The monitoring of performance progress due to long-term physical activity by paper-based training diaries: do training diaries reflect training progress?

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The monitoring of performance progress due to long-term physical activity by paper-based training diaries: do training diaries reflect training progress?

Short title: bicycle stress test vs. training diary

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Abstract:

Introduction: Training diaries are a common tool for training monitoring, however, their correlation with the effective performance gain is unclear.

Objectives: The aim of this prospective study was to investigate whether monitoring of training by paper-based training diaries reflects the training progress in hobby athletes, as measured by bicycle stress tests.

Patients and methods: Out of 109 hobby athletes who were instructed to work out for 8 months with a calculated training pulse, 98 participants completed the study. Training workload (intensity and time) was recorded with special training diaries. In order to assess the objective performance gain/change, bicycle stress tests were performed at the beginning and the end of the study. Surrogate parameters, which are associated with increased physical activity, were also recorded.

Results: Those participants who had a performance gain of at least 3.0% (mean gain about 12%) in the bicycle stress tests, worked out between 547 and 576 minutes per month in moderate, and between 14 and 187 minutes per /month in high intensity. There was neither a
correlation concerning the duration of moderate training with performance gain nor concerning intensive training with performance gain.

Conclusion: Paper-based training diaries might serve as accompanying tool in the monitoring of a training progress. But because of the discrepancy between reported training loads and objectively measured training progress, they are not suitable to replace regular bicycle stress tests for an exact determination of a performance gain in hobby athletes. Probably new devices such as fitness trackers/watches present better alternatives.

Key words: bicycle stress test, performance, physical activity, sports, training diary

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Introduction:

Because of its beneficial effect on cardiovascular risk factors it is incontestable that physical activity is a mainstay in primary, secondary but also tertiary prevention of cardiovascular disease (CVD) [1, 2]. CVD-risk factors lead to an increased inflammation status and therefore promote vascular calcification. Regular training has a positive impact by ameliorating the lipid and glucose profile, decreasing blood pressure and facilitating weight loss, and subsequently reduces inflammation [3, 4]. Furthermore, it increases the thrombolytic activity and decreases platelet aggregation [5].

In contrast to medication-based therapy, it is often difficult to ensure patients’ adherence to physical activity. Training diaries might increase this adherence [6]. Furthermore, physical activity as therapy is much more difficult to “dose”. The European Society of Cardiology proposes a minimum of 75 min/week of high or 150 min/week of moderate intensity training in healthy subjects. Similarly, The American Diabetes Association recommends 150 min. or more of moderate to high intensity activity per week over at least 3 days per week with no more than 2 consecutive days without activity [7]. A modern patient care, in particular concerning patients with cardiovascular risk factors and/or cardiovascular disease, depends on the motivation to be physically active and the observation of the patient’s activity status. Training diaries are cheap, simple to use and a common method to monitor the training effort. However, there is only few data showing whether monitoring with training diaries really leads to an improvement of the performance.

The aim of this prospective study was to investigate whether the monitoring of training by paper-based training diaries reflects the training progress in hobby athletes, as measured by bicycle stress tests.
Patients and methods:

Study population:

In total 109 participants were recruited with the following inclusion criteria: age 30-65 years, the physical ability to perform a bicycle stress test and endurance training, and at least one classical cardiovascular risk factor defined as follows: overweight or obesity (body mass index - BMI > 25.0 kg/m^2), hypertension (systolic blood pressure - SBP > 140 +/- diastolic blood pressure - DBP > 85 mmHg at rest / antihypertensive medication), hyper/dyslipidaemia (anamnestic therapy with statins), diabetes mellitus (HbA1c > 6.5 rel% / antidiabetic medication), current smoking, known chronic heart disease - CHD (anamnestic myocardial infarction - MI, percutaneous coronary intervention - PCI, coronary artery bypass graft - CABG, stroke) and a positive family history for MI/CVD/stroke of mother and/or father. Exclusion criteria were: current infectious and/or oncologic disease (anamnestic or increased baseline inflammation parameters). Out of 109 participants, 11 subjects did not complete the study for different reasons. Thus, 98 subjects completed the study.

