study, intensity was self-selected by young adults during 20 min of exercise.[6] Participants were instructed to "exercise at a steady rate so you feel you are working equally hard for all exercise modes and to pace yourself at a comfortable but challenging intensity, similar to what you would do during a normal aerobic workout". The results showed that heart rate on average was about 13 beats per min higher during running than during cycling.[6] In a similar study, heart rate in young adults was reported to be on average 24 beats per min higher during running as compared to cycling at self-selected exercise intensity.[7]

Regarding the aspect of enjoyment, less research has been conducted. A study compared the enjoyment of moderate cycling and running performed for 20 min at an intensity corresponding to 20% below the ventilatory threshold. No statistically significant difference in enjoyment was detected between the two modes of exercise.[8] In the study by Rendi et al mentioned above, enjoyment was also similar during cycling and running.[7] In another study, it was found that enjoyment was greater during running than during cycling.[9] However, Kriel et al studied high-intensity exercise rather than moderate to high intensity,[9] as focused on in the present study. It should also be noted that heart rate and rate of perceived exertion was lower during running than during cycling.[9]

The novelty of the present study included several aspects. As an example, the preference for mode of exercise activity – stated before testing – was determined. Thus, a potential spillover of preference for mode of exercise activity onto the self-selected exercise intensity and the magnitude of enjoyment scores could be studied. Also, an instruction applied in practice: "Now you need to raise the pulse", was used to initiate the exercise.[10] Besides, an indoor bike with a manual tension control for resistance adjustment was used for cycling.[11]

There was a threefold purpose of the present study, which involved healthy adult persons. Firstly, the hypothesis was tested that following the instruction "Now you need to raise the pulse", the self-selected exercise intensity is higher during treadmill exercise as compared to indoor cycling. Secondly, the enjoyment scores collected after the two different modes of exercise activity were evaluated. Thirdly, in a person-centered analysis, taking the participants'

preference for mode of exercise activity (stated before testing) into account, it was evaluated whether preference for one of the activity modes is accompanied by higher exercise intensity. A supplementary analysis of pacing strategy during exercise was also performed for exploration.

Methods

The present study was designed as a repeated-measures crossover trial. Two test sessions, which simulated physical training and included the two different modes of exercise activity of indoor cycling and treadmill exercise, were performed by each participant. Half of the participants were randomly selected to perform treadmill exercise first and indoor cycling subsequently. For the other half of the participants, the order was reversed. It follows that for each participant, the order was random. The purpose of the design was to counteract potential biases due to the order of sessions. The test sessions were separated by 7 ± 3 days. That amount of time was considered sufficient to avoid a noteworthy influence of one session on the other session. As for physical activity on the day before testing, participants were informed to behave in the same way before both test sessions.

Participants

A prior estimation of the sample size resulted in 15 participants.[19,20] The calculation was performed on one of the primary outcomes, which was heart rate. The calculation was based on a Student's paired two-tailed t-test to be performed with an alpha value of 0.05, an expected mean difference of 4% ± 5%, and a power of 0.80. In order to account for potential dropout, 26 participants were recruited. Five participants dropped out for reasons that were not stated, which resulted in 21 participants completing all testing. We have no reason to believe that the conclusions from the present study were affected by the dropout.

The present article contains data from a total of 21 healthy adults who completed all the testing. The group of participants was a convenience sample. Familiarity with indoor cycling and treadmill exercise was an inclusion criterion. An inserted pacemaker was an exclusion criterion. As a part of the characterization of the participants, their amount of physical activity during the last 7 days before the participation was determined with the Danish short version of the International Physical Activity Questionnaire, IPAQ,.[12] The characteristics of the participants are displayed in Table 1. Each participant provided informed consent before participation. Participants were kept naïve to the specific purpose of the study in order to avoid deliberate behavior that could affect the results. The study conformed to the standards set by the Declaration of Helsinki as well as by the procedures stated by The Danish National Center for Ethics. In Denmark, quality assurance studies do not require approval by a Research Ethics Committee. That was the case for the present study, as confirmed by The Scientific Ethics Committee for Region Zealand (journal number EMN-2025-01610). This research was carried out fully in accordance with the ethical standards of the *International Journal of Exercise Science*.[13]

Protocol

Test sessions.

