SVOA Orthopaedics
ISSN: 2752-9576

ScienceVolks Open Access

Review Article

Therapeutic Boxing: Narrative Review About Boxing as Therapeutic Tool

Javier Sáa Molina[1]* and Sandra Mahecha[2]

[1] *Sports Medicine Residency program, Facultad de Ciencias, Universidad Mayor, Santiago, Chile.*

[2] *Director of science postgraduate program, Facultad de Ciencias, Universidad Mayor, Santiago Chile.*

***Corresponding Author:** Javier Sáa Molina, Sports Medicine Residency program, Facultad de Ciencias, Universidad Mayor, Santiago, Chile.*

DOI: https://doi.org/10.58624/SVOAOR.2024.04.074

***Received:** June 06, 2024* ***Published:** July 24, 2024*

Abstract

Aim: To make a narrative review of the present evidence about boxing-based training and rehabilitation programs, their benefits and applicability in different conditions (age, sex, and health status).

Method: Narrative review.

Results: Evidence is scarce in terms of boxing-based training programs and its applicability, mainly focused on neurological disorders and/or mobility limitations disorders. Nevertheless, the underlying principles that sustain its usefulness are promising.

Conclusion: In spite the limited evidence, boxing based training, with its case-to-case customization, seems safe and feasible, both in physiological and pathological conditions, probably due to its stimuli to cardiovascular and muscle fitness and motor skills acquirement.

Keywords: *Boxing; Boxing training; Noncommunicable diseases; Physical activity; Muscle strength; Motor skill; Sports participation.*

1. Background

Recent evidence shows the benefits that physical exercise has on non-communicable diseases, such as hypertension (1), having a comparable impact to antihypertensive drugs, reducing systolic pressure around 9 mmHG, and up to a 50% reduction of the mortality risk; diabetes (2), incidence of diabetes, cardiovascular events, microvascular complications, and death in diabetics, osteoporosis (3), increasing bone density, reducing fracture risk up to 10% (4). Besides its positive effects on cardiorespiratory fitness (5-7), and muscle fitness (8,9). These benefits are also seen on social and psychological health (10,11). Furthermore, physical exercise has a positive association with sports participation and sports-based games participations, in both healthy and non-healthy population (12,13).

According to the WHO, physical inactivity is an increasing problem, with a 27.5% global age-standardized prevalence of insufficient physical activity, having women in Latin America and the Caribbean the highest prevalence with a 43.7%. Among levels of income, high-income countries have more than twice the prevalence than low-income countries: 36.8% and 16.2%, respectively. Therefore, physical activity and exercise presents as a useful tool for the treatment and prevention of multiple chronic diseases across all life span (15-18).

Different modalities of exercise and training methods are used to improve physical exercise or training adherence, among healthy and non-healthy population. Sports or sports-based training can be valuable in this term, in different populations, with its proper adaptations and modifications (12, 19). Boxing-based training appears as a suitable choice to stimulate different fitness variables such as cardiorespiratory and muscle fitness, balance, flexibility, and body composition (20, 21).

Boxing is a combat sport with a high physical, functional and physiological demand (22, 23). Punching explosiveness is determined by muscle strength and power (22). Throughout combat, a high punching output must be maintained, despite fatigue, demanding a high level of physical fitness, and its manifestations: speed, strength, power, coordination, aerobic capacity (23). This is why boxing-based training seeks to improve performance and functional ability (20, 24). These same variables are affected in different chronic diseases (osteoarthritis, respiratory chronic diseases, Parkinson disease, diabetes, coronary artery disease, etc) (5,15, 25-27).

To this date, some studies use this type of training during rehabilitation and to improve fitness (28-31), in adults, children and adolescents, inpatients and outpatients' services, and community interventions.

This review aims to synthesize actual evidence around boxing and boxing-based training across different populations, age and physiological conditions.

2. Method

Bibliographic search was done in English in PubMed, SCIELO, Web of Science, with the terms *boxing,* with *exercise therapy (51), community bases (13), rehabilitation (114).* Being the aim of the review to show therapeutic or beneficial applications of boxing and its variations (kick-boxing, tai chi and others), articles that study competitive sport were not considered, neither the ones that study sports related injuries and rehabilitation nor pilot studies without partial results. Selected studies should explore the relation between boxing and/or boxing based training and any fitness variable mentioned above. Leaving a total of 36 articles with diverse characteristics: age, exercise type, diseases and methodology.

