Articles

Evaluation of the impact of a Physical Training Program on the university Community's Physical Capacity: A 16-Week Study

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Abstract: This pre-experimental study evaluated the effect of a 16-week physical training program on the aerobic capacity of university faculty and administrative staff. Thirteen subjects (6 men and 7 women) aged between 33 and 60 years participated, selected intentionally. The Cooper Test (12 minutes) was used, and maximum oxygen consumption (VO_2 max) was calculated using the standard formula VO_2 max = (d_{12} − 504.9) / 44.73 at three time points: baseline (week 4), mid-term (week 8), and final (week 16). The results showed an average group increase of 27.6% in distance covered (from 1,415 m to 1,805 m) and 43.0% in VO_2 max. (from 20.33 to 29.07 ml/kg/min). Women showed greater percentage increases in both distance (+32.4%) and VO_2 max (+55.1%), possibly related to their lower baseline values. The results confirm that the program was effective in improving cardiovascular endurance in this population and highlight the need to implement permanent physical activity programs in university institutions.

Keywords: Aerobic capacity; Cooper test; University physical training; Cardiovascular endurance.

Introduction

Physical activity is central to the maintenance of physical, mental, and organic health. However, in the university environment, especially among faculty and administrative staff, sedentary behavior constitutes a recurring problem. Long working hours, daily stress, and limited availability of time for physical activity practice notably reduce physical capacity and increase the risk of developing chronic non-communicable diseases such as obesity, arterial hypertension, and type 2 diabetes mellitus (World Health Organization [WHO], 2020).

According to WHO guidelines (2020), adults should accumulate at least 150 to 300 minutes of moderate-intensity aerobic physical activity — or 75 to 150 minutes of vigorous intensity — per week to preserve their cardiovascular and metabolic health. Despite this recommendation, a considerable proportion of university staff do not meet these minimum parameters, a situation aggravated by the predominantly sedentary nature of their work duties (Gómez-López et al., 2022).

Studies conducted in Latin America show that faculty and administrative staff of higher education institutions present insufficient levels of physical activity, with inactivity rates ranging between 55% and 70% of the university working population (González-Jurado et al., 2021; Martínez-Lemos et al., 2020). This situation generates a negative impact not only on individual health but also on work productivity and institutional climate.

Previous research has consistently demonstrated that interventions based on structured physical training programs are capable of significantly improving key cardiovascular health indicators, including maximum oxygen consumption (VO_2 max), aerobic endurance, and body composition. García-Hermoso et al. (2022) reported average improvements of 15 to 30% in VO_2 max following 12 to 20-week interventions in adult populations with characteristics similar to those of this research.

The Cooper Test, developed by Kenneth H. Cooper in 1968, is validated as a diagnostic tool for assessing aerobic capacity in adult populations. Its applicability, low cost, and ease of administration make it appropriate for university settings with limited resources (Cooper, 1968; Mayorga-Vega et al., 2016). The formula $VO_2 \text{ max} = (d12 - 504.9) / 44.73$ allows estimation of maximum oxygen consumption from the distance covered in meters during the 12 minutes of the test, providing an objective and reproducible measure of aerobic status.

Several studies have documented that, although university faculty recognize the benefits of regular physical activity, they present insufficient levels of practice and perceive greater barriers than other university groups (Arboleda Serna et al., 2016). This paradox between knowledge and behavior — where practice is sporadic and lacks structured progression — limits the attainment of physiological adaptations derived from systematic training, which justifies the design of supervised institutional interventions (González Reyes et al., 2019).

The program was designed applying the foundations that the specialized literature in exercise physiology and training methodology has consolidated for the adult population. Below, based on the referenced authors, it is explained why a distribution of three aerobic and two strength sessions per microcycle was chosen, and why the methods that integrate the planning were selected.

Distribution 3 aerobic / 2 strength per Microcycle

According to Wilmore and Costill (2007), three weekly aerobic sessions constitute the minimum frequency to produce measurable improvements in VO_2 max in adults aged 33 to 60 years. Along the same lines, Garber et al. (2011) recommend 3 to 5 days/week of moderate-vigorous aerobic exercise for increasing maximum oxygen consumption. Considering these criteria, the program establishes three aerobic sessions over four available days, respecting the recovery capacity of the age group without reducing the cardiorespiratory stimulus.

Regarding the strength component, Siff and Verkhoshansky (2000) point out that two weekly sessions curb sarcopenia, improve bone density, and reduce locomotor metabolic cost, a criterion coincident with that of Kraemer and Ratamess (2004), who establish this minimum to maintain and develop strength in adults. Strength is not conceived as a secondary component: its effect on movement economy elevates functional VO_2 max for the same external load (Paavolainen et al., 1999).

The weekly sequence Aerobic-Strength-Aerobic-Strength-Aerobic (A-S-A-S-A) proposed by Forteza de la Rosa and Ramírez Farto (2005) applies the recovery principle, which requires at least 48 hours between sessions of the same type. Turner and Comfort (2018) point out that concurrent training improves VO_2 max and body composition to a greater extent than each modality separately. The sequence also avoids acute aerobic-strength interference (Docherty & Sporer, 2000) and ensures that each capacity has the necessary supercompensation time.

Periodization in Mesocycles

Verkhoshansky (1988) highlights that block periodization takes advantage of the residual training from each phase. Bompa & Haff (2009) establish that blocks of 4 to 6 weeks per mesocycle in conditioning programs for adults are adequate for managing fatigue and avoiding stagnation. The macrocycle structure follows Verkhoshansky's proposal: Accumulation (weeks 1-4) → Advanced Accumulation (5-8) → Transformation (9-12) → Realization (13-16), with unloading weeks in weeks 4, 8, and 12.

