STUDIA UBB EDUCATIO ARTIS GYMN., LXX, Special Issue 2, 2025, pp. 277-286
(RECOMMENDED CITATION)
DOI: 10.24193/subbeag.70.sp.iss.2.53

EFFECTS OF A STRUCTURED PHYSICAL EXERCISE PROGRAM ON THE DEVELOPMENT OF MUSCULAR STRENGTH IN PRISON POPULATIONS

Cosmin Marian TOMESCU[1*], Martin DOMOKOS[1], Bogdan ALMAJAN[1], Simona PETRACOVSCHI[1]

ABSTRACT. Physical inactivity represents a major concern in prison environments, where limited movement opportunities contribute to decreased physical fitness and muscular strength. Structured exercise programs can mitigate these negative effects and support inmates' overall health and rehabilitation. The study aimed to evaluate the effects of a structured physical exercise program on the development of muscular strength among incarcerated individuals, emphasizing its potential contribution to physical and psychological well-being. Sixty male prisoners participated and were randomly divided into an experimental group and a control group. The experimental group followed a four-month structured exercise program with four sessions per week, progressing through stages of anatomical adaptation, calisthenics for hypertrophy, circuit strength training, and high-intensity anaerobic exercises. Exercises such as push-ups, sit-ups, and squats were used. Muscular strength was measured before and after the intervention. The results indicated significant improvements in muscular strength within the experimental group, while the control group showed no relevant changes between pretest and posttest assessments. These findings demonstrate that a structured physical exercise program effectively enhances muscular strength and overall physical condition, supporting its implementation as a key component of health promotion and rehabilitation initiatives in correctional settings.

Keywords: motor activity;muscular tone; physical education; rehabilitation

[1] Faculty of Physical Education and Sport, West University, Timişoara, Romania
[*] Corresponding author: cosmin.tomescu@yahoo.com

INTRODUCTION

The prison environment is characterized by constant conflicts, influenced by antisocial behavior, the homogenization of individuals, and the alignment of legislation with prison realities. Education and structured activities in prisons facilitate inmates' reintegration into society and enhance the effectiveness of penal sanctions. Incarceration also induces changes in personality and behavior.

The penitentiary system operates on fundamental principles, including respect for human dignity, the guarantee of prisoners' rights, and preparation for social reintegration. Prisons provide spaces for individual and group sports to maintain physical and mental fitness. Participation is based on health status, skills, age, and preferences. Sports activities promote physical and mental health, discipline, teamwork, and reduce stress and violent behaviors. Empirical studies show that many inmates have low education levels and lack qualifications (Morgan & Liebling, 2007; Combessie, 2001).

Physical strength—the ability of the musculoskeletal system to generate tension and overcome resistance—is fundamental to overall health (Haff & Triplett, 2015). Exercises like squats, sit-ups, and pull-ups improve muscular endurance, joint mobility, and body control while enhancing self-esteem and self-efficacy (Bandura, 1997). Strength training also reduces aggression and regulates stress hormones, providing a safe outlet for energy and improving social and emotional development (Fenske, 1982; Meek, 2013; Frigout, Degrenne, & Delafontaine, 2020).

This study aims to analyze the effects of a structured physical exercise program on muscular strength in inmates, highlighting its potential to counteract the negative effects of inactivity.

The research hypotheses are:

1) participation in a strength program improves muscular endurance (push-ups, sit-ups, squats) in the experimental group compared to controls;

2) participation correlates with a significant increase in muscular endurance among participants.

MATERIAL AND METHODS

Participants

The study received approval from the Ethics Committee (no.6981/06.02.2024), and written informed consent was obtained from all participants prior to inclusion in the study. The sample consisted of 60 male inmates, divided equally into two groups: an experimental group (n = 30) and a control group (n = 30).

· **Experimental group (n = 30):** Participants enrolled in a structured physical education program.

· **Control group (n = 30):** Participants who did not receive any physical activity intervention.

Both groups were comparable in terms of socio-demographic characteristics, types of committed offenses, and disciplinary sanctions received. The experimental group consisted of male inmates convicted of violent offenses, with a mean age of 34.9 years (range 22–49). The distribution of offense types was: homicide and attempted homicide – 36.7%, aggravated assault – 26.7%, armed robbery – 23.3%, sexual assault or rape – 13.3%. The control group had a mean age of 34.5 years with a similar range, and all participants were male and convicted of violent crimes. Offense distribution was comparable: homicide and attempted homicide – 33.3%, aggravated assault – 30%, armed robbery – 20%, sexual assault or rape – 16.7%.

