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Autonomic and Haemodynamic Adaptation to Aerobic Versus Statodynamic Exercise in Previously Untrained Young Adults: A Randomized Controlled Trial

Ivan Bocharin[1], Elena Romanova[2], Asylbek Eshiev[3], Yurii Vyazovichenko[4], Konstantin Kanatev[5], Maria Kadysheva[1]

AFFILIATIONS

[1]Privolzhsky Research Medical University, Nizhny Novgorod, Russia
[2]Altai State University, Barnaul, Russia
[3]Osh State University, Osh, Kyrgyzstan
[4]I.M. Sechenov First Moscow State Medical University (Sechenov University), Moscow, Russia
[5]National Research Lobachevsky State University of Nizhny Novgorod, Nizhny Novgorod, Russia

CORRESPONDENCE

I. Bocharin, Privolzhsky Research Medical Univeristy, Department of Physical Culture and Sport , Minin and Pozharsky Square 10/1, 603000 Nizhny Novgorod, Russia, *bocharin.ivan@mail.ru*

Abstract

The effect of various modes of muscular activity on the autonomic regulation of the cardiovascular system in previously untrained young people has not been sufficiently studied, and direct comparisons of aerobic and predominantly static loads of similar duration are few. We compared changes in heart rate variability (HRV), central haemodynamics, and cardiovascular response types to a standardised exercise test after ten-week aerobic cyclic and statodynamic exercise programmes. The randomized controlled trial included 58 apparently healthy individuals aged 20-30 years, allocated using gender-stratified randomization into the group of aerobic cyclic loads (n=29) and the group of statodynamic loads involving large muscle groups with a limited heart rate of 120-130 beats per minute (n=29). The duration of the intervention was 10 weeks (3 sessions per week). In the group of aerobic loads, there was an increase in RMSSD, SDNN, pNN50 and the power of the high-frequency component, a decrease in the LF/HF ratio, the stress index of regulatory systems and total peripheral vascular resistance, as well as an increase in the proportion of normotonic reactions to a functional test. There were no comparable changes in HRV parameters in the group of statodynamic loads. In previously untrained young people, ten-week aerobic cyclic loads are accompanied by a more pronounced favourable autonomic and haemodynamic adaptation than statodynamic loads involving large muscle groups. The data obtained are preliminary and require confirmation in studies with a large sample size.

Keywords: *heart rate variability, aerobic exercise, statodynamic exercise, autonomic nervous system, haemodynamics, muscular metaboreflex*

Introduction

Insufficient motor activity remains one of the leading modifiable risk factors for cardiovascular diseases, with unfavourable autonomic shifts appearing long before clinical manifestations. Even in apparently healthy young people, physical inactivity lowers heart rate variability (HRV), shifts the autonomic balance towards sympathetic predominance, and reduces cardiovascular efficiency. At the same time, the indicators of central haemodynamics differ markedly in individuals with different levels of motor activity (Bocharin et al., 2022). Identifying exercise regimes that best improve autonomic regulation and central haemodynamics thus remains relevant for preventive medicine and recreational physical education.

The beneficial effect of regular moderate-intensity aerobic exercise on the autonomic regulation of heart rhythm has now been well documented. Systematic endurance training increases vagal modulation, raises time-domain (RMSSD, SDNN, pNN50) and high-frequency (HF) HRV parameters, and lowers resting heart rate. According to a modern network meta-analysis covering aerobic, strength, combined, and high-intensity interval training programs, different modalities of physical activity have different effects on HRV in adults, which underscores the need for a differentiated assessment of specific training regimens (Yang et al., 2024).

The effect of predominantly power and static loads on autonomic regulation remains less certain. A number of studies and meta-analyses in recent years have shown that isometric training can reduce blood pressure and favourably affect autonomic balance, comparable to aerobic exercise (Baffour-Awuah et al., 2023; Edwards et al., 2024; Kotwal et al., 2022). At the same time, acute physiological studies show that the autonomic control of heart rate during static and dynamic work differs qualitatively even at comparable heart rates, and the pressor response during static is associated with activation of muscle metaboreflex and an increase in peripheral vascular resistance (Weippert et al., 2013); at the same time, the nature of the autonomic response to isometric work may depend on the initial cardiovascular reactivity (Rodríguez et al., 2019). Importantly, these data are heterogeneous, obtained mainly in acute experiments and in protocols with isolated small muscle groups (isometric handgrip, wall squat) at low load, whereas regimes involving large muscle masses have been studied far less. Direct comparisons of aerobic and strength regimes in HRV indicators are few and do not always agree with each other (De Paula et al., 2019; Ortiz Guzmán et al., 2012). In some studies, prolonged strength training is associated with improved parasympathetic modulation (Barbosa et al., 2025), which further highlights the ambiguity of the available data.