The study was carried out in adherence to the Declaration of Helsinki and its later amendments. The protocol has been approved by the Ethical Committee of the Medical University of Vienna (EC-number: 1830/2013), and informed consent was obtained from all participants before inclusion.

Measurement of anthropometric data and laboratory analysis:

Anamnesis and physical examination including anthropometric data (height, weight, body water/muscle mass/fat with a diagnostic scale, as measured by Beurer BG 16, Beurer GmbH, Ulm, Germany) were performed at the beginning of the study. Concerning nutrition, the subjects were requested not to change their eating habits. Blood samples were drawn in a not
starving state at baseline, after 2, 4, 6 and 8 months, however, only the baseline and final values are presented. All blood samples were taken after 10 minutes from an arm vein with a tube/adapter system and analysed immediately after drawing.

*Bicycle stress test:*

In course of the first meeting, the participants had to do a bicycle stress test to define the individual performance level objectively and to calculate an individual training pulse/target heart rate (using the Karvonen formula with an intensity level of 65-75% for moderate and 76-93% for high intensity [8]).

The bicycle stress tests were always performed with the same system (Ergometer eBike comfort, GE Medical Systems, Freiburg, Germany), and protocol was started with a resistance of 25 W and increasing the resistance every 2 minutes by 25 W (according to the protocol of the Austrian Society of Cardiology which is equal to the guidelines of the European Society of Cardiology). Systolic and diastolic blood pressure and heart rate were taken every 2 minutes, while the subjects were permanently ECG-monitored. Participants were told to perform 50-70 cycles/min until exhaustion. The target performance was calculated using sex, age and body surface (calculated according to DuBois formula: body surface (m$^2$) = 0.007184 x height [cm]$^{0.725}$ x weight [kg]$^{0.425}$) [9]. An individual target performance of 100% represents the performance level of an untrained collective. For that reason we first divided the participants in initially unathletic and initially athletic ones.

The participants decided themselves the kind of activity/sports, however, they were asked to do sports for at least 75 minutes per week of high or 150 minutes per week of moderate intensity (or a mixture; strength training was also allowed, but not mandatory) within the previously calculated training pulse. A second bicycle stress test was done after 8 months of
training at the end of the study, in order to prove and quantify exactly and objectively the performance change/gain. Based on the results of the bicycle stress test, the population was divided into the following groups dependent on the initial performance level and the performance gain over 8 months of training to receive comparable data:

- Group 1: initially unathletic (initial performance < 100%), performance gain ≤ 2.9% (n=9)
- Group 2: initially unathletic (initial performance < 100%), performance gain ≥ 3% (n=32)
- Group 3: initially athletic (initial performance ≥ 100%), performance gain ≤ 2.9% (n=18)
- Group 4: initially athletic (initial performance ≥ 100%), performance gain ≥ 3% (n=39)

**Training diaries:**

The subjects obtained paper-based training diaries to record their training effort during the study period. The participants were asked to fill in the minutes of moderate an intensive physical activity of each training session. Moderate intensity was defined as: quick walking, Nordic walking, slow cycling or swimming, (inline) skating or hiking. High intensity was defined as: playing soccer/tennis/basketball, quick cycling or swimming, paddling or jogging/running. Every two months they obtained a new training diary. The analysis is a post-hoc retrospective analysis of prospectively collected data.

**Statistical analysis**
Statistical analysis was accomplished using SPSS 20.0. Figure 1 was created using Excel 2010. Continuous and normally distributed data is described by mean (standard deviation), not normally distributed data is given as median/first quartile/third quartile. For investigating the correlation of the performance gain and the workload we used Spearman Correlation. Furthermore, a linear regression analysis was done to investigate training-specific data as potential predictors for the performance gain. To analyse the change in baseline and ending levels, a paired sample t-test was used. All tests were performed in accordance with two-sided testing and \( p \) values \( \leq 0.05 \) were considered significant.