Upon arrival at the first test session, the participant was asked whether the mode of exercise activity of indoor cycling or treadmill exercise was preferred. Indifference was also accepted as an answer. Then, body height was measured, and age was stated. Body mass and fat percentage was also determined (Tanita, model SC-330, TANITA Europe B. V., Amsterdam, The Netherlands). For the latter, "standard person" was selected on the body composition analyzer's display, for all participants. The maximal heart rate was estimated for each participant, according to equation 1, developed earlier.[14]

Maximal heart rate (in beats/min) = 208 – (0.7 × age in years) (Eq. 1)

One test session consisted of exercise on an Excite Connect Run treadmill (Technogym S.p.A, Cesena, Italy). First, the chest belt was mounted on the participant for heart rate transmission. Next, the participant was familiarized to the treadmill. Subsequently, the participant performed 16 min of treadmill exercise. The exercise was initiated by the instruction "Now you need to raise your pulse".[10] The participant could adjust the velocity and the gradient, as preferred, during the whole duration of the exercise. Furthermore, the participant was allowed to walk or run, as preferred. The participant was informed about the time passed, after 8 min. For collection of heart rate, the Body Bike® app version 2.3.0 (Body Bike International A/S, Frederikshavn, Denmark) was used. The participant was blinded to heart rate, distance, and time. Approximately 2 min after the treadmill exercise, enjoyment of the performed physical activity was determined with the Danish version [15] of the PACES-8 questionnaire.[16] This is the only version of the PACES questionnaire that is available in Danish.

Another test session consisted of indoor cycling on a Body Bike® Smart+ (Body Bike International A/S, Frederikshavn, Denmark). First, the seat height was adjusted for the participant, by applying "the heel method", which is nicely illustrated in a review paper on effects of saddle height.[17] Next, the handlebar was placed at the same level as the seat. Then, a Polar H9 chest belt (Polar Electro Oy, Kempele, Finland) was mounted for transmission of heart rate, and the participant was familiarized to the indoor cycle. Then, as before the treadmill exercise, 16 min of cycling was initiated by the instruction "Now you need to raise your pulse". The participant could alter the resistance and the cadence as preferred during the whole duration of the cycling. The participant was informed about the time passed, after 8 min. For all data collection, including heart rate, power output, and cadence, the Body Bike® Train smart+ app version 2.3.0 was used. The participant was blinded to heart rate, power output, cadence, and time. Approximately 2 min after the cycling, enjoyment was determined in the same way as after treadmill exercise.

Data collection and analysis.

As for the physical activity, a single value of MET-min/week was calculated for each participant.[18] These data were used for further analysis. For each participant and test session, the time of day was noted.

During treadmill exercise, heart rate, velocity, and gradient were noted every second min. During indoor cycling, heart rate, power output, and cadence were noted every second min.

Mean values were calculated across the 16 min of activity. These values were used for further analysis. Relative heart rate, reflecting exercise intensity, was calculated as the mean heart rate across the 16 min of activity divided by the estimated maximal heart rate and multiplied by 100%.

As for the enjoyment, the PACES-8 questionnaire consists of eight items and asks participants to rate how they feel at the moment about the physical activity they have been doing. Responses were indicated on a 7-point scale and included choices such as "I find it pleasurable/I find it unpleasurable". A total sum score of PACES-8 for each participant, and for each test session, was calculated.[15,16] These data were used for further analysis. The sum scores can range from 8-56, with a higher score indicating higher enjoyment. Heart rate and enjoyment were considered the main outcomes. Other data can be considered supplementary.

Statistical Analysis

The enjoyment data were analyzed using a Wilcoxon signed-rank test in SPSS 30.0 (IBM Corporation, IBM SPSS Statistics, Armonk, NY, USA). The rest of the data were evaluated with a Student's paired two-tailed t-test in Excel version 2503 (Microsoft Corporation, Bellevue, WA, USA). Effect size (Cohen's d) was calculated (as dividing the mean difference by the standard deviation of difference) to provide insights into the magnitude of observed difference. Values of 0.2, 0.5, and 0.8 were considered small, medium, and large. For supplementary evaluation of pacing strategy within the 16-min activity periods, a General Linear Model with repeated measures in SPSS 30.0 (IBM Corporation, IBM SPSS Statistics, Armonk, NY, USA) was performed. Unless otherwise indicated, results are presented as mean ± SD [95 % confidence interval], where SD represents standard deviation. $p < 0.050$ was considered statistically significant.

Results

Participant characteristics

The characteristics of the participants are reported in Table 1. Of all the participants, 17 had a preferred mode of exercise activity, when asked before any testing. Thus, thirteen participants preferred treadmill exercise while four participants preferred indoor cycling. The rest of the participants were indifferent and were therefore not included in the person-centered analysis, which took into account the participants' preference for mode of exercise activity (Table 2).

Table 1. Characteristics of the participants. n = 21. Data are presented as mean ± SD.