3. Results

Given the diverse characteristic of studies in terms of methodology, population, results, and types of training, it was decided to display the findings focusing on the fitness component that the study evaluated. (Table 1)

Cardiorespiratory Fitness

Among the studies, both direct and indirect variables were considered: energy expenditure (EE), heart rate (HR), oxygen consumption (VO2) and 6-minute walk test (6MWT). Some studies used video games as the intervention, defined as *active video games* (AVG), these AVG showed a stimulus comparable to moderate intensity physical activity (MPA) (27, 29, 33- 35, 37, 39, 41, 46). Depending on the sports emulated and the studied individuals, EE increases from a baseline of 1 MET to 5 METs (34, 36) on healthy and unhealthy population, increases of VO2, from 4-5 ml/kg/min to 21 ml/kg/min on elderly adults playing a boxing AVG, and even reach a 7.2 METs or 46.4% VO_2 max on healthy young adults (34, 36). In those where HR was assessed, 3 studies showed that participants engaging in AVG reach a HR comparable to the first ventilatory threshold (VT_1) on individuals that suffered a stroke, and 64-75% of their HRmax on young adults (31, 40, 46). Other studies compared sedentary video games and AVG, the latter, showing two-fold VO2 vs sedentary video games, and a three-fold VO2 compared to resting VO2 (42,44). When comparing Boxing AVG with a punching bag training, Matrosly et al (48), showed that both activities had a 4.4 METs of EE among spinal cord injury patients.

Only 3 studies explored cardiorespiratory fitness without video games, through adapted boxing training (35) and adapted Thai boxing (51,52). In the first study, improvement in 6MWT were observed at 24 and 36 weeks, even for patients with advanced Parkinson's disease. Interventions with adapted thai boxing, were conducted on both healthy and OA diagnosed individuals, and showed improvement in 6MWT after 12 weeks of training. When healthy individuals were assessed, the thai boxing training group improved from 462.2 ± 48.5 meters baseline to 480.3 ± 49.7 meters on the 12th week (p= 0,031), whereas the control group showed a significative decrease from 449.5 ± 25.7 to 415.8 ± 25.1 (p=0,038). Positive changes were also seen on adults with knee OA, having significative improvement as early as the 4th week of intervention, compared to the control group (INT: 333.0± 30.4 - 386.0± 33.6 vs CON: 354.5± 32.1 - 374.5± 42.1, $p < 0.05$).

Muscular fitness

Direct and indirect assessments were considered for this fitness component. Direct assessments included handgrip strength and upper limb strength and indirect assessment included TUG (35, 37, 54), some motor subscales from Parkinson's disease scores as UPDRS (35), gait speed (37), gross motor skills scales as GMFM (39), 10 minutes walking test (10MWT) (50) and 8FUFGT (54). AVG was also used as intervention when muscle fitness was assessed in 2 studies, both on pediatric patients (39, 43).

Body Composition

Only one study assessed some form of body composition (29), in which body weight, Body mass index (BMI) and waist circumference were considered. The authors studied Hispanic children and adolescents with overweight/obesity through a boxing-based training program of 12 weeks. The participants showed a significative reduction in waist circumference (t=-2.57, p= 0.02, d=0.64) and BMI (t=-2.53, p=0.023, d=0.20).

Body composition improvements on children and adolescents diagnosed with overweight/obesity is associated with a decreased risk of diabetes type 2 and cardiovascular disease.

Balance

8 articles assessed balance through different scales and instruments. The most used was Balance Bers Scale (BBS) (35, 37, 50, 52), then the activities specific balance confidence scale (ABC) (35, 36, 37). Other scales used were Sensory Organization Testing (SOT) (32) of the Smart Balance Master System. (Wong et al., 2001), dynamic gait index (DGI) (37), Romberg tandem test (54), and subjective proprioception and balance (33).

In those studies where BBS was used, different types of interventions where performed: boxing (35, 50), kick-boxing (37), thai-boxing (51). All of those show to be effective in improving balance in neurological disease diagnosed patients (35,37,50), and osteoarthritis diagnosed patients (52).

On the other hand, the 3 studies that included ABC scale, results were not as consistent. Just one of those found significative improvement after the intervention, a 12 week boxing based program for PD patients (35). Other study that used ABC scale did not show significative changes on patients with multiple sclerosis (37). One of the studies did not evaluate ABC scale as an outcome after the training program (36).