Moreover, aerobic and strength training are usually studied in isolation; their direct comparison at matched duration, frequency, and external intensity is rare, especially in apparently healthy untrained young people – the population for which mass wellness programmes are designed. In students, unfavourable autonomic shifts (higher LF/HF, lower pNN50, higher total peripheral vascular resistance) may develop already over the course of study (Martusevich et al., 2021), making it difficult to separate changes due to the specific muscular work from those due merely to increased overall activity.

To address this gap, unlike most static-load studies based on low-volume isometric protocols for small muscle groups, we used a set of statodynamic exercises involving large muscle arrays with controlled limitation of heart rate (120-130 beats/min), which allowed minimising the aerobic component of the load while maintaining the frequency and duration of exercises equivalent to the aerobic group. The aim of the study was to conduct a comparative assessment of changes in heart rate variability, central haemodynamics, and types of cardiovascular system response to a standardized exercise test after ten-week programs of aerobic cyclic and statodynamic exercise in apparently healthy young people.

Methods

Research design

The study was performed as a randomized controlled trial with two parallel groups and a prospective design. Participants were allocated by simple gender-stratified randomisation using sealed opaque envelopes; the allocation sequence was prepared before recruitment. Assessors were not blinded during recording and processing of functional data. Reporting followed the CONSORT recommendations.

Participants

The study included 58 apparently healthy volunteers aged 20–30 years without systematic physical training during the previous 12 months; all were in health group I by medical examination.

Inclusion criteria: age 20–30 years; no chronic cardiovascular, respiratory, or endocrine disease; no regular physical training; written informed consent. Exclusion criteria: smoking; body mass index of more than 30 kg/m2; arterial hypertension (blood pressure ≥140/90 mmHg); taking medications that affect the cardiovascular system or autonomic regulation; contraindications to moderate-intensity physical exertion.

Participants were divided into two groups of 29: an aerobic cyclic training group and a statodynamic exercise group. At baseline, the groups did not differ significantly in age, anthropometric, or basic functional characteristics.

Ethics

The study was conducted in accordance with the ethical principles of the Helsinki Declaration regarding research involving humans and was reviewed and approved by the institution's local ethics committee (Privolzhsky Research Medical University, protocol No. 7, dated 3 July 2026). All participants received detailed information and provided written informed consent before inclusion. Participation was voluntary, with the right to withdraw at any stage without consequences. Personal data was depersonalised before statistical processing and analysis.

Training programs

The programme lasted 10 weeks, with sessions three times a week of about 40 minutes each.

The aerobic exercise group performed cyclic loads (running on a treadmill or cycling) with an intensity of 65-75% of the heart rate reserve calculated according to the Karvonen formula (Karvonen et al., 1957); heart rate monitoring was carried out by individual heart rate monitors.

The statodynamic group performed predominantly static exercises involving large muscle groups, using body weight and elastic resistance bands (plank, static lunges, "chair" hold, rubber-band exercises, etc.). The intensity was adjusted according to the Borg scale of perceived tension (about 17 points; Borg, 1973), while the heart rate during exercise was maintained in the range of 120-130 beats/min. The protocol was designed to minimise the aerobic component of exercise and to evaluate primarily the contribution of static muscle tension.

Functional examination

Examinations were performed twice – before (T0) and after the 10-week course (T1) – in the morning, under standard laboratory conditions, after at least 10 minutes of rest.

HRV was recorded using the Varikard 2.51 software and hardware complex (Russia) based on five-minute electrocardiogram recordings at rest; this methodological approach to HRV assessment was previously used by us in studies of the functional state of the cardiovascular system (Bocharin et al., 2021). Temporal parameters (SDNN, RMSSD, pNN50) and spectral characteristics (TP, HF, LF, LF/HF ratio) were calculated in accordance with the recommendations of the Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology (1996). Additionally, Baevsky's stress index (SI) of the regulatory systems was calculated (Baevsky et al., 2002).

Blood pressure was measured by the auscultation method with the calculation of the Kerdo vegetative index (Vagin et al., 2021) according to the formula: $IR=(1−DBP/HR)\times100$, where DBP is diastolic blood pressure (mmHg), HR is heart rate (beats/min).