**Results:**

Out of 98 participants, 27 did not achieve a performance gain of more than 2.9% (group 1+3), the remaining subjects (group 2+4) showed a performance gain of at least 3%. The baseline data of the 4 groups concerning anthropometric and laboratory data as well as the cardiovascular risk profile are shown in *Table 1*. The most frequent risk factors were overweight and a positive family history. Concerning smoking, the prevalence of current smokers was much higher in the initially unathletic participants compared to the athletic ones. Regarding age and laboratory parameters, there were no relevant differences.

*Table 2* shows the self-recorded duration (in minutes) of moderate and high intensity training over the observation period according to the records of the training diaries. *Figure 1* shows the median amount of minutes per month of moderate (darker bar) and high intensity training (brighter bar) of the four groups. Group 1 und 4 recorded the highest amount of minutes in moderate intensity (766 and 576 min/month, respectively) followed by group 3 and 2 (558 and 547 min/month, respectively). However, the difference between group 2, 3 and 4 was
marginal, concerning the moderate intensity training amount. Regarding high intensity training, the initially athletic groups (3+4) showed a much higher median amount of minutes/month (211 and 187 min/month, respectively) compared to the initially unathletic groups 1+2 (0 and 14 min/month, respectively). None of the groups had an amount of >75 min/week. The performance gain was 0.4% in group 1, 12.2% in group 2, -3.8% in group 3 and 12.2% in group 4. There was no significantly positive correlation of the performance gain with the total minutes of moderate or intensive training or the minutes per month of moderate or intensive training (P-values for group 2: total minutes moderate training: 0.69/ total minutes of intensive training: 0.16/ minutes per month moderate training: 0.69/ minutes per month intensive training: 0.16; P-values for group 4: total minutes moderate training: 0.28/ total minutes of intensive training: 0.05/ minutes per month moderate training: 0.28/ minutes per month intensive training: 0.05). However, the correlation of the performance gain and the total duration of intensive training as well as the monthly duration of intensive training were very close to statistical significance in group 4. To further analyse these results a linear regression analysis was done to investigate whether training-specific data are predictors for the performance gain. We obtained only a trend concerning the correlation of the performance gain and the monthly minutes of intensive training in group 4 (p=0.05) with a regression coefficient of 0.01.

Apart from the performance gain measured by bicycle stress test, we measured anthropometric and laboratory surrogate parameters (which are associated with increased physical activity) at the end of the observation period and p-value of the change (Table 3). At baseline, the initially athletic groups 3+4 had a lower BMI, body fat and LDL cholesterol levels but higher body water, body muscle mass and HDL cholesterol levels compared to group 1+2. In those groups that did not achieve a performance gain ≤ 2.9% (group 1+3), we stated a not significant change in surrogate parameters. Concerning the groups that achieved a performance gain of at least 3.0% (group 2+4), we measured significant changes in body
water and body fat. Group 2 even showed significant changes in HDL cholesterol \((P=0.04)\) and diastolic blood pressure \((P=0.01)\).

**Discussion:**

Physical activity is one of the most important preventive interventions in modern medicine, not only in secondary and tertiary, but also in primary prevention. However, as it is the case with all interventions and medications, the appropriate dose is often difficult to quantify, whereas the verification of the effect of the intervention, in this case physical activity, is essential. A further important point is how an effect is achieved. Concerning drug-based interventions, this aspect is mostly conditioned by the agent and dose of a drug; concerning physical activity, it mainly depends on training frequency and load. The most objective and exact way of measuring a performance gain is by (bicycle) stress test. However, paper-based training diaries might present a cheap and simple alternative for monitoring of training in hobby athletes, whose training monitoring differs significantly from that of professional athletes [10]. Therefore, we investigated whether training diaries are able to reflect the training progress in hobby athletes.