Table 1.

Glossary: TCC: Tai Chi Chuan (Form Of Thai Chi), AVG: Active Video Game, SVG: Sedentary Video Game , ABC Scale: Activities Specific Balance Confidence Scales, FRT: Functional Reach Test, BBS: Berg Balance Scale, TUG: Timed Up And Go , 6MWT: Six-Minute Walk Test, UPDRS: Unified Parkinson Disease Ratting Scale, PDQL: Parkinson's Disease Quality Of Life Scale, CPM: Counts Per Minute , DGI: Dynamic Gait Index. CRF: Cardiorespiratory Fitness, EE: Energy Expenditure, PACES: Physical Activity Enjoyment Scale, HR: Heart Rate, ICU: Intensive Care Unit, HG: Hand Grip, SPO2: Oxygen Saturation, ACC: Accelerometers Assessment, RPE: Ratings of Perceived Exertion. T2DM: Type 2 Diabetes , SDS: Self-Rating Depression Scale, SAS: Self-Rating Anxiety Scale, A1C: Glycated Hemoglobin, EEG: Electroencephalography, MFT: Manual Functional Test (MFT), 10MWT: 10 Meters Walk Test, SS-QOL: Stroke-Specific Quality Of Life Questionnaire, FTSST: Five Times Sit To Stand Test, OA: Osteoarthritis, SR: Sit And Reach Test, KOOS: Knee Injury And Osteoarthritis Outcome Score, VT1: First Ventilatory Thresholds, VT2: Second Ventilatory Thresholds, WC: Waist Circumference, PD: Parkinson's Disease, CSR: Chair Sit And Reach Test, 8FUGT: 8 Foot Up-And-Go Test .

Author, year	Type of training	Sample	Method	Variable assessed	Results/conclusion	Observations
(32) A. Wong, 2001	TCC	N=39 25 TCC practition-ers 14 healthy and active adults	Cross section-al study	Balance (Static and dynamic balance of Sensory Organization Testing (SOT) of the Smart Balance Master)	TCC individuals show better balance on complex tasks.	TCC group also show a greater speed and bodyweight transfer control

(33) L. King, 2009	Tai Chi and Boxing	Patients with PD	Progressive Exercise program for PD patients	Proprioception, balance, attention, executive function, strength	Exercise complexity progression throughout the program.	The program show progression of the complexity of the different exercise, but not a protocolized evaluation.
(34) H. Hurkmans, 2010	AVG (Wii Sports Boxing)	N=8 Patients diagnosed with CP	Cross sectional study	VO2 and EE	WiiSports Boxing show an 5 ±1.1 METs of EE comparable to a moderate intensity physical activity.	AVG show as an alternative to physical disabled patients.
(35) S. Combs, 2011	Boxing	N=6 Patients with PD	Case series Boxing training programs of 12 – 36 weeks, 90 minutes per sessions Assessments at weeks 0, 12, 24, 36.	FRT, BBS, ABC, TUG, 6MWT, gait cadence, stride length,step width, activities of daily living and motor examination subscales of the UPDRS and PDQL scale.	5 out of 12 parameters improve in al subjects after 12 weeks 5 out 6 patients improve in all categories after competion of programs.	Improvements tend to increase afeter 24 and 336 weeks Patients with moderate PD improve earlier than those with moderate to severe PD.
(36) L. Taylor, 2012	AVG (Wii and XBOX 360 Kinect)	N= 19 Community-dwelling adults aged 70.7▯6.4 years.	Cross-sectional study. 5 minutes of AVG, standing and sitting	EE, CPM, ABC, TUG	Boxing AVG reach the highest EE and CPM (accelerations)	Boxing games present the highest EE and accelerations compared with other games.
(37) K. Jackson, 2012	Kick-Boxing	N=4 Four individuals with relapsingere mitting or secondary progressive MS.	kickboxing program two times per week for 8 weeks	BBS, DGI, TUG, gait speed, ABC,	3 of 4 participants had improvements in BBS performance. All participants demonstrated improvements in the DGI. Changes in the TUG, ABC, and walking speed were variable	Some patients were highly functional before the intervention, this could explain the non-changing variables.
(38) M. Kho, 2012	Boxing and other AVG	N= 22 adults patients admitted to a medical ICU (median age: 52 years)	Longitudinal and observational study	14 prospectively monitored safety events.	During 35 hours of Physical therapy treatment, 0 safety events occurred.	Novel use of interactive video games is feasible and appears safe in critically ill patients.
(39) C. Gordon, 2012	Boxing and other sports AVG	N=7 children, aged 6 to 12 years, with dyskinetic CP	Pilot study with a pre–post-test design	Gross Motor Function Measure (GMFM)	GMFM score increased from 62.83 [standard deviation (SD) 24.86] to 70.17 (SD 23.67) or 7%	Even a 1% increase of GMFM is considered clinically meaningful.