The central haemodynamics parameters were calculated according to generally accepted formulas. Stroke volume (SV, ml) was determined by the Starr formula: $SV=90.97+0.54\times PP−0.57\times DBP−0.61\times A$, where PP is pulse pressure (mmHg), DBP is diastolic blood pressure (mmHg), and A is age (years). The cardiac output (CO, l/min) was calculated as the product of stroke volume and heart rate: $CO=SV\times HR/1000$. The cardiac index (CI, l/min/m2) was calculated as the ratio of the cardiac output to the body surface area: $CI=CO/BSA$, where the body surface area (BSA, m2) was determined by the Dubois formula. Total peripheral vascular resistance (TPVR, dyn·s·cm^{-5}) was calculated using the formula: $TPVR=79.9\times MAP/CO$, where MAP is the average arterial pressure (mmHg), calculated as $MAP=DBP+PP/3$.

The functional state of the cardiovascular system was assessed using a standardized functional test with 20 squats in 30 seconds (the Martinet-Kushelevsky test), a common test of the reactivity of the cardiovascular system to a dosed dynamic load in Russian functional diagnostics (Karpman et al., 1988). Heart rate and blood pressure were recorded at rest, immediately after exercise, and during the recovery period (up to 3-5 minutes). By the nature and magnitude of the shifts in heart rate and blood pressure, as well as by the time of their recovery, the type of reaction of the cardiovascular system was determined: normotonic (moderate increase in heart rate and systolic pressure with constant or slightly reduced diastolic pressure, recovery within 3 minutes); hypertensive (excessive increase in systolic and/or diastolic pressure, delayed recovery); dystonic (a sharp decrease in diastolic pressure, up to the "infinite tone" phenomenon"); asthenic / hypotonic (slight increase in systolic pressure with a marked increase in heart rate); step-wise (stepwise rise in systolic pressure in the first minutes of recovery). The normotonic type is considered the most favourable.

Statistical analysis

Statistical processing was performed in the Statistica 10.0 package (StatSoft, USA). The normality of the distribution of quantitative variables was assessed using the Shapiro–Wilk criterion (Shapiro & Wilk, 1965). The quantitative data are presented as the mean ± standard deviation (M±SD). Categorical data is presented in the form of absolute frequencies and fractions (%).

Baseline comparability of quantitative indicators (T0) was assessed using the independent Student's t-test or, for non-normal data, the Mann–Whitney U-test. Gender differences at the initial stage were assessed using Pearson's $\chi 2$ criterion. The dynamics of quantitative indicators within each group (T0 versus T1) was assessed using the paired Student's t-test or the Wilcoxon test for related samples, depending on the nature of the distribution. The intergroup comparison of indicators at stages T0 and T1 was carried out using the independent Student's t-test or the Mann-Whitney U–test. The distribution of reaction types to a functional test is presented descriptively (absolute frequencies and fractions). The differences were considered statistically significant at a two-way level of $p<0.05$. A mixed-design group × time repeated-measures ANOVA was not applied; instead, within-group (T0 vs T1) dynamics and baseline/endpoint between-group comparisons were used, as these directly address the study questions in this pilot trial. The rationale and implications of this choice are considered in the limitations. Standardised effect sizes (Cohen's d) for within-group changes were calculated from the reported means and standard deviations, with the averaged standard deviation used as the standardiser (Cumming, 2012); values of 0.2, 0.5, and 0.8 were interpreted as small, medium, and large, respectively.

No formal calculation of the sample size was carried out a priori; the study was in the nature of a pilot comparative intervention, which is reflected in the limitations section.

Results

All 58 participants completed the full ten-week programme with no dropouts, attending at least 90% of the prescribed sessions. Baseline anthropometric, haemodynamic, and HRV parameters did not differ significantly between groups (Table 1), indicating comparability before the intervention.

Mean age was about 24 years and body mass index was within the physiological norm. Baseline heart rate, blood pressure, cardiac index, total peripheral vascular resistance, and HRV characteristics matched data reported earlier for apparently healthy untrained young people (Spitsin et al., 2020). In both groups, RMSSD, pNN50, and HF were typical of individuals with relatively low motor activity, the LF/HF ratio approached 2.0, and the stress index exceeded 110 conv. units, suggesting a moderate resting sympathetic predominance.