Age (years)	Height (m)	Body mass (kg)	BMI (kg/m^2)	Body fat (%)	Maximal heart rate[A] (beats/min)	Sex (F/M)	Physical activity (MET-min/week)
27 ± 10	1.71 ± 0.12	69.3 ± 14.1	23.5 ± 3.0	24 ± 7	189 ± 7	15/6	3489 ± 1681

Abbreviations: BMI = body mass index. F = female. M = male. MET = metabolic equivalent of task. [A]Estimated based on age.[14]

Table 2. Main results of the present study. Data are presented as mean ± SD [95% confidence interval].

	Heart rate, average (beats/min)	Heart rate, % of maximal (%)	Enjoyment (PACES-8 score, a.u.)
Primary analysis (n = 21)			
Treadmill exercise	161±14 [155, 167]	85.0±7.7[81.7, 88.4]	47.2±5.1[C] [45.0, 49.4]
Indoor cycling	156±16 [149, 163]	82.6±8.6[78.9, 86.3]	42.8±9.3 [38.8, 46.8]
Person-centered analysis (n = 17)			
The preferred mode of exercise activity[#]	164±13[A][158, 170]	87.0±6.7[B] [84.1, 89.9]	45.9±6.7[43.0, 48.7]
The other mode of exercise activity	156±19 [148, 164]	82.9±9.9[78.7, 87.2]	42.1±9.0 [38.2, 45.9]

Abbreviation: PACES = physical activity enjoyment scale. a.u. = arbitrary unit. [#]The preferred mode of exercise activity was stated before any testing took place. [A]Different from the other mode of exercise activity, p = 0.031. [B]Different from the other mode of exercise activity, p = 0.029. [C]Different from indoor cycling, p = 0.012

Time of day

There was no significant difference in time of day across the two test sessions (0.1 ± 1.5 h, p = 0.748).

Treadmill exercise

During treadmill exercise, the gradient was 1.3% ± 2.6%. Velocity was 8.6 ± 2.0 km/h. For both variables, there was no significant effect of time across the duration of treadmill exercise (p = 0.241 and p = 0.086, respectively). Regarding heart rate, there was an effect of time across the duration of treadmill exercise (p < 0.001). As an illustration of the latter, values were 139 ± 20 and 169 ± 15 beats/min after 2 and 16 min, respectively. The mean value across the duration of treadmill exercise is reported in Table 2.

Indoor cycling

During indoor cycling, power output was 144 ± 51 W. There was no significant effect of time on power output across the duration of cycling (p = 0.407). Cadence was 79 ± 10 rpm. Also, for cadence, there was no significant effect of time across the duration of cycling (p = 0.392). Regarding heart rate, there was an effect of time across the duration of cycling (p < 0.001). As an illustration of the latter, values were 142 ± 18 and 165 ± 15 beats/min after 2 and 16 min, respectively. The mean value across the duration of cycling is reported in Table 2.

Comparison of treadmill exercise and indoor cycling

Exercise intensity in terms of heart rate and heart rate as percent of maximal heart rate was not significantly different between treadmill exercise and indoor cycling (p = 0.155 and p = 0.148, respectively). Effect sizes were 0.32 and 0.33, respectively. Enjoyment, on the other hand, was 4.4 ± 7.6 units greater for treadmill exercise than for indoor cycling (p = 0.012). Effect size was 0.58 and considered medium. Absolute values are displayed in Table 2.

Comparison of the preferred and the other mode of exercise activity

The person-centered analysis, which took into account the participants' preference for mode of exercise activity, showed that exercise intensity in terms of heart rate and heart rate as percent of maximal heart rate was 6% ± 9% and 4 ± 7 percentage points higher (p = 0.031 and p = 0.029, respectively) during the preferred mode of exercise activity as compared to the other activity mode. Effect sizes were 0.61 and 0.58, respectively, and considered medium. Enjoyment tended to be 3.8 ± 8.9 units greater for the preferred mode of exercise activity, but did not quite reach statistical significance (p = 0.092). Effect size was 0.43. Absolute values are displayed in Table 2.

Discussion

The novel and most noteworthy result from the present study of healthy adults indicated the following. Exercise, which is person-centered as for preference for mode of exercise activity, can result in a higher self-selected exercise intensity as compared to exercise in another not-preferred mode of exercise activity. It follows that using a preferred mode of exercise activity during training can be presumed to be more effective for aerobic conditioning [21] and ultimately health.[22] Obviously, embedded in this presumption it is that the present short term results can be extended to a longer lasting period of training, and that the results found for the relatively small number of participants is generalizable.