(40) P. Bosch, 2012	Boxing AVG	N=20 healthy 23 to 27 years old adults	Cross sectional study maximum heart rate (HRmax) via a treadmill test and heart rate (HR) response to 30 minutes of Wii Sports boxing.	percentage of HRmax	Mean HR response to boxing was 143 bpm or 77.5% of HRmax	Even in heathy individuals, boxing AVG provides a moderate to vigorous aerobic response.
(41) J. Howcroft 2012	Boxing AVG	N=17 children diagnosed with CP	Single-group, experimental study comparing different AVG	EE, Upper limb kinematics, exercise enjoyment by PACES	Boxing AVG presented greater EE and upper limb muscle activation than other AVG A high level of enjoyment was reported on the PACES (4.5 out of 5).	Boxing AVG appears as the most stimulant AVG
(42) P. Gaffurini 2013	Boxing AVG	N=10 male subjects with SCI (lesion levels from C7 to L1) age 26 to 55 years	Repeated measures at rest and while playing virtual bowling, tennis and boxing games using a portable metabo- limeter equipped with ECG electrodes	pulmonary ventilation (VE), VO2, EE, HR, METs.	Boxing AVG showed to be the most stimulant AVG, producing greater increases in all parameters	METs exceeded in average 3 during boxing games.
(43) F. Abdulsatar 2013	Boxing AVG	N=8 Children aged 3–18 years at a pediatric critical care unit	Pilot trial Twice a day, 2-day sessions of Boxing AVG	HR, sPO2, ACC, (upper limbs accelerations counts), adverse events	No adverse events, no desaturation episodes, no changes in HG, significative changes in ACC,	Parent rating based on a Likert scale (from 1 to 7) around safety, benefits and perceived enjoyment were 6.9, 5.3 ,5.7, respectively.
(44) L. Siegmund 2014	Boxing AVG	N= 17 children (age 8.5 ± 0.4 years)	Individuals played sedentary video games and AVG for 10 minutes each, with and without a peer. Motivation and physiological response were assessed	VO2, RPE, enjoyment based on visual analog scale.	AVG presented twice de VO2 than sedentary games and similar levels of enjoyment.	Children were less motivated in the presence of a peer relative to playing alone, this finding was in contrast to the authors hypothesis.

(45) Y. Zheng 2015	TCC	N= 120	Longitudinal intervention study between intervention TCC (Tai chi shadow boxing) and control group. Depression and anxiety scores were assessed, and A1C hemoglobin	SDS, SAS, A1C	Differences between SDS and SAS in the intervention group before and after treatment were statistically significant. No differences were non-significant in the control group. Reduction in the A1C were greater in the intervention group.	The TCC group received specific and didactic training guidance and the control group a general guide.
(46) G. Barry 2016	Boxing AVG	N= 19 healthy adolescents	Cohort study. Comparisson between SVG and AVG	VO2, HR, RPE,	AVG reached significantly higher values of the three parameters. AVG reached intensities comparable to moderate intensity physical activity	AVG reached 7.2 METs or 46.4% VO2 max on average.
(47) P.Wollseiffen 2016	Boxing	N= 50 working adults (23 females)	5 cohorts with different types of breaks (active and resting) on cognitive performance and related cortical activity.	EEG, cognitive tests	Active breaks (boxing and cycling) reached better cognitive performance and a more functional EEG.	Breaks had a 20 -minute duration. Boxing was the most enjoyable active break.
(48) M. Matrosly 2017	Boxing AVG	N=17 participants with spinal cord injury	Cross-sectional study. 15-minute session of Boxing AVG and heavy-bag boxing in a sitting position.	EE, VO2, RPE	AVG and heavy bag boxing achieved moderate exercise intensities (MEt: 4.4±1.0)	Post session user survey reported all the participants found exergaming boxing more enjoyable.
(49) K. Rourke 2017	Boxing	N=31 adolescents	Longitudinal intervention study. 4-week fitness course. Including sports, non-contact boxing drills, and games	Warwick Edinburgh Mental Well-being Scale	All of the scale's items improved significantly after the intervention	74% said feeling more confident >80% said feeling more cheerful and interested in new things There was a 83% assistance
(50) J. Park 2017	Boxing (sitting)	N=26 patients diagnosed with hemiplegia due to stroke	Randomized control trial. 6 -week boxing training vs control (physical therapy).	MFT, BBS, TGB, 10MWT, SS-QOL	All the parameters significantly improved in the boxing group and and showed significantly greater improvements in the boxing group compared to the control group after 6 weeks.	Intervention and control group presented the same activity time.