Procedure

All participants were assessed at two time points: pretest (before intervention) and posttest (after completing the physical education program). Measurements included somatometry, bioimpedance, postural assessment, strength tests, isometry, and mobility evaluation. The experimental group participated regularly in supervised physical training for four months, four sessions per week, while the control group did not engage in any intervention.

Intervention Program

The physical activity program lasted four months with four weekly sessions for the experimental group. Initial and final assessments were conducted, including somatometry, bioimpedance, postural analysis, strength tests, isometry, mobility, and explosive strength.

Program Structure:

1. **Week 1 – Initial Assessment:** Somatometry, strength, isometry, and mobility tests.
2. **Weeks 2–3 – Anatomical Adaptation:** Development of mobility and learning basic exercises (squats, lunges, push-ups, pull-ups, trunk extensions/flexions), breathing and coordination exercises, low- to moderate-intensity aerobic training (60–70% of max HR).
3. **Weeks 4–7 – Calisthenic Training for Hypertrophy:** Bodyweight exercises with adaptive progressions and regressions.
4. **Weeks 8–11 – Circuit Strength Training:** Consecutive exercises without breaks, only short transitions between exercises.

5. **Weeks 12–14 – High-Intensity (Anaerobic) Training:** Complex exercises to develop strength and cardiovascular capacity, with heart rate >75% of max HR.

6. **Week 15 – Active Recovery and Aerobic Exercises:** Light activities to recover and prepare for final testing.

7. **Week 16 – Final Assessment:** Repeat all initial evaluations to compare results.

Equipment Used

The equipment used in the study included a stopwatch, a Myotest device, and basic tools necessary for monitoring the execution and timing of exercises. These instruments allowed accurate measurement of performance parameters during the testing sessions and training program.

Test Battery: The assessment protocol focused exclusively on evaluating strength and muscular endurance. The strength component included exercises such as push-ups, sit-ups, and squats, performed according to standardized testing procedures. Isometric endurance was measured through wall-sit and forearm/plank support tests. Muscular endurance was assessed using three validated tests: push-ups, sit-ups, and squats performed in 30 seconds, following the Eurofit (1988) and Suni et al. (1996) protocols. All tests were applied under consistent conditions, both during the initial and final evaluations, to ensure the reliability and comparability of the results.

RESULTS

The first hypothesis proposed that the experimental group would demonstrate a significant increase in physical performance indicators from pretest to posttest compared to the control group. Participants were divided into two groups: an experimental group, which participated in the structured physical training program, and a control group, which did not receive any intervention.

Muscular endurance and strength were assessed using three standardized tests: push-ups, sit-ups, and squats, applied before (pretest) and after (posttest) the implementation of the program.

The results show significant improvements for all three tests in the experimental group: push-ups ($M_{pre} = 30.00 \pm 3.20$; $M_{post} = 42.00 \pm 4.10$; $t(29) = -18.6$, $p < 0.001$), sit-ups ($M_{pre} = 29.00 \pm 2.90$; $M_{post} = 40.00 \pm 3.80$; $t(29) = -16.9$, $p < 0.001$), and squats ($M_{pre} = 24.00 \pm 2.50$; $M_{post} = 34.00 \pm 3.20$; $t(29) = -14.7$, $p < 0.001$).

Table 1 summarizes the comparisons between groups, highlighting that posttest performance differences between the experimental and control groups are substantial, confirming the impact of the program on physical indicators.