Of greatest interest, the exercise intensity during the preferred mode of exercise activity in the present study (on average 87% of the maximal heart rate) was considerably higher (on average 4 percentage points) than during the other activity mode. It is presumed that exercising at a higher intensity with time will result in better physiological adaptations, including in the maximal oxygen uptake.[21]

In a previous study of 80 adults, which were divided into two groups, the self-selected exercise intensity in the form of percent of maximal heart rate was on average 84% in treadmill running and 73% in ergometer cycling.[7] In that study, the duration of the exercise was 20 min and the difference in exercise intensity was significant. In another similar study, applying a cross-over design, 18 young adults performed 20 min of treadmill running and ergometer cycling at self-selected exercise intensity.[6] In that study, the percent of maximal heart rate was on average 83% and 76% during running and cycling, respectively.[6] Again, the difference in exercise intensity between exercise modes was significant. For comparison, the self-selected exercise intensity in the present study was generally like previously published data. In particular, as for running. Though, the present study differed from the two previous studies mentioned above regarding the present finding of a non-significant difference between running and cycling. It is not possible to conclude why the above-mentioned previous studies found the exercise intensity to be highest during treadmill running when that was not found in the present study. Differences in instruction, applied cycle ergometer and treadmill, as well as population characteristics might have played a role. For example, participants in the study of Rendi et al were on average 35 years old and, thus, older than in the present study.[7] As another example, the instructions to the participants were not explained in the paper.

The pacing strategy during the exercise, in the form of magnitude of treadmill gradient, velocity, and power output, could be considered constant and thereby unlike the slightly rising or intensifying strategy that was previously observed in senior adult persons with rheumatic and musculoskeletal diseases.[10] Whether this difference in pacing strategy is due to the difference in age, health status, a combination, or something else is not possible to determine.

In the previous study by Rendi et al,[7] which is referred to above, enjoyment was not found to be different between treadmill running and ergometer cycling. This was in contrast to the present study, which showed significantly greater enjoyment during treadmill exercise than during indoor cycling. It is speculated that the observed difference between modes of exercise activity in the present study reflects that most of the participants stated that they preferred the exercise activity of treadmill exercise before the testing began. It follows that in the person-centered analysis, enjoyment might be anticipated to be greatest in the preferred mode of exercise activity. However, there was only a tendency for that. Possibly, the lack of statistical significance reflects a type 2 error due to the relatively low number of individuals in the person-centered analysis. Alternatively, it is possible that the higher self-selected exercise intensity in the preferred mode of exercise activity compromised the enjoyment scores a little. Lastly, it should be noted that enjoyment was observed to be somewhat greater in a previous study of persons participating in indoor cycling.[11] This appears to be meaningful since the participants in the study by Beck et al were recruited from a local commercial training center in which the persons regularly participated in group indoor cycling classes.[11] An activity that they had sought out themselves and paid to participate in.

The present participants were healthy adults. Regarding their level of physical activity, the participants in the present study were less active,[23] more active,[24] and comparably active [25] in comparison to similar groups of adults. Caution should be exercised if it is desired to transfer the present findings to other populations. It is possible that executing the same tests as in the present study, on different populations, will result in different results. The findings regarding pacing strategy discussed above might be an example of exactly that.

A strength of the present study is that preference for mode of exercise activity was stated by each participant before any testing was done. This enabled us to complete the person-centered analysis that is particularly relevant for the work that performed in clinics, training centers etc. Besides, the applied crossover design is a strength with regard to statistical power since it allows the use of powerful paired statistical tests. The present findings are limited to the studied population of healthy adults. In case the present research question is of interest for other populations, for example persons with certain symptoms or diagnoses, the study must be replicated with the populations of interest. Furthermore, it may be considered a limitation that the present participants cannot be described in more details, for example regarding their experience with training.

The analysis that compares treadmill exercise and indoor cycling could reflect a situation from practice where a therapist or instructor initiates a group training session with one of the two modes of exercise activity. The exercise intensity will be similar – and amounting to a mean value of about 83% to 85% of the maximal heart rate – whether it is indoor cycling or treadmill exercise that is performed. On the other hand, the person-centered analysis could reflect a

situation from practice where both treadmill exercise and indoor cycling constitute possibilities, and the instructor has a participant selecting the preferred exercise activity. In that case, the exercise intensity will be higher – amounting a mean value of about 87% of the maximal heart rate – than if the other mode of exercise activity was applied. In other words, allowing persons to use a preferred mode of exercise activity results in higher self-selected exercise intensity.

In conclusion, the present study showed that the self-selected exercise intensity following the instruction "Now you need to raise the pulse" was not significantly different between treadmill exercise and indoor cycling. Secondly, at the same time, the enjoyment was found to be significantly greater during treadmill exercise. Thirdly, a novel person-centered analysis, considering the participants' preference for mode of exercise activity (stated before testing), showed that exercise intensity was higher during the preferred mode of exercise activity than during the other mode of activity.

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The datasets presented in the present study can be found in an online repository (https://doi.org/10.6084/m9.figshare.29234030).

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