Selection of Training Methods

In the field of sport and physical culture, the method constitutes one of the structural elements of the training process. Authors such as Bompa & Haff (2009) and Matveyev (1977) agree in pointing it out as the means through which the coach organizes and directs the athlete's activity toward achieving previously defined objectives. Forteza de la Rosa and Ramírez Farto (2005) also conceive them as a pedagogical category that articulates contents, means, and the coach-athlete relationship in a conscious direction.

The objective of the present study is to evaluate the impact of a physical training program on the development of aerobic capacity of faculty and administrative staff at the Universidad Estatal de Milagro.

Material and Method

The design used is experimental in its pre-experimental modality with a single group, with an explanatory scope and a causal relationship that expresses the incidence of the independent variable (Physical training program) on the dependent variable (Aerobic capacity) of the study subjects. The study has a quantitative approach with a longitudinal orientation with three measurements — baseline (week 4), mid-term (week 8), and final (week 16) — to verify changes in cardiovascular endurance and maximum oxygen consumption (VO_2 max) in the studied sample.

Participants

The reference population consisted of 48 faculty and administrative staff who attended the program. The intentional sample included 13 participants (6 men and 7 women). As selection criteria, subjects between 35 and 60 years of age (M = 44.69, SD = 8.12), in good health at the time of measurements, and with frequent attendance at training sessions were chosen.

The sample consisted of 13 participants: 6 men (46.2%) and 7 women (53.8%), with ages ranging between 33 and 60 years (M = 44.69, SD = 8.12). The average initial body weight was 72.5 kg (range: 57-98 kg). No participant reported previous sports experience prior to the start of the program, which reinforces the comparability of the data and the internal validity of the study. Inclusion criteria were: no medical restrictions for physical exercise practice, availability to participate in training sessions and all three evaluations, and signing of informed consent. Subjects diagnosed with cardiovascular diseases or medical contraindications for physical exercise, attendance below 80% of program sessions, and musculoskeletal injuries that prevented performing the tests were excluded.

Instruments

The **Cooper Test.** It was used to measure aerobic endurance where participants covered the greatest possible distance in 12 minutes on a standardized 400-meter athletic track, recording the meters covered at the end of the established time. Environmental conditions were controlled (temperature between 18°C and 22°C, flat surface, morning schedule). The standard Cooper formula (1968) applicable to men and women was used: VO_2 max = (d12 – 504.9) / 44.73, where d12 corresponds to the distance covered in meters during the 12 minutes of the test. The result is expressed in ml/kg/min. Additionally, for greater precision by gender, differentiated formulas were considered:

- Men: VO_2 max = $(22.351 \times d_{12}) - 11.288$
- Women: VO_2 max = $(22.351 \times d_{12}) - 8.286$

Normative Classification Tables

VO_2 max results were classified according to international normative tables stratified by sex and age group (ACSM, 2021), with the following categories: Very Poor/Poor, Fair/Average, Good, and Excellent.

Table 1.
Normative data for VO_2 max (ml/kg/min) by sex and age group.

Age Group	Very Poor	Poor	Fair (average)	Good	Excellent
Men					
20–29 years	< 33	33–36	37–41	42–50	> 50
30–39 years	< 29	29–32	33–37	38–46	> 46
40–49 years	< 25	25–28	29–33	34–42	> 42
50–59 years	< 21	21–24	25–29	30–38	> 38
60–69 years	< 18	18–21	22–25	26–34	> 34
≥ 70 years	< 15	15–18	19–22	23–30	> 30
Women					
20–29 years	< 27	27–30	31–35	36–43	> 43
30–39 years	< 24	24–27	28–31	32–39	> 39
40–49 years	< 21	21–24	25–28	29–36	> 36
50–59 years	< 18	18–21	22–25	26–32	> 32
60–69 years	< 15	15–17	18–21	22–29	> 29
≥ 70 years	< 13	13–15	16–18	19–25	> 25

Note: VO_2 max values (ml/kg/min) correspond to the normative categories of cardiorespiratory fitness established by the American College of Sports Medicine (ACSM) in its Guidelines for Exercise Testing and Prescription (11th ed.) and complemented with normative data from the Cooper Institute, derived from the Fitness Registry and the Importance of Exercise National Database (FRIEND). The cutoff points reflect population percentiles adjusted by sex and age group.

Procedures

The baseline assessment was conducted at the end of the first conditioning phase (week 4) to ensure that participants had the minimum preparation necessary to correctly perform the test. The absence of a control group is justified by the ethical and practical restrictions inherent to the university institutional context.

Based on the described context and available evidence, the impact of a physical training program on the university community was evaluated using validated diagnostic instruments. The study used the Cooper Test and VO_2 max measurement at three points of the program (week 4, week 8, and week 16) to quantify changes in aerobic capacity of university faculty and administrative staff. The results obtained will provide local scientific evidence that can guide the design and implementation of permanent physical activity programs in higher education institutions.

To evaluate the impact of a 16-week physical training program on the aerobic capacity of faculty and administrative staff of a university, through the application of the Cooper Test and VO_2 max measurement at three evaluation time points (week 4, week 8, and week 16).