Table 1. Initial characteristics of the groups (M±SD)

Variable	Aerobic group (n=29)	Statodynamic group (n=29)	p
Age, years	23.8±2.9	24.1±3.0	>0.05
Gender (male/female)	14/15	14/15	>0.05
Body height, cm	177.0±6.1	178.0±6.3	>0.05
Body weight, kg	70.2±5.4	71.1±6.2	>0.05
BMI, kg/m²	22.4±2.3	22.7±2.5	>0.05
RHR, bpm	71.6±8.1	72.3±8.4	>0.05
SBP, mmHg	118.5±7.2	119.1±7.5	>0.05
DBP, mmHg	73.2±5.8	74.0±6.1	>0.05
Kerdo index, conv. units	−2.1±4.3	−1.8±4.0	>0.05
CI, l/min/m²	2.98±0.31	3.01±0.29	>0.05
TPVR, dyn·s·cm^{-5}	1210.0±180.0	1190.0±175.0	>0.05
SDNN, ms	51.8±14.2	52.3±13.8	>0.05
RMSSD, ms	42.6±12.5	43.1±11.7	>0.05
pNN50, %	18.4±8.9	19.1±9.2	>0.05
TP, ms²	3120.0±980.0	3050.0±940.0	>0.05
HF, ms²	890.0±340.0	870.0±310.0	>0.05
LF, ms²	1140.0±390.0	1120.0±380.0	>0.05
LF/HF	1.87±0.82	1.83±0.78	>0.05
SI, conv. units	118.5±43.2	115.7±41.8	>0.05

Note. Data are presented as M±SD. BMI – body mass index; RHR – resting heart rate; SBP – systolic blood pressure; DBP – diastolic blood pressure; CI – cardiac index; TPVR – total peripheral vascular resistance; SDNN, RMSSD, pNN50 – time-domain HRV indices; TP – total power; HF – high-frequency component; LF – low-frequency component; SI – Baevsky's stress index of the regulatory systems.

After ten weeks, multidirectional changes in the indicators were recorded (Table 2).

In the aerobic group, parasympathetic indicators rose: RMSSD from 42.6±12.5 to 54.7±13.1 ms, pNN50 from 18.4±8.9 to 27.9±10.1%, and HF by more than 50%. At the same time, a decrease in the LF/HF ratio from 1.87±0.82 to 1.21±0.51 and a decrease in the stress index of regulatory systems from 118.5±43.2 to 79.3±28.5 conv. units were noted. Central haemodynamics shifted towards reduced vascular burden: total peripheral vascular resistance fell from 1210.0±180.0 to 1050.0±165.0 dyn·s·cm^{-5} and diastolic blood pressure decreased, while the cardiac index did not change significantly. The within-group changes in the aerobic group corresponded to large effect sizes (Cohen's d: RMSSD 0.95, SDNN 0.79, pNN50 1.00, HF 1.15, LF/HF −0.99, stress index −1.09, TPVR −0.93, resting heart rate −1.03), indicating a substantial magnitude of adaptation.

In the statodynamic group, HRV parameters changed little: RMSSD, SDNN, pNN50, and HF remained close to baseline after the cycle. There was a statistically significant increase in the low-frequency component and the LF/HF ratio, as well as an increase in total peripheral vascular resistance and diastolic blood pressure. Within-group effect sizes in the statodynamic group were negligible to small (Cohen's d: RMSSD 0.07, SDNN 0.05, pNN50 0.07, HF −0.13, LF/HF 0.46, stress index 0.20, TPVR 0.66, resting heart rate 0.13), consistent with the absence of meaningful autonomic adaptation.

An intergroup comparison at stage T1 showed the most pronounced differences in RMSSD, HF, LF/HF ratio, stress index, and total peripheral vascular resistance.

Table 1. Initial characteristics of the groups (M±SD)

Variable	Aerobic T0	Aerobic T1	p	Statodynamic T0	Statodynamic T1	p	Between-group p (T1)
DBP, mmHg	73.2±5.6	71.1±6.2	<0.01	74.0±6.0	77.2±5.8	>0.05	<0.01
RHR, bpm	71.6±8.3	63.3±7.8	<0.01	72.3±8.0	73.4±8.7	>0.05	<0.01
SDNN, ms	51.8±14.2	63.4±15.0	<0.01	52.3±13.8	53.0±14.1	>0.05	<0.01

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Table 1. Initial characteristics of the groups (M±SD)