(51) T. Jan-yacharoen 2018	Thai Boxing	N=56 Healthy elderly subjects	randomized controlled study. 12-week program of adapted Thai boxing training vs control group.	6MWT, FTSST, trunk flexibility by trunk flexometer, TUG, BBS, QOL	Positive and significant differences were found in terms of all seven outcomes between the two groups	ancient boxing exercise significantly improved physical functions, balance, and QOL in the elderly
(52) T. Jan-yacharoen 2018	Thai Boxing	N=40 patients with osteoarthritis	randomized controlled study. 12-week program of adapted Thai boxing training vs control group.	6MWT, SR, BBS, TUG, KOOS, QOL	Positive and significant differences were found in 6MWT, FTSST, trunk flexibility, TUG, BBS y QOL	Control presented no changes throughout the RCT.
(31) J. Silva de Sousa 2018	Boxing AVG	N=12 chronic hemiparetic stroke survivors	Single subjects repeated measure design. 2 sessions of AVG and 1 control.	HR, VO2, VT1 y VT2	Boxing AVG promoted reproducible responses of HR and VO2 that corresponded, respectively, to VT1 and below VT2.	Boxing AVG promoted greater responses than tennis AVG
(29) S. Yli-Piipari 2018	Boxing	N=22 high-risk pediatric primary care patient	Case series: pre and post intervention assessment. 12 -week program, twice a week	Waist circumference (WC), BMI, cholesterol, triglycerides, glucose, physical activity time, sedentary behavior time, levels, motivation by Behavioral Regulation in Exercise Questionnaire.	Significant reduction in WC, fasting glucose and amotivation levels. Significant increases in moderate and vigorous physical activity levels, intrinsic motivation and introjected regulation	Intervention also included nutrition education and guidance to the parents.
(53) J. Domingos 2019	Boxing	N=26 persons with PD and 10 boxing instructors	qualitative descriptive design to address the implementation of a boxing program in a community setting	satisfaction, instructors' appreciation of the educational resources; and numbers of patients interested in participating in the boxing program, patients and instructors satisfaction, adverse events, facilitators barriers	Workshop (Time 0) Satisfaction: 80·% patients and instructors scored as “very satisfied Instructors found the educational resources either “helpful” (4/10; 40%) or “very helpful” (6/10; 60%). All participants completed the workshop without any serious adverse events 18 month follow up Participants indicated that they were very satisfied (9/17; 53%), satisfied (6/17; 35%) and nei- ther satisfied nor unsatisfied (2/17; 12%).	Physical disabilities and transportation were the main barriers.

(54) P. Areeu-domwong 2019	Thai Boxing	N= 78 com-munity-dwelling older adults	RCT. 4-week Adapted Thai boxing training vs control (education through a fall prevention booklet). .	TUG, Lower limb strength, Tandem Romberg test, 8FUGT	significantly greater improvements in balance and all functional fitness when compared to the control group. Effects except for body flexibility were still maintained at 4-month follow-up.	Between the follow up at 4 months and in the interventions, participants went back to their previous routine.
(30) L. Borrero 2020	Boxing	N= 8 adults with PD	Qualitative phenomeno-logical approach. Individual interview are interested in everyday or "lived" experiences.	experiences with exercise and the multi-faceted role it played in their lives. Inter-view data were analyzed using system-atic coding and organized into primary themes.	3 primary themes emerged: 1. The unique importance of social connections with others diagnosed with PD, 2. a sense of purpose, and 3. determination and confidence.	The only study with individual and personal interviews.