Three evaluations were conducted with the Cooper Test: at the end of the first conditioning mesocycle (week 4, Monday), at the midpoint of the program (week 8, Wednesday), and at the conclusion of the program (week 16, Wednesday). Each evaluation followed a standardized protocol: 15-minute warm-up, 12-minute test execution, and active recovery. The training program was supervised by professionals in the field during weeks 1 through 16.

Statistical Analysis

Data were analyzed using descriptive statistics (arithmetic mean, standard deviation, and ranges) to characterize the sample and results by evaluation and gender.

Student's T-test for related samples (pre-post) was applied to evaluate the statistical significance of the observed changes, establishing a significance level of α = 0.05. Percentage improvements between evaluations were also calculated.

Ethical Considerations

Results

The program was developed over 16 weeks with a frequency of 5 weekly sessions (3 aerobic and 2 strength) of 60 minutes each.

The fixed distribution per microcycle was: Monday = Aerobic | Tuesday = Strength | Wednesday = Aerobic | Thursday = Strength | Friday = Aerobic. The program was structured in four progressive mesocycles. Below, the aerobic training methods (Table 1) and the strength work phases (Table 2) are presented.

Table 2.

Selected *aerobic training methods for the program*

Method	Reference and foundations	Intensity	Weeks of Application
Extensive continuous	Wilmore & Costill: develops mitochondrial efficiency and oxidative base. Haskell et al. (2007): moderate-intensity aerobic activity as the axis of conditioning in adults. Forteza de la Rosa: progression principle. Increase no greater than 5-10% of weekly volume in adults >40 years. McArdle et al. (2015): progressive overload is the central mechanism of aerobic adaptation.	50-65% HR max RPE 11-13	Weeks 1-4 (base), 8, 12, 15-16 (recovery and taper)
Progressive increase of loads	Verkhoshansky: chaining sections of different intensity without pause trains tolerance to sustained effort and prepares the cardiovascular system for higher intensities without the sudden impact of intervals.	Variable according to phase	Throughout the 16 weeks. Expressed in duration (+5 min/week), intensity (+3-5%) or number of intervals.
Standard chain exercise	Turner & Comfort: 75-85% HR max intervals with active recovery generate the most consistent stimulus on VO_2 max. Helgerud et al. (2007): 4 × 4 min at 90-95% HR max increases VO_2 max by 7.2% in 8 weeks.	55-72% HR max	Weeks 2-3 (intro), 5-7 (development), 15 (taper). Base structure: jogging → active walking → jogging.
Extensive interval	Wilmore & Costill: 5-10 min intervals at 80-85% HR max keep the body in the zone of maximum cardiorespiratory demand longer than short intervals. Billat (2001): long sections at 100% VO_2 max optimize time in zone.	72-86% HR max (work)	Introduction Week 6. Development Weeks 9-11, 13-14. Progression: first increase repetitions, then intensity.
Long-section interval	80-86% HR max (work)	Weeks 10-11 (development), 13-15 (realization and taper). Progression: from 4×5 min (Week 10) to 3×10 min (Week 13).	

Fartlek	Forteza de la Rosa: variety principle. Fartlek forces the cardiovascular system to respond to non-standardized stimuli, avoids stagnant adaptation, and improves adherence in non-athlete adults. Billat (2001): fartlek produces VO_2 responses similar to formalized intervals.	Variable	Weeks 5-15 (one session/week, Friday). Each mesocycle increases the duration or intensity of fast sections.

Note: HR max = maximum heart rate; RPE = rate of perceived exertion (Borg 6-20). Intensities adjusted to the age range of the sample (33-60 years).

Table 3.

Strength work phases incorporated into the program as a complement to the aerobic component

Phase	Weeks	Series x Reps	Load (% 1RM)	Rest	Reference
Anatomical adaptation	1-4	3x15-20	40-50%	60-90 seg	Siff & Verkhoshansky; Kraemer & Ratamess (2004)
Functional hypertrophy	5-8	4x10-12	55-65%	60-75 seg	Bompa & Haff (2009); ACSM (2009)
Strength endurance	9-12	4x8-10	65-75%	90-120 seg	Turner & Comfort; Siff & Verkhoshansky
Maintenance and Consolidation	13-16	3x12-15	50-65%	60-75 seg	Verkhoshansky; Kraemer & Ratamess (2004)

Note: 1RM = one repetition maximum. Load progression according to the principle of progressive overload (ACSM, 2009; Bompa & Haff, 2009).

Table 3 presents the synthetic scheme of the 16-week program, organized in four mesocycles.

Table 4.

Summary of the training program — 16 weeks

Mesocycle	Weeks	Objective	Aerobic methods	Strength load
1. Initiation / aerobic base	1-4	Conditioning, cardiovascular adaptation	Extensive continuous	Anatomical adaptation (40–55% 1RM, 2x12–15)
2. Resistance development	5-8	Increase VO_2 Max, effort tolerance	Extensive continuous + Variable continuous (Fartlek)	Functional hypertrophy (60–70% 1RM, 3x10–12)
3. Intensification / aerobic capacity	9-12	Improvement of aerobic threshold, metabolic efficiency	Variable continuous + Extensive interval	Strength-endurance (60–70% 1RM, 3x12–15)
4. Consolidation and transfer	13-16	Maintenance of adaptations, functional integration	Extensive interval + Extensive continuous (recovery)	Strength-endurance (maintenance, 50–60% 1RM)

Note: 1RM = one repetition maximum. The fixed weekly distribution was: Monday/Wednesday/Friday = aerobic; Tuesday/Thursday = strength.