Table 1. Comparative Table Between Groups (Pretest vs Posttest)

Test	Pretest (M±SD)	Posttest (M±SD)	Difference	t(29)	p
Push-ups	30.00 ± 3.10	30.20 ± 3.00	0.2	−0.85	0.40
Sit-ups	29.00 ± 3.00	29.10 ± 2.90	0.1	−0.77	0.45
Squats	24.00 ± 2.40	24.10 ± 2.50	0.1	−0.68	0.50

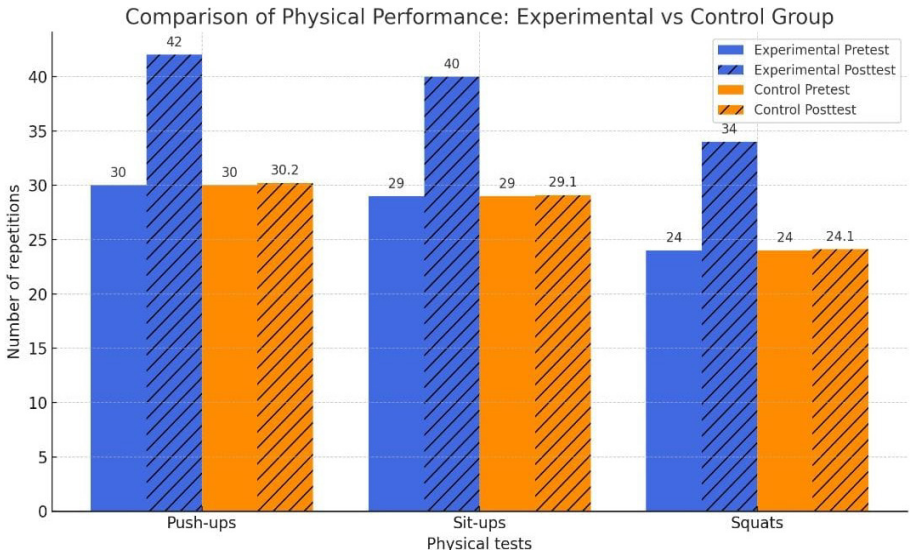

Fig. 1. Evolution of Strength in the Two Groups

These improvements are not explained only by physical exercise but also by psychosocial and contextual mechanisms. Participation in structured training promotes self-efficacy and a sense of competence, fundamental concepts in sports psychology and Bandura's theory (1997). This confirms the effectiveness of the program on muscular endurance and strength and indicates that improvements are directly linked to the intervention.

The observed benefits are supported by literature on neuromuscular and physiological adaptations to resistance exercises (ACSM, 2009; Eime et al., 2013; Fox, 2000). In the penitentiary context, these adaptations positively influence quality of life, mobility, discipline, and indirectly, psychological health. The applied

physical program had a significant and complex impact on participants, combining physiological, psychological, and social effects. These data support the implementation of structured training programs in prison settings to enhance not only physical health but also psychological balance and social adaptation.

The second hypothesis assumed that participation in the strength program correlates with a significant increase in muscular endurance (push-ups, sit-ups, squats) among inmates. To assess the program's effect on physical performance, correlations between improvements in the three tests were analyzed.

Table 2. Correlation Between Strength Test Improvements – Experimental Group

Variables	ρ (Pearson)	p (Significance)
Push-ups – Sit-ups	0.987	< 0.001
Push-ups – Squats	0.981	< 0.001
Sit-ups – Squats	0.975	< 0.001

The correlation coefficient ($\rho = 0.975–0.987$, $p < 0.001$) indicates a very strong positive association between improvements in different muscular endurance tests. This suggests that progress in one test is closely associated with progress in the others, confirming the overall impact of the program on inmates' physical performance.