Our results show that there is a significant discrepancy between the reported workload and the objectively measured performance gain. The initially unathletic group 1 reported the highest amount of monthly training minutes in moderate intensity (766 minutes), but had a performance gain of only 0.4%. In contrast, the initially unathletic group 2 with a performance gain of about 12% reported “only” 547 minutes of moderate training per month. Comparably, the initially athletic group 3 reported an only marginally lower workload (558 min/month) of moderate intensity training and a higher workload (211 min/month) concerning high intensity training compared to group 4 (576 min/month of moderate and 187 min/month
of high intensity training). There was no correlation of workload with performance gain, however, it should be mentioned that in group 4 the correlation between reported minutes/month of high intensity training and performance gain was almost significant but with a very weak regression coefficient. It should also be mentioned that the performance in group 3 even decreased in course of the study by 3.8% (although they reported the highest amount of high intensity training), supporting our thesis.

Concerning the surrogate parameters, we obtained very conclusive data: initially athletic participants had a lower BMI, body fat and LDL-cholesterol and higher HDL-cholesterol levels compared to initially unathletic subjects. The performance gain was associated with decreasing body fat and body water. In the initially unathletic group 2 with a performance gain of about 12%, we even found significantly increasing HDL-cholesterol levels and a lower diastolic blood pressure. The beneficial effect of regular physical activity on these surrogates has already been described, inter alia, by our group [11, 12].

Our data show that the self-reported moderate training load does not correlate with the objectively measured performance gain. The discrepancy between reported training load and performance gain comes to light apparently in unathletic individuals. It is a basic principle in training theory that a specific, individual training stimulus has to be reached to achieve a performance gain. Probably, those individuals who reported a high number of minutes at moderate intensity did not reach a sufficiently high intensity to achieve a performance gain. However, it seems that in general, intensive training contributes more to performance gain compared to moderate intensity. These results might be of interest for e.g. patients in cardiac rehabilitation (who are generally unathletic). For patients in a rehabilitation program, an initial bicycle stress test, a consecutive ability streaming and a personalized workout plan (based on the calculated training pulse) seems to be medically sensible.
It should be mentioned that those participants who did not reach a performance gain also showed an improvement in some surrogate parameters: Group 1 and 3 showed a decrease of body fat and diastolic blood pressure and an increase in HDL-cholesterol. Although these changes were statistically not significant, they might be of clinical relevance.

Of course there exist other questionnaires trying to evaluate the physical activity level of individuals. Examples for very popular tools are the International Physical Activity Questionnaire (IPAQ) and the Baecke questionnaire. These tools also gathers data concerning the activity level at work, while doing housework or while using means of transportation [13, 14]. However, several studies showed that the level of physical activity might be overestimated/over reported by the subjects concerning the IPAQ [15].

In general, the mentioned questionnaires might serve as tool delivering a vague overview concerning the physical fitness status [16, 17], but studies comparing them to objective means of performance diagnostics, such as bicycle or treadmill stress test, are very rare.

As a future perspective it should be mentioned that modern devices such as smart phones/watches with adequate apps could immensely improve the recording of training-specific data. Modern devices are able to exactly chart heart rate, heart rate variability, speed, distances per GPS and much more and might therefore conduce to monitor the training progress of hobby athletes. In this connection it should be mentioned that also videogames and virtual reality could be used as complementary tools for patients in cardiovascular rehabilitation [18]. However, as it is the case with every new technology, only a few brands are frequently used in research-based studies [19] and very few are scientifically validated [20]. A potential way to become those devices established might be in the field of cardiovascular rehabilitation, offering on the one hand the opportunity for guarded and controlled training and on the other handy for testing new devices and apps using scientifically established methods.
Limitations:

The study has several limitations: First, there is not enough data available for a well-founded sex-specific analysis. Second, the categories of the training diaries (moderate and high intensity) may be suitable for hobby athletes, but as they are arbitrary, an exact definition of the training load of a specific form of sport is vague. Although bicycle stress tests are standard in performance testing, they are just a glimpse on the performance of an individual, which might be influenced by several (uncontrolled) circumstances. However, we did not perform an echocardiography or 24h-ECG. Furthermore, the recording of duration and intensity training was done by the participants and was not controlled. Finally, there was a significant difference concerning the baseline performance of group 3 and 4; as group 4 had a lower baseline performance, it was easier for these participants to achieve a performance gain.