- Mesocycle 1 — Initiation and aerobic base (weeks 1-4): general conditioning through extensive continuous methods, with initial evaluation via Cooper Test at the end (week 4, Monday).
- Mesocycle 2 — Aerobic development (weeks 5-8): progressive increase of intensity, incorporation of fartlek and extensive intervals. Mid-term evaluation via Cooper Test (week 8, Wednesday).
- Mesocycle 3 — Intensification and VO_2 max (weeks 9-12): specific work with extensive intervals and long-section intervals to maximize time in the high cardiorespiratory demand zone.
- Mesocycle 4 — Realization and consolidation (weeks 13-16): consolidation of adaptations with progressive taper. Final evaluation via Cooper Test (week 16, Wednesday).

Cooper Test Results — Baseline (Week 4)

Table 4 presents the individual results of the first test, applied at the end of the conditioning mesocycle (week 4). The average group distance was 1,415 m and the average VO_2 max was 20.33 ml/kg/min. Eight of the 13 participants (61.5%) were classified in the "Very Poor" category, evidencing an initial state of deficient aerobic condition.

Table 5.

Individual results — First Cooper Test (Baseline, Week 4)

N°	Sex	Weight (kg)	Age	Meters covered	VO_2 Max (ml/kg/min)	Physical Condition
1	H	98	42	1,500	22.24	Very Poor
2	F	70	45	1,100	13.30	Very Poor
3	F	68	44	1,350	18.89	Very Poor
4	H	87	44	1,200	15.54	Very Poor
5	F	63	54	1,500	22.24	Fair
6	F	63	35	1,400	20.01	Very Poor
7	F	60	53	1,100	13.30	Very Poor
8	H	94	45	1,900	31.19	Fair
9	H	77	57	1,570	23.81	Poor
10	H	88	44	1,780	28.50	Fair
11	F	61	60	1,100	13.30	Vey Poor
12	F	57	41	1,000	11.06	Very Poor
13	H	85	33	1,890	30.97	Poor

Note: F = female, M = male; VO_2 Max = maximum oxygen consumption (ml/kg/min), estimated from the distance covered in the Cooper Test (Cooper, 1968). Classification according to normative tables (ACSM, 2021).

Cooper Test Results — Mid-term (Week 8)

Table 5 shows the results obtained in the mid-term evaluation (week 8). The average distance increased to 1,631 m (+15.3% compared to baseline) and the average VO_2 max increased to 25.17 ml/kg/min (+23.8%). A generalized improvement in physical condition was recorded: nine participants migrated to the "Fair" category, while two remained in "Very Poor"; this evidences the early effect of progressive training.

Table 6.
Individual results — Second Cooper Test (Mid-term, Week 8)

N°	Sex	Weight(kg)	Age	Meters covered	VO_2 Max (ml/kg/min)	Physical Condition
1	H	95	42	1,700	26.72	Fair
2	F	67	45	1,500	22.24	Fair
3	F	63	44	1,650	25.60	Fair
4	H	84	44	1,650	25.60	Poor
5	F	61	54	1,500	22.24	Fair
6	F	60	35	1,650	25.60	Poor
7	F	59	53	1,500	22.24	Fair
8	H	92	45	2,050	34.54	Fair
9	H	76	57	1,700	26.72	Fair
10	H	85	44	1,900	31.19	Fair
11	F	60	60	1,200	15.54	Very Poor
12	F	57	41	1,200	15.54	Very Poor
13	H	83	33	2,000	33.42	Poor

Note: F = female, M = male; VO_2 Max = maximum oxygen consumption (ml/kg/min), estimated through the Cooper Test (Cooper, 1968). Classification according to normative tables (ACSM, 2021).

Cooper Test Results — Final (Week 16)

Table 6 presents the final results (week 16). The average group distance reached 1,805 m (+27.6% compared to baseline) and the average VO_2 max stood at 29.07 ml/kg/min (+43.0%). 76.9% of participants improved their physical condition category: three reached the "Good" category, seven the "Fair" category, and three remained in "Poor." The case of Byron Piedra Arévalo stands out, who reached the "Excellent" category with a VO_2 max of 42.81 ml/kg/min.

Table 7.
Individual results — Third Cooper Test (Final, Week 16)

N°	Sex	Weight (kg)	Age	Meters covered	VO_2 Max (ml/kg/min)	Physical Condition
1	M	93	42	2,050	34.54	Fair
2	F	65	45	1,800	28.95	Fair
3	F	61	44	1,700	26.71	Fair
4	M	83	44	1,950	32.31	Fair
5	F	59	54	1,700	26.71	Fair
6	F	58	35	1,960	32.53	Good
7	F	59	53	1,550	23.36	Fair
8	M	92	45	2,420	42.81	Excellent
9	M	76	57	1,620	24.93	Fair
10	M	84	44	2,100	35.66	Good
11	F	60	60	1,300	17.77	Poor
12	F	57	41	1,300	17.77	Very Poor
13	M	82	33	2,020	33.87	Poor

Note: F = female, M = male; VO_2 Max = maximum oxygen consumption (ml/kg/min), estimated through the Cooper Test (Cooper, 1968). Classification according to normative tables (ACSM, 2021).

Group Progression in the Three Evaluations

Table 7 summarizes the group evolution of aerobic indicators throughout the program. A progressive and sustained increase is observed in both distance covered and VO_2 max, with the largest percentage jump recorded between the baseline and mid-term evaluation (+23.8%), reflecting the early adaptive response to progressive aerobic stimulation.