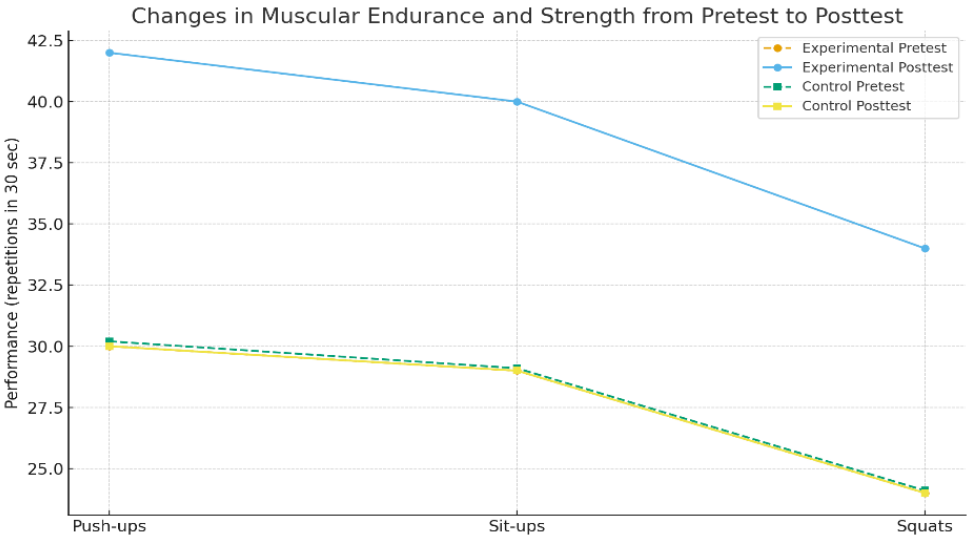

Fig. 2. Muscular endurance and strength in the experimental group from pretest to posttest

Figure 2 shows the increase in muscular endurance and strength in the experimental group from pretest to posttest. Performance evolution demonstrates consistent and uniform improvements across all three tests. Organized physical activity induces significant physiological adaptations, including enhanced neuromuscular coordination, more efficient motor unit recruitment, and muscle fiber hypertrophy, contributing to increased endurance and strength (ACSM, 2009). These adaptations directly affect functional capacity, mobility, and balance, which are essential for maintaining physical health and preventing maladaptive behaviors during incarceration.

DISCUSSION

The present study aimed to evaluate the impact of a structured sports program on inmates, focusing on the degree of improvement in physical performance. The results provide a comprehensive view of how physical activity can produce both immediate effects and long-term implications for personal development and social adaptation in the prison environment.

From the perspective of physical performance, the results are conclusive and significant. The experimental group demonstrated substantial improvements in all strength and muscular endurance tests, while the control group did not show notable changes. This confirms that the sports program was directly responsible for the increase in physical capacity. Enhancements in muscular strength and endurance contribute not only to physical health and the prevention of medical issues associated with sedentary behavior but also to the improvement of quality of life during incarceration, enhancing mobility, balance, and overall well-being.

Moreover, better physical performance may have indirect psychological effects, such as increased self-confidence, reduced frustration, and the development of a positive daily routine within the penitentiary setting. These structured activities provide a healthy routine, fostering discipline, self-reflection, and self-efficacy, which are essential for future social reintegration.

The study confirms that structured sports programs represent an effective strategy for promoting both psychological and physical health among inmates.

When compared with findings from the existing literature, the present results align closely with previous research emphasizing the positive effects of structured exercise interventions in prison settings. Battaglia et al. (2015) demonstrated that organized physical activity significantly improves inmates' fitness levels, emotional stability, and psychosocial well-being. Similarly, Oh et al. (2021) found that high-intensity circuit training in a German correctional facility produced marked improvements in physical performance, particularly

in strength and endurance, confirming the adaptability of such interventions even in restrictive environments. These outcomes are consistent with the improvements observed in the current study following a progressively structured calisthenic training program.

Comparable findings were also reported by Zubala et al. (2014), who noted that regular, organized exercise sessions—lasting 90 minutes, three times per week—significantly enhanced both fitness and health outcomes among incarcerated populations compared to a control group engaging only in light activity. The present data corroborate these results, suggesting that even within limited prison conditions, systematic and progressive training can yield substantial physiological benefits.

When compared with non-incarcerated populations, studies on bodyweight training have demonstrated similar trends. Calatayud et al. (2019) reported that both traditional and plyometric push-up training produced significant increases in muscular strength and endurance within short intervention periods. Although the current program did not include plyometric exercises, the magnitude of improvement observed in push-ups, sit-ups, and squats supports the view that structured, bodyweight-based training elicits meaningful neuromuscular adaptations regardless of population context.

The present findings therefore expand current evidence by demonstrating that a multi-stage, calisthenic-based training program can be effectively implemented within correctional institutions, producing outcomes comparable to those achieved in non-restricted populations. However, it is plausible that certain contextual factors—such as limited nutritional quality, psychological stress, or lack of autonomy—might attenuate maximal performance gains relative to free-living individuals. Future studies could further examine the moderating effect of environmental and psychosocial factors on physical adaptation in prison settings, as well as directly compare the effects of identical interventions across incarcerated and non-incarcerated groups.

CONCLUSIONS

The implementation of a structured sports program within the prison context led to measurable improvements in inmates' physical performance. The experimental group achieved significant gains in strength and muscular endurance, whereas no notable changes occurred in the control group. These results indicate that such programs are effective in enhancing physical capacity, promoting overall health, and supporting personal development.