Conclusion:

Paper-based training diaries might serve as accompanying tool in the monitoring of a training progress. But because of the discrepancy between reported training loads and durations respectively, and the objectively measured training progress, they are not suitable to replace regular bicycle stress tests for an exact determination of a performance gain.
|                      | Group 1 unathletic gain≤2.9% n=9 | Group 2 unathletic gain≥3% n=32 | Group 3 athletic gain≤2.9% n=18 | Group 4 athletic gain≥3% n=39 |
|----------------------|---------------------------------|---------------------------------|---------------------------------|------------------------------|
| Female, %            | 44.4                            | 53.1                            | 61.1                            | 71.8                         |
| Age, years           | 50.3 (6.1)                      | 48.6 (7.9)                      | 50.4 (6.5)                      | 49.1 (6.1)                   |
| Weekly alcohol intake, units/week | 0/0/2                       | 2/0/4                           | 2/0/7                           | 2/1/4                        |
| Smoking, %           |                                 |                                 |                                 |                              |
| - never              | 22.2                            | 31.1                            | 27.8                            | 48.7                         |
| - ex                 | 22.2                            | 43.8                            | 55.6                            | 41.0                         |
| - current            | 55.6                            | 25.0                            | 16.7                            | 10.3                         |
| T2DM, %              | 11.1                            | 3.1                             | 5.6                             | 0                            |
| Hypertension, %      | 33.3                            | 43.8                            | 33.3                            | 23.1                         |
| Dyslipidaemia, %     | 33.3                            | 25.0                            | 38.9                            | 28.2                         |
| Weight, %            |                                 |                                 |                                 |                              |
| - BMI 25.0-29.9      | 44.4                            | 34.4                            | 50.0                            | 50.0                         |
| - BMI ≥30.0          | 22.2                            | 43.4                            | 16.7                            | 13.3                         |
| Positive family history, % | 66.7                        | 43.8                            | 50.0                            | 38.5                         |
| Erythrocytes, T/l    | 4.6 (0.4)                       | 4.8 (0.5)                       | 4.6 (0.4)                       | 4.7 (0.4)                    |
| Haemoglobin, g/dl    | 13.3 (1.5)                      | 14.2 (1.5)                      | 13.8 (1.0)                      | 14.2 (1.2)                   |
| Thrombocytes, G/l    | 257 (53)                        | 239 (61)                        | 256 (59)                        | 246 (41)                     |
| Leukocytes, G/l      | 7.5 (1.8)                       | 6.7 (1.8)                       | 6.5 (2.0)                       | 6.2 (1.2)                    |
| Creatinine, mg/dl    | 0.8 (0.1)                       | 0.8 (0.2)                       | 0.9 (0.2)                       | 0.9 (0.2)                    |
| Cholinesterase, kU/l | 8.1 (1.3)                       | 8.4 (1.7)                       | 8.2 (1.7)                       | 8.1 (1.7)                    |
| Gamma-GT, U/l        | 18/11/43                        | 23/14/37                        | 19/16/24                        | 21/13/34                     |
| Triglycerides, mg/dl | 135/109/184                     | 124/87/175                      | 88/65/130                       | 109/68/151                   |