Table 8.

Group progression — Average Distance and VO_2 Max in the three evaluations

Evaluation	Average Distance (m)	Average VO_2 Max (ml/kg/min)	VO_2 Increase (%)
Baseline (Week 4)	1,415	20.33	—
Mid-term (Week 8)	1,631	25.17	+23.8%
Final (Week 16)	1,805	29.07	+43.0%

Note: Δ = percentage variation compared to baseline (week 4); VO_2 Max expressed in ml/kg/min

Figure 1. Progression of Average Distance Covered

Figure 1. Progression of Average Distance Covered (Cooper Test, 12 min) in the three evaluations (weeks 4, 8, and 16). Values correspond to group mean (n = 13).

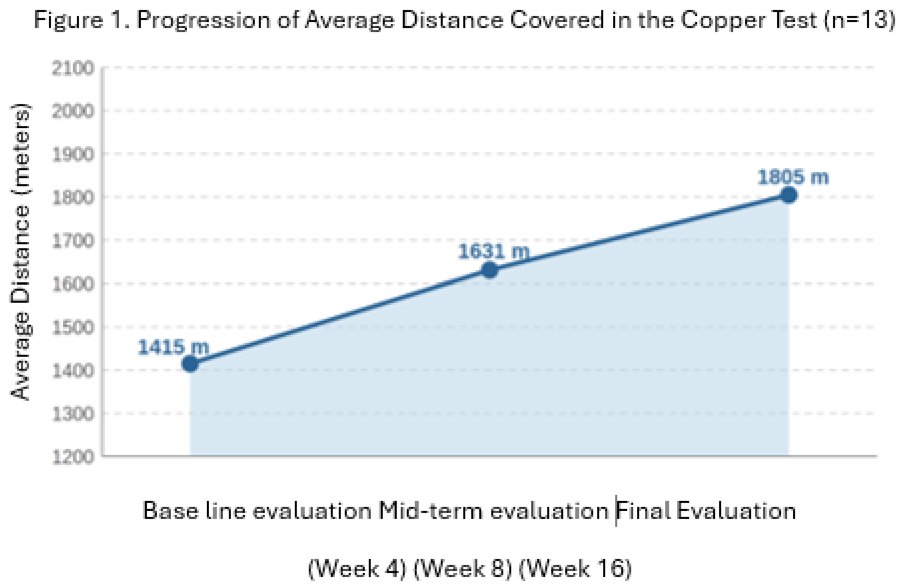
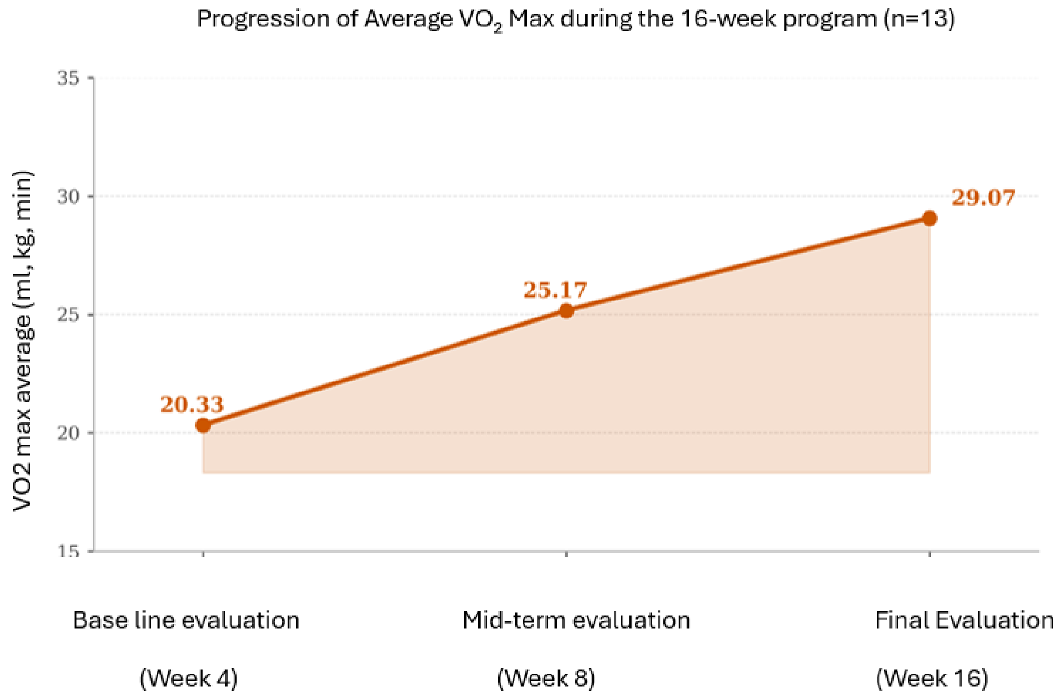


Figure 2 — Progression of Average VO_2 Max

Figure 2. Evolution of the group average VO_2 max (ml/kg/min) across the three evaluations. The curve reflects the adaptive response to progressive training.



Comparative Analysis by Gender

Table 8 presents the comparison of results by gender. Both groups significantly improved their aerobic indicators; however, women registered higher percentage increases, which is consistent with their lower baseline physical condition level. This difference does not necessarily imply a greater capacity for physiological adaptation but rather reflects the effect of the lower starting point (known as the "low floor" phenomenon).