4. Discussion

Physical inactivity has been considered the new global public health issue of this century by WHO (56). This pushes new ways of incorporating physical activity and exercise in people's life, emerging a variety of training programs to increase enjoyment and adherence to exercise and an active lifestyle (12, 57, 58)

Sports and sports-based training present themselves as a more dynamic and stimulating way of training and rehabilitation (59, 60). This could increase exercise and training enjoyment, thus its adherence.

Therefore, boxing and boxing-based training has shown to be an enjoyable training, while stimulating different aspects of fitness across different types of patients, with or without diagnosed diseases, and from children to elderly patients (29, 51, 54).

The most studied adult population is Parkinson's Disease patients. Boxing based interventions show promising results, improving functionality, gaits speed, muscle power and balance (30, 35, 53). In contrast, in young individuals with cardiometabolic risk, traditional boxing programs and AVG, appear to be safe and effective to improve fitness (34,44,46). The latter, being an interesting alternative to inpatient units and remote areas (36, 46).

5. Conclusion

Finally, focusing on the adherence and fitness stimulating quality of boxing and boxing-based training, this review shows that is a considerable alternative for a great span of individuals and different contexts, from inpatient units to community programs, and from healthy individuals to chronic disease diagnosed patients.

6. Limitations

Being a relatively novel type of training in the aspects of rehabilitation and healthy lifestyle programs, evidence is still very limited and highly heterogenous. Thus, future research should provide more evidence on the benefits and the underlying mechanisms of this type of training and rehabilitation programs.

Conflicts of interest

The authors has no conflict of interests.

References

1. Garrahy E, Davison K, Hardcastle S, O'Brien J, Pedersen S, Williams A, et al. Exercise as cardiovascular medicine. Aust J Gen Pract. 2020;49(8):483–7.
2. Gong Q, Zhang P, Wang J, Ma J, An Y, Chen Y, et al. Morbidity and mortality after lifestyle intervention for people with impaired glucose tolerance: 30-year results of the Da Qing Diabetes Prevention Outcome Study. Lancet Diabetes Endocrinol. 2019;7(6):452–61.
3. Watson SL, Weeks BK, Weis LJ, Harding AT, Horan SA, Beck BR. High-Intensity Resistance and Impact Training Improves Bone Mineral Density and Physical Function in Postmenopausal Women With Osteopenia and Osteoporosis: The LIFTMOR Randomized Controlled Trial. J Bone Miner Res. 2018;33(2):211–20.
4. Troy KL, Mancuso ME, Butler TA, Johnson JE. Exercise early and often: Effects of physical activity and exercise on women's bone health. Int J Environ Res Public Health. 2018;15(5).
5. Cristi-Montero C, Ramírez-Campillo R, Alvarez C, Méndez AG, Martínez MA, Martínez XD, et al. Fitness cardiorrespiratorio se asocia a una mejora en marcadores metabólicos en adultos chilenos. Rev Med Chil. 2016;144(8):980–9.
6. Reyes Amigo T, Gomez Mazorra M, Gallardo Hinostroza M, Palmeira A. Effectiveness of High-Intensity Interval Training on cardiorespiratory fitness and body composition in preadolescents: A systematic review. Eur J Hum Mov. 2017;(39):32–47.
7. Aadland E, Martin O, Rajalahti T, Skrede T, Kåre G. Aerobic fi tness and metabolic health in children : A clinical validation of directly measured maximal oxygen consumption versus performance measures as markers of health. Prev Med Reports [Internet]. 2017;7:74–6. Available from: http://dx.doi.org/10.1016/j.pmedr.2017.05.001
8. Codella R, Ialacqua M, Terruzzi I, Luzi L. May the force be with you: why resistance training is essential for subjects with type 2 diabetes mellitus without complications. Endocrine [Internet]. 2018;62(1):14–25. Available from: http://dx.doi.org/10.1007/s12020-018-1603-7
9. García-Hermoso A, Ramírez-Campillo R, Izquierdo M. Is Muscular Fitness Associated with Future Health Benefits in Children and Adolescents? A Systematic Review and Meta-Analysis of Longitudinal Studies. Sports Med. 2019 Jul;49(7):1079–94.
10. Salman A, Sellami M, Al-mohannadi AS. The Associations between Mental Well-Being and Adherence to Physical Activity Guidelines in Patients with Cardiovascular Disease : Results from the Scottish Health Survey. :1–13.
11. Davis CL, Tomporowski PD, Gregoski M, Boyle CA, Waller JL, Miller PH, et al. Effects of aerobic exercise on overweight children's cognitive functioning: A randomized controlled trial. Res Q Exerc Sport. 2007;78(5):510–9.
12. Krustrup P, Krustrup BR. Football is medicine : it is time for patients to play ! 2018;0(0):1–2.
13. BÄfdicugeorgian.badicu@unitbv.ro G, Balint L. The importance sports activities have over the quality of life in the adult population. J Soc Sci Res. 2017;10(1):2003–6.
14. Guthold R, Stevens GA, Riley LM, Bull FC. Worldwide trends in insufficient physical activity from 2001 to 2016: a pooled analysis of 358 population-based surveys with 1·9 million participants. Lancet Glob Heal [Internet]. 2018;6(10):e1077–86. Available from: http://dx.doi.org/10.1016/S2214-109X(18)30357-7
15. Pedersen BK, Saltin B. Exercise as medicine - Evidence for prescribing exercise as therapy in 26 different chronic diseases. Scand J Med Sci Sport. 2015;25:1–72.
16. Donnelly JE, Blair SN, Jakicic JM, Manore MM, Rankin JW, Smith BK. Appropriate physical activity intervention strategies for weight loss and prevention of weight regain for adults. Med Sci Sports Exerc. 2009;41(2):459–71.
17. Stepto NK, Patten RK, Tassone EC, Misso ML, Brennan L, Boyle J, et al. Exercise Recommendations for Women with Polycystic Ovary Syndrome: Is the Evidence Enough? Sport Med [Internet]. 2019;49(8):1143–57. Available from: https://doi.org/10.1007/s40279-019-01133-6
18. Cvetković N, Stojanović E, Stojiljković N, Nikolić D, Scanlan AT, Milanović Z. Exercise training in overweight and obese children: Recreational football and high-intensity interval training provide similar benefits to physical fitness. Scand J Med Sci Sport. 2018;28.