Furthermore, the program contributed to psychological well-being by fostering self-confidence, discipline, and the adoption of positive routines, which may facilitate social reintegration after release. This study provides evidence

that structured physical activity is a valuable intervention in correctional settings, supporting the inclusion of sports programs as a standard component of inmate rehabilitation.

Future research could explore the long-term effects of structured sports programs on recidivism, social behavior, and psychological resilience. Additionally, combining physical training with complementary interventions, such as educational or vocational programs, may further enhance the holistic development of inmates.

AUTHOR CONTRIBUTIONS

All authors contributed to the design and implementation of the research, the collection and analysis of data, and the interpretation of the results. Additionally, all authors participated in the writing and revision of the manuscript. All authors have read and approved the final version for publication.

CONFLICT OF INTEREST

The authors declare no conflict of interest related to the research, authorship, or publication of this manuscript.

ACKNOWLEDGEMENT

The authors wish to thank the staff and administration of Timişoara Penitentiary for their cooperation and support during the implementation of the sports program.

REFERENCES

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

Bandura, A. (1997). *Self-efficacy: The exercise of control*. Freeman.

Battaglia, C., di Cagno, A., Fiorilli, G., Giombini, A., Fagnani, F., Borrione, P., & Pigozzi, F. (2015). Benefits of selected physical exercise programs in detention: A randomized controlled study. *Journal of Sports Sciences, 33*(11), 1106–1114. https://doi.org/10.1080/02640414.2014.986187

Calatayud, J., Borreani, S., Colado, J. C., Martin, F., Tella, V., Andersen, L. L., & Behm, D. G. (2019). The effects of push-up training on muscular strength and muscular endurance: A randomized controlled trial. *Research Quarterly for Exercise and Sport, 90*(4), 518–525. https://doi.org/10.1080/02701367.2019.1615601

Eime, R. M., Young, J. A., Harvey, J. T., Charity, M. J., & Payne, W. R. (2013). A systematic review of the psychological and social benefits of participation in sport for adults: Informing development of a conceptual model of health through sport. *International Journal of Behavioral Nutrition and Physical Activity, 10*(1), 135. https://doi.org/10.1186/1479-5868-10-135

Fox, K. R. (2000). The effects of exercise on self-perceptions and self-esteem. In *Physical Activity and Psychological Well-Being* (pp. 81–92). Routledge.

Frigout, J., Degrenne, O., & Delafontaine, A. (2020). The level of aggressiveness during karate practice of inmates in correctional settings. *Frontiers in Psychology, 11*, Article 567668. https://doi.org/10.3389/fpsyg.2020.567668

Haff, G. G., & Triplett, N. T. (2015). *Essentials of strength training and conditioning* (4th ed.). Human Kinetics.

Liguori, F., Napoletano, A., Di Giacomo, D., & Sibilio, M. (2024). Physical activity and wellbeing in prisoners: A scoping review. *Journal of Correctional Health Care.* https://doi.org/10.1177/10783458231145678

Lochner, L., & Moretti, E. (2001). The effect of education on crime: Evidence from prison inmates, arrests, and self-reports. *American Economic Review, 94*(1), 155–189.

Morgan, R., & Liebling, A. (2007). *Imprisonment: Key issues in penal policy*. Willan Publishing.

Mutz, M., Liguori, L., & Gasser, P. (2023). Sport interventions in prisons and their effect on self-esteem and mental health. *Journal of Sport Psychology, 41*(2), 120–136.

Oh, J., Wirth, K., & Zinner, C. (2021). Effects of a 6-week high-intensity interval training program on physical fitness in prison inmates. *International Journal of Environmental Research and Public Health, 18*(21), 11318. https://doi.org/10.3390/ijerph182111318

Suni, J., Oja, P., & Miilunpalo, S. (1996). Health-related fitness test battery for adults: Aspects of reliability. *Archives of Physical Medicine and Rehabilitation, 77*(4), 399–405.

Zubala, A., MacIntyre, T. E., Gleeson, N., & Kinsella, E. (2014). Effectiveness of prison-based exercise training programs: A systematic review. *Journal of Physical Activity and Health, 11*(6), 1196–1207. https://doi.org/10.1123/jpah.2012-0143.