Table 9.

Comparison by gender — Distance and VO_2 Max (Baseline vs. Final)

Gender	Initial Dist. (m)	Final Dist. (m)	Δ Dist. (%)	Initial VO_2	Final VO_2	Δ VO_2 (%)
Men	1,640	2,027	+23.6%	25.38	34.02	+34.0%
Women	1,221	1,616	+32.4%	16.01	24.83	+55.1%

Note: Δ Dist. = percentage variation of distance covered; Δ VO_2 = percentage variation of maximum oxygen consumption (ml/kg/min) compared to baseline.

Figure 3. Comparison of Average Distance Covered by Gender (Baseline vs. Final)

Figure 3. Comparison of the average distance traveled by gender between the initial and final assessments. Men exhibited higher absolute values, while women showed a greater percentage of improvement.

Figure 3. Comparison of Average Distance Covered by Gender (Baseline vs. Final assessments)

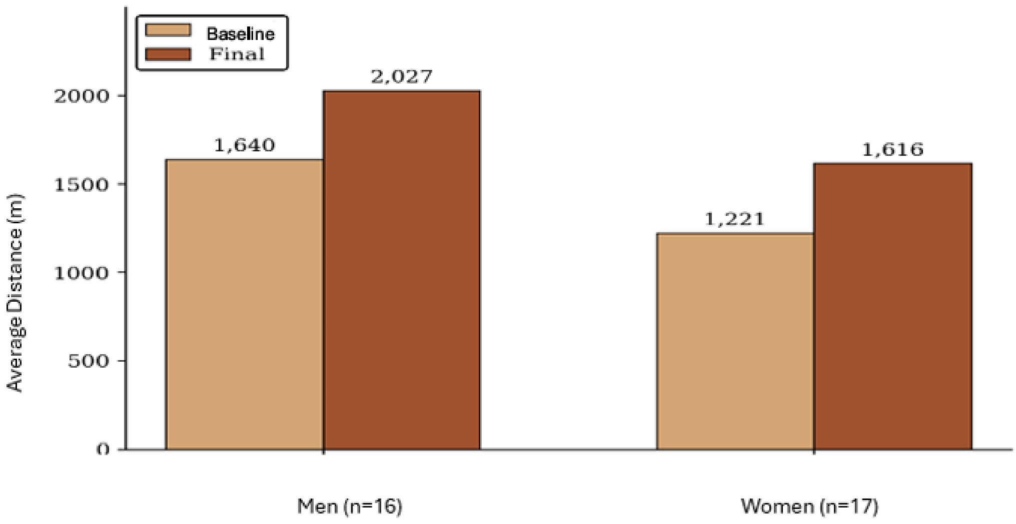
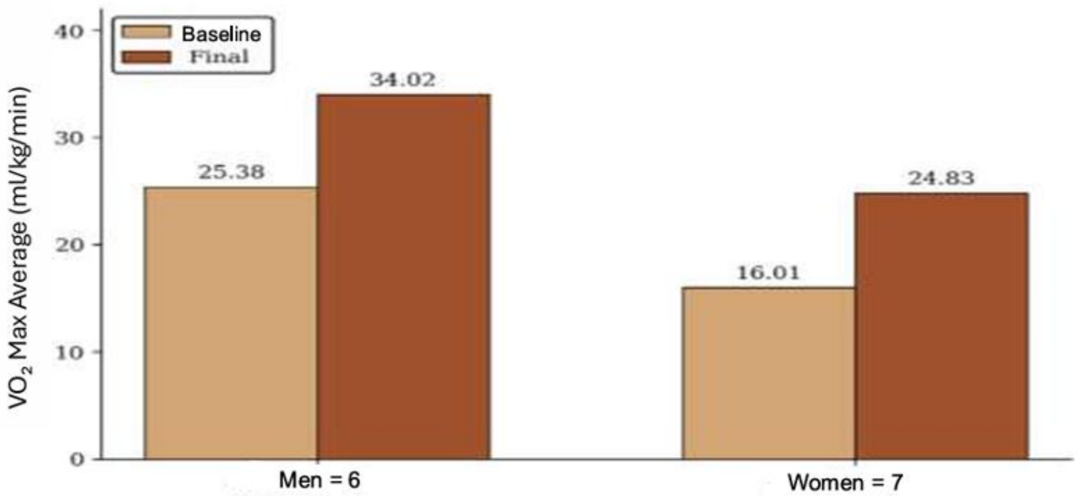


Figure 4 — Comparison of VO_2 Max by Gender.

Figure 4. Comparison of the average VO_2 Max by gender between the initial and final assessments. Men exhibited higher absolute values, while women showed a greater percentage of improvement.

Figure 4 — Comparison of VO_2 Max by Gender. Baseline vs Final Assessment



Statistical Analysis

The analysis using Student's T-test for related samples (pretest-posttest) showed a statistically significant increase in the distance covered during the Cooper Test ($t(12) = -8.74$, $p < 0.001$), with an average improvement of 391 meters (95% CI: 259–523 m).

Likewise, the average VO_2 max increased from 20.33 ± 6.93 ml/kg/min to 29.07 ± 7.21 ml/kg/min (difference = 8.74 ml/kg/min, $p < 0.001$), representing an increase of 43.0%. The effect size calculated using Cohen's d was large ($d = 1.79$), indicating a clinically relevant response to the training program.