Variable	Aerobic T0	Aerobic T1	p	Statodynamic T0	Statodynamic T1	p	Between-group p (T1)
RMSSD, ms	42.6±12.5	54.7±13.1	<0.001	43.1±11.7	44.0±12.3	>0.05	<0.001
pNN50, %	18.4±8.9	27.9±10.1	<0.01	19.1±9.2	19.8±9.6	>0.05	<0.01
TP, ms²	3120.0±980.0	3980.0±1120.0	<0.01	3050.0±940.0	2980.0±1010.0	>0.05	<0.01
HF, ms²	890.0±340.0	1350.0±460.0	<0.001	870.0±310.0	830.0±290.0	>0.05	<0.001
LF, ms²	1140.0±390.0	1180.0±410.0	>0.05	1120.0±380.0	1280.0±420.0	<0.05	<0.05
LF/HF	1.87±0.82	1.21±0.51	<0.001	1.83±0.78	2.23±0.95	<0.05	<0.001
SI, conv. units	118.5±43.2	79.3±28.5	<0.001	115.7±41.8	124.6±48.1	>0.05	<0.001
Kerdo index, conv. units	−2.1±4.3	−12.4±5.1	<0.001	−1.8±4.0	−5.2±4.7	>0.05	<0.001
CI, l/min/m²	2.98±0.31	3.09±0.28	>0.05	3.01±0.29	2.87±0.33	>0.05	>0.05
TPVR, dyn·s·cm⁻⁵	1210.0±180.0	1050.0±165.0	<0.01	1190.0±175.0	1310.0±190.0	<0.05	<0.01

Note. Data are presented as M±SD. p – significance level for within-group dynamics (T0 vs T1); between-group p (T1) – comparison at the final stage. Abbreviations as in Table 1.

At baseline, the distribution of response types was similar in both groups (Table 3). After the programme, in the aerobic group the normotonic type rose from 44.8% to 75.9%, while hypertonic and dystonic variants decreased. In the statodynamic group, the proportion of the normotonic response decreased (from 48.3% to 41.4%), and the proportion of the hypertensive type increased (from 27.6% to 44.8%); some participants retained dystonic recovery options. In general, these data are consistent with a more favourable adaptation of the cardiovascular system to standard exercise in the aerobic group.

Table 3. Distribution of cardiovascular response types to the Martinet–Kushelevsky test

Response type	Aerobic T0	Aerobic T1	Statodynamic T0	Statodynamic T1
Normotonic	13 (44.8%)	22 (75.9%)	14 (48.3%)	12 (41.4%)
Hypertonic	9 (31.0%)	4 (13.8%)	8 (27.6%)	13 (44.8%)
Dystonic	7 (24.1%)	3 (10.3%)	6 (20.7%)	4 (13.8%)
Asthenic/step-wise	0	0	1 (3.4%)	0

Note. Data are presented as the absolute number of participants (percentage, %). T0 – before the intervention; T1 – after the intervention.

Discussion

In this randomised study, two modes of muscular activity of comparable duration, frequency, and external intensity produced different patterns of autonomic and haemodynamic adaptation in previously untrained young people. The most pronounced beneficial changes – higher vagal HRV parameters, lower total peripheral vascular resistance, and more normotonic responses – occurred after the aerobic programme. The heart-rate-limited statodynamic programme produced no comparable HRV changes.

The results for the aerobic group are consistent with current understanding of the physiology of training adaptation. Increased vagal modulation, shown by higher RMSSD, HF, and total HRV power, is an early marker of cardiovascular adaptation in those starting systematic training; in our study it appeared by the tenth week, consistent with a network meta-analysis on the effect of aerobic exercise on HRV in adults (Yang et al., 2024).

We interpret the decrease in the LF/HF ratio against the background of an increase in RMSSD and HF cautiously. The LF/HF ratio has known limitations as a measure of sympathovagal balance, since low-frequency power reflects not only sympathetic but also parasympathetic and baroreflex influences. Nevertheless, the coordinated shift of all vagus-dependent indicators in one direction points to parasympathetic predominance more confidently than any single parameter would. The fall in total peripheral vascular resistance with an almost unchanged cardiac index indicates a predominantly vascular rather than cardiac adaptation, which may involve improved endothelium-dependent vasodilatation and baroreflex control of vascular tone, although these mechanisms were not directly assessed in the present study.

The key question is why the statodynamic group showed no favourable autonomic adaptation comparable to the aerobic group. This may seem at odds with reviews reporting that isometric training reduces blood pressure and can favourably affect autonomic balance (Baffour-Awuah et al., 2023; Edwards et al., 2024); we attribute the discrepancy mainly to differences in training protocols. Most studies showing a beneficial effect used classical isometric protocols with isolated small muscle groups (isometric handgrip, wall squat) at low total load. We used a different regimen – statodynamic exercises involving large muscle masses at a working heart rate of 120–130 beats/min — whose haemodynamic response differs from low-intensity isolated isometrics.