19. Khan KM, Thompson AM, Blair SN, Sallis JF, Powell KE, Bull FC, et al. Sport and exercise as contributors to the health of nations. Lancet [Internet]. 2012;380(9836):59–64. Available from: http://dx.doi.org/10.1016/S0140-6736(12)60865-4

20. Chaabène H, Tabben M, Mkaouer B, Franchini E, Negra Y, Hammami M, et al. Amateur Boxing: Physical and Physiological Attributes. Sport Med. 2015;45(3):337–52.

21. Neidecker J, Sethi NK, Taylor R, Monsell R, Muzzi D, Spizler B, et al. Concussion management in combat sports: Consensus statement from the Association of Ringside Physicians. Br J Sports Med. 2019;53(6):328–33.

22. Bruzas V, Kamandulis S, Venckunas T, Snieckus A, Mockus P. Effects of plyometric exercise training with external weights on punching ability of experienced amateur boxers. J Sports Med Phys Fitness. 2018;58(3):221–6.

23. Ambroży T, Maciejczyk M, Klimek AT, Wiecha S, Stanula A, Snopkowski P, et al. The effects of intermittent hypoxic training on anaerobic and aerobic power in boxers. Int J Environ Res Public Health. 2020;17(24):1–11.

24. Eric A, Mekary S, Léger LA. Vo2 requirements of boxing exercises. J Strength Cond Res. 2011;25(2):348–59.

25. Joschtel B, Gomersall SR, Tweedy S, Petsky H, Chang AB, Trost SG. Effects of exercise training on physical and psychosocial health in children with chronic respiratory disease : a systematic review and meta-analysis. 2018;1–11.

26. Colberg SR, Sigal RJ, Fernhall B, Regensteiner JG, Blissmer BJ, Rubin RR, et al. Exercise and type 2 diabetes: The American College Of Sports Medicine and The American Diabetes Association: Joint position statement executive summary. Diabetes Care. 2010;33(12):2692–6.

27. Esco M. Resistance Training for Health and Fitness. Am Coll Sport Med. 2013;1–2.

28. Lambert C, Beck BR, Harding AT, Watson SL, Weeks BK