Discussion

This 16-week aerobic and strength training program produced significant and clinically relevant improvements in the aerobic capacity of participants. The average increase of 43.0% in VO_2 max coincides with what has been reported in similar interventions for untrained adult populations, ranging between 15% and 40% (García-Hermoso et al., 2022; Warburton et al., 2006).

The progression in four mesocycles — initiation, development, intensification, and realization — allowed a gradual adaptation of the cardiovascular system, minimizing the risk of injury and dropout. The greatest percentage gain in VO_2 max was recorded between the first and second evaluations (+23.8%), reflecting the early adaptive response to structured aerobic training. The 16-week duration proved adequate to consolidate adaptations of clinically relevant magnitude in this population.

The greater percentage of improvement observed in women (+55.1% in VO_2 max) compared to men (+34.0%) can be explained by the greater physiological plasticity associated with lower baseline values, in line with the training principle of progressive overload and the "low floor" phenomenon documented in the literature (Haskell et al., 2007). Nevertheless, men achieved higher absolute VO_2 max values in all evaluations, which agrees with inherent physiological gender differences.

Adherence was high: all participants completed more than 80% of the sessions, which is key to the validity of the results and to sustaining long-term improvements. This data suggests that professional supervision and group work were relevant motivating factors.

As limitations and perspectives of the study, the following are determined: establishing permanent and institutional physical activity programs for university staff, with periodic monitoring using the Cooper Test and VO_2 max at least twice a year; designing personalized training plans according to the initial physical condition level and individual characteristics (age, gender, health status) to maximize benefits; incorporating strength and flexibility sessions as a complement to aerobic work to obtain comprehensive benefits in the musculoskeletal health of staff; replicating the study with a larger sample, including a control group, to increase internal validity and generalizability of results; developing institutional awareness campaigns about the benefits of physical activity, especially focused on staff with higher levels of sedentary behavior; exploring the association between improvements in physical condition and variables of work well-being such as productivity, absenteeism, and perceived quality of life.

Conclusions

The 16-week aerobic and strength training program was effective in improving the aerobic capacity of university faculty and administrative staff:

- The average group VO_2 max increased by 43.0% (from 20.33 to 29.07 ml/kg/min), with statistically significant differences ($p < 0.001$) and large effect size (Cohen's $d = 1.79$).
- The average distance covered in the Cooper Test increased by 27.6% (from 1,415 m to 1,805 m), evidencing a substantial improvement in aerobic endurance.
- 76.9% of participants improved their physical condition category, with three participants reaching the "Good" category at the end of the program.
- Women presented greater percentage increases (+55.1% in VO_2 max), while men achieved higher absolute values, in accordance with physiological differences between genders.

- Adherence greater than 80% in all participants validates the viability and acceptability of the program in the university context.
- The results indicate the importance of implementing permanent physical activity programs in educational institutions to reduce sedentary behavior and promote staff health.

References

American College of Sports Medicine. (2009). American College of Sports Medicine position stand. Progression models in resistance training for healthy adults. Medicine & Science in Sports & Exercise, 41(3), 687-708. https://doi.org/10.1249/MSS.0b013e3181915670

American College of Sports Medicine. (2021). ACSM's guidelines for exercise testing and prescription (11.ª ed.). Wolters Kluwer.

Arboleda Serna, V. H., Arango Vélez, E. F., & Feito, Y. (2016). Actividad física y percepciones de beneficios y barreras en una universidad colombiana. Retos, 30, 160–165. https://doi.org/10.47197/retos.v0i30.35175

Billat, V. L. (2001). Interval training for performance: A scientific and empirical practice. Special recommendations for middle- and long-distance running. Part I: Aerobic interval training. Sports Medicine, 31(1), 13-31. https://doi.org/10.2165/00007256-200131010-00002

Bompa, T., & Haff, G. G. (2009). Periodization: Theory and methodology of training (5.ª ed.). Human Kinetics.

Cooper, K. H. (1968). A means of assessing maximal oxygen intake: Correlation between field and treadmill testing. JAMA, 203(3), 201-204.https://doi.org/10.1001/jama.1968.03140030033008

Docherty, D., & Sporer, B. (2000). A proposed model for examining the interference phenomenon between concurrent aerobic and strength training. Sports Medicine, 30(6), 385-394. https://doi.org/10.2165/00007256-200030060-00001

Forteza de la Rosa, A., & Ramírez Farto, E. (2005). Teoría, metodología y planificación del entrenamiento deportivo: De lo ortodoxo a lo contemporáneo. Wanceulen Editorial.

Garber, C. E., Blissmer, B., Deschenes, M. R., Franklin, B. A., Lamonte, M. J., Lee, I. M., Nieman, D. C., & Swain, D. P. (2011). American College of Sports Medicine position stand. Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently healthy adults: Guidance for prescribing exercise. Medicine & Science in Sports & Exercise, 43(7), 1334-1359. https://doi.org/10.1249/MSS.0b013e318213fefb

García-Hermoso, A., Ramírez-Vélez, R., Sáez de Asteasu, M. L., Martínez-Velilla, N., Zambom-Ferraresi, F., Izquierdo, M., & Cadore, E. L. (2022). Safety and effectiveness of long-term exercise interventions in older adults: A systematic review and meta-analysis of randomized controlled trials. Sports Medicine, 52(6), 1385-1396. https://doi.org/10.1007/s40279-022-01649-0