Table 1: baseline data of the 4 cohorts concerning anthropometric and laboratory data as well as the cardiovascular risk profile. Concerning cardiovascular risk factors data is given as % of the cohort, normally distributed data is given as mean (std.dev), not normally distributed data is given as median/first quartile/third quartile. T2DM: type 2 diabetes mellitus; BMI: body mass index, kg/m²; gamma-GT: gamma glutamyl transferase
Table 2:

|                | Group 1 unathletic gain ≤ 2.9% | Group 2 unathletic gain ≥ 3% | Group 3 athletic gain ≤ 2.9% | Group 4 athletic gain ≥ 3% |
|----------------|-------------------------------|-------------------------------|-------------------------------|----------------------------|
|                | n=9                           | n=32                          | n=18                          | n=39                        |
| **Moderate Intensity** |                               |                               |                               |                            |
| Month 1+2      | 1910/676/2540                 | 949/581/1322                  | 868/492/1466                  | 1000/671/1449               |
| Month 3+4      | 1087/786/2820                 | 1085/675/1455                 | 892/540/1823                  | 1030/446/1560               |
| Month 5+6      | 1230/345/1819                 | 1087/675/1740                 | 1100/614/2191                 | 1205/730/1628               |
| Month 7+8      | 1800/810/2710                 | 888/550/1316                  | 1283/489/2693                 | 1208/701/1785               |
| Total minutes  | 6130/3710/9860                | 4373/3186/5984                | 4465/2618/7155                | 4605/2985/5656              |
| Minutes/month  | 766/464/1233                  | 547/398/748                   | 558/327/894                   | 576/373/707                 |
| **High Intensity** |                               |                               |                               |                            |
| Month 1+2      | 0/0/53                        | 83/0/430                      | 369/54/638                    | 377/0/829                   |
| Month 3+4      | 0/0/214                       | 0/0/181                       | 438/208/675                   | 433/0/718                   |
| Month 5+6      | 0/0/45                        | 0/0/189                       | 355/150/555                   | 296/0/679                   |
| Month 7+8      | 0/0/0                         | 0/0/195                       | 273/131/720                   | 305/0/563                   |
| Total minutes  | 0/0/345                       | 113/0/1218                    | 1688/715/2461                 | 374/0/673                   |
| Minutes/month  | 0/0/43                        | 14/0/152                      | 211/89/308                    | 187/0/337                   |

Table 2: self-recorded minutes of moderate and high intensity training over the observation period. Data is given as median/first quartile/third quartile.
Table 3: Anthropometric and laboratory surrogate parameters at baseline, at the end of the observation period. Performance (performance tested by bicycle stress test in %); BMI – body mass index (kg/m²); body water (%); body fat (%); body muscle mass (%); LDL – low density lipoprotein cholesterol (mg/dl); HDL – high density lipoprotein cholesterol (mg/dl); SBP – systolic blood pressure (mmHg); DBP – diastolic blood pressure (mmHg).