It is important to distinguish acute from chronic effects. Acute studies show that autonomic control differs qualitatively between static and dynamic work, and that the pressor response to static work reflects mainly increased peripheral vasoconstriction; during static work itself, vagus-mediated HRV indicators may even rise relative to dynamic work at a comparable heart rate (Weippert et al., 2013). Our data relate to a different phenomenon – the state of autonomic regulation at rest after a ten-week course. The absence of increased resting vagal parameters in the statodynamic group indicates that repetitive, mostly static work with large muscle groups in this regimen did not produce the resting parasympathetic adaptation seen with aerobic exercise. One possible mechanism is repeated activation of the muscle metaboreflex, which raises heart rate mainly through increased cardiac sympathetic activity, with a contribution from parasympathetic withdrawal appearing specifically during work with a large muscle mass (Fisher et al., 2013). However, we emphasise that our design did not include direct methods for assessing sympathetic activity, so this mechanism remains speculative and requires direct confirmation.

Thus, our results are not evidence of an adverse effect of static loads in general. Rather, modality matters within static regimes: statodynamic work with large muscle groups in this protocol did not reproduce the favourable resting autonomic adaptation of aerobic exercise. This conclusion does not apply either to classical low-volume isometric protocols (isometric hand grip, wall squat), for which there is evidence of a beneficial effect, or to strength training programs for athletes.

The study has several limitations. First, only young, apparently healthy people were examined, limiting extrapolation to other age groups and to patients with cardiovascular disease. Second, the ten-week follow-up does not allow judgement of long-term stability. Third, no a priori sample size calculation was performed and the study was a pilot; the conclusions are therefore preliminary, and subgroup analysis by response type is limited by small category counts. As no a priori power analysis was performed, the study may have been underpowered to detect smaller between-group differences; accordingly, non-significant findings should be interpreted with caution rather than as evidence of no effect, and the results should be regarded as hypothesis-generating. Fourth, we used no direct measures of vascular function (pulse wave velocity, flow-mediated vasodilatation) or sympathetic activity (microneurography, catecholamines), which limits mechanistic interpretation. Fifth, the blindness of the evaluators of functional indicators was not carried out. Finally, the LF/HF ratio as a measure of sympathovagal balance has known physiological limitations, accounted for in the discussion. In addition, significance is reported using threshold levels rather than exact p-values; standardised effect sizes are additionally provided to aid interpretation of the practical significance of the findings.

Conclusion

In young previously untrained individuals, ten weeks of aerobic cyclic training improved heart rate variability (reflecting increased parasympathetic activity), lowered total peripheral vascular resistance, and increased the proportion of normotonic responses to a standard functional test. The program of statodynamic loads with a limited heart rate was not accompanied by comparable changes. The data obtained suggest that at the initial stages of wellness training, aerobic cyclic loads provide a more favourable autonomic and haemodynamic adaptation of rest than statodynamic exercises involving large muscle groups.

The results have direct practical value for wellness programmes in previously untrained young people. First, at the initial stage (the first 8-10 weeks), moderate-intensity aerobic cyclic loads (65-75% of heart rate reserve, about three 40-minute sessions per week) are advisable as the main means, since this regimen forms a favourable autonomic and vascular profile. Secondly, predominantly static (statodynamic) exercises involving large muscle groups at the initial stage should not be used as an independent means of wellness training; it is more rational to include them as an additional component in combination with aerobic exercise, rather than instead of it. Third, when statodynamic loads are used in this population, cardiovascular monitoring (heart rate, blood pressure, and, where possible, HRV and functional-test response type) is advisable to detect adverse pressor reactions in time. In practice, a starting programme may comprise three weekly 30-40-minute sessions of cyclic aerobic exercise (treadmill, cycling, or brisk walking) at 65-75% of heart rate reserve, progressing over 8-10 weeks, with statodynamic exercises added later as a supplementary component rather than the primary stimulus, under periodic monitoring of heart rate and blood pressure. Finally, HRV and functional-test response type can serve as accessible criteria for monitoring adaptation when selecting and adjusting wellness programmes.

As a pilot study, these findings are preliminary; confirming them and refining practical recommendations will require larger, adequately powered trials, longer follow-up, and direct measures of vascular function and autonomic regulation.

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Conflicts of Interest
The authors declare no conflict of interest.

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