Gómez-López, M., Granero-Gallegos, A., Isorna-Folgar, M., Arbinaga-Ibarzábal, F., & Rodríguez-García, P. L. (2022). Sedentary behavior and physical activity level in university professors: Associated factors and barriers. Frontiers in Public Health, 10, 963082. https://doi.org/10.3389/fpubh.2022.963082

González-Jurado, J. A., Martín-Tamayo, I., & Campos-Mesa, M. C. (2021). Physical activity habits and sedentary behaviors of non-physical education university professors. International Journal of Environmental Research and Public Health, 18(11), 5757. https://doi.org/10.3390/ijerph18115757

González Reyes, Y., Ríos Guarango, P. A., Parreño Urquizo, Á. F., Chávez Hernández, J. P., Yaulema Brito, L. P., & Guacho Tixi, M. E. (2019). Influencia de las actividades físicas en la autoestima de docentes universitarios: efectos a corto tiempo. Revista Cubana de Investigaciones Biomédicas, 37(4). (Revista Scielo, acceso abierto)

Haskell, W. L., Lee, I. M., Pate, R. R., Powell, K. E., Blair, S. N., Franklin, B. A., Macera, C. A., Heath, G. W., Thompson, P. D., & Bauman, A. (2007). Physical activity and public health: Updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. Medicine & Science in Sports & Exercise, 39(8), 1423-1434. https://doi.org/10.1249/mss.0b013e3180616b27

Helgerud, J., Høydal, K., Wang, E., Karlsen, T., Berg, P., Bjerkaas, M., Simonsen, T., Helgesen, C., Hjorth, N., Bach, R., & Hoff, J. (2007). Aerobic high-intensity intervals improve VO2max more than moderate training. Medicine & Science in Sports & Exercise, 39(4), 665-671. https://doi.org/10.1249/mss.0b013e3180304570

Kraemer, W. J., & Ratamess, N. A. (2004). Fundamentals of resistance training: Progression and exercise prescription. Medicine & Science in Sports & Exercise, 36(4), 674-688. https://doi.org/10.1249/01.MSS.0000121945.36635.61

Martínez-Lemos, R. I., Puig-Ribera, A., & García-García, O. (2020). Perceived barriers to physical activity and related factors in Spanish university employees. Journal of Sports Science & Medicine, 19(1), 56-67. https://www.researchgate.net/profile/R_Ivan_Martinez-Lemos/publication/272878626_Perceived_Barriers_to_Physical_Activity_and_Related_Factors_in_Spanish_University_Students/links/555d91d908ae6f4dcc8c3b8f/Perceived-Barriers-to-Physical-Activity-and-Related-Factors-in-Spanish-University-Students.pdf

Mayorga-Vega, D., Merino-Marban, R., & Viciana, J. (2016). Criterion-related validity of physical fitness tests in youth: A systematic review. Journal of Sports Science & Medicine, 13(1), 1-14. https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0151671

McArdle, W. D., Katch, F. I., & Katch, V. L. (2015). Exercise physiology: Nutrition, energy, and human performance (8.ª ed.). Wolters Kluwer Health / Lippincott Williams & Wilkins.

Organización Mundial de la Salud. (2020). Directrices de la OMS sobre actividad física y comportamiento sedentario. OMS. https://www.who.int/es/publications/i/item/9789240014886

Paavolainen, L., Häkkinen, K., Hämäläinen, I., Nummela, A., & Rusko, H. (1999). Explosive-strength training improves 5-km running time by improving running economy and muscle power. Journal of Applied Physiology, 86(5), 1527-1533. https://doi.org/10.1152/jappl.1999.86.5.1527

Siff, M. C., & Verkhoshansky, Y. V. (2000). Supertraining (6.ª ed.). Supertraining Institute.

Turner, A., & Comfort, P. (Eds.). (2018). Advanced strength and conditioning: An evidence-based approach. Routledge.

Verkhoshansky, Y. V. (1988). Fundamentos del entrenamiento especial de fuerza en el deporte. Comité Olímpico Español.

Warburton, D. E. R., Nicol, C. W., & Bredin, S. S. D. (2006). Health benefits of physical activity: The evidence. CMAJ: Canadian Medical Association Journal, 174(6), 801-809. https://doi.org/10.1503/cmaj.051351

Wilmore, J. H., & Costill, D. L. (2007). Fisiología del esfuerzo y del deporte (6.ª ed.). Paidotribo.

American College of Sports Medicine. (2022). ACSM's guidelines for exercise testing and prescription (11.ª ed.). Wolters Kluwer.

Kaminsky, L. A., Arena, R., Beckie, T. M., Brubaker, P. H., Church, T. S., Forman, D. E., Franklin, B. A., Gulati, M., Myers, J., Patel, M. J., Pina, I. L., Weintraub, W. S., & Williams, M. A. (2013). The importance of cardiorespiratory fitness in the United States: The need for a national registry. A policy statement from the American Heart Association. Circulation, 127(5), 652–662. https://doi.org/10.1161/CIR.0b013e31827ee100

The Cooper Institute. (2023). Physical fitness assessments and norms for adults and law enforcement (10.ª ed.). The Cooper Institute.

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Rodrigo Valdivia Quintero: Participated in the development of the instruments, applied and processed the tests. Developed the training program.

Bruno André Mieles Augurto: Carried out the theoretical systematization of the research variables and constructed the bibliographic references in APA Standards.

David Alejandro Fernández Guevara: Participated in the measurements and control of the applied tests and in the statistical processing of the data.

Kenya Paola Calva Oñate: Participated as an assistant in the application of the tests and developed the discussion and conclusions of the research