|                      | Group 1 unathletic gain≤2.9% n=9 | Group 2 unathletic gain≥3% n=32 | Group 3 athletic gain≤2.9% n=18 | Group 4 athletic gain≥3% n=39 |
|----------------------|-----------------------------------|----------------------------------|---------------------------------|-------------------------------|
| performance baseline | 87.4 (9.9)                        | 88.8 (7.1)                       | 122.0 (16.8)                    | 116.0 (15.9)                  |
| performance end      | 87.0 (9.1)                        | 101.0 (10.0)                     | 118.2 (18.0)                    | 128.2 (15.6)                  |
| P for performance change | **0.90**                         | *<0.01*                         | *<0.01*                        | *<0.01*                      |
| BMI baseline         | 27.8 (4.2)                        | 28.5 (5.2)                       | 27.2 (3.7)                      | 26.8 (3.3)                    |
| BMI end              | 27.7 (4.6)                        | 28.1 (4.8)                       | 27.3 (4.1)                      | 26.7 (3.2)                    |
| P for BMI change     | **0.87**                          | **0.18**                         | **0.42**                        | **0.32**                      |
| body water baseline  | 48.6 (2.4)                        | 50.3 (4.9)                       | 53.2 (6.4)                      | 54.2 (5.9)                    |
| body water end       | 50.4 (4.5)                        | 52.1 (5.4)                       | 53.9 (6.1)                      | 56.3 (6.2)                    |
| P for body water change | **0.14**                        | *<0.01*                         | **0.40**                        | *<0.01*                      |
| body fat baseline    | 33.9 (3.3)                        | 31.6 (6.7)                       | 27.7 (8.7)                      | 27.8 (11.8)                   |
| body fat end         | 31.5 (6.1)                        | 29.7 (7.3)                       | 26.7 (8.3)                      | 23.4 (8.4)                    |
| P for body fat change | **0.15**                         | **0.01**                         | **0.40**                        | **0.01**                      |
| body muscle baseline | 32.4 (3.3)                        | 33.9 (4.1)                       | 34.4 (3.9)                      | 36.1 (4.0)                    |
| body muscle end      | 32.2 (3.7)                        | 34.3 (4.4)                       | 34.4 (3.9)                      | 36.2 (3.9)                    |
| P for body muscle change | **0.48**                         | **0.20**                         | **0.90**                        | **0.35**                      |
| LDL baseline         | 126 (50)                          | 117 (32)                         | 112 (29)                        | 116 (35)                      |
| LDL end              | 129 (43)                          | 111 (31)                         | 112 (26)                        | 110 (33)                      |
| P for LDL change     | **0.67**                          | **0.18**                         | **0.87**                        | **0.07**                      |
| HDL baseline         | 52 (19)                           | 56 (22)                          | 62 (12)                         | 60 (15)                       |
| HDL end              | 55 (20)                           | 59 (20)                          | 66 (14)                         | 63 (17)                       |
| P for HDL change     | **0.13**                          | **0.04**                         | **0.15**                        | **0.17**                      |
| SBP baseline         | 130 (9)                           | 133 (9)                          | 132 (15)                        | 131 (12)                      |
| SBP end              | 131 (10)                          | 132 (10)                         | 130 (5)                         | 130 (11)                      |
| P for SBP change     | **0.88**                          | **0.68**                         | **0.49**                        | **0.65**                      |
| DBP baseline         | 80 (10)                           | 79 (8)                           | 80 (9)                          | 77 (7)                        |
| DBP end              | 77 (7)                            | 74 (7)                           | 76 (10)                         | 75 (7)                        |
| P for DBP change     | **0.25**                          | *<0.01*                         | **0.12**                        | **0.29**                      |
Table 4: Advantages and disadvantages of training diaries and bicycle stress test to monitor performance changes due to long-term physical activity

| Table 4          | Training diary                                                                 | Bicycle stress test                                                                 |
|------------------|--------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| Advantages       | - cheap                                                                         | - gold standard in performance diagnostics                                         |
|                  | - easy to perform                                                               | - standardised methods/procedure                                                    |
|                  | - potentially improving compliance                                               | - good comparability                                                                |
|                  | - continuous/close-meshed follow-up                                             | - delivers exact metric values                                                      |
|                  |                                                                                 | - good availability                                                                 |
| Disadvantages    | - extremely subjectively vague/difficult grading of training intensity          | - comparatively costly                                                              |
|                  | - no consistent form/mode                                                        | - elaborately                                                                      |
|                  |                                                                                 | - dependent on condition on particular day                                          |
|                  |                                                                                 | - potential advantage for skilful cyclists                                           |
Figure 1: Median amount of minutes per month of moderate (darker bar) and high intensity training (brighter bar) of the four groups and the performance gain measured by bicycle stress test. Data concerning the training amount is given as median/first quartile/third quartile.
Author contribution:

Schukro: performing stress test, manuscript preparation

Emich: manuscript preparation, statistical analysis, study design

Fritzer-Szekeres: lab analysis

Strametz-Juranek: manuscript preparation, statistical analysis, study design

Sponder: study design, clinical management, stress tests, statistical analysis, manuscript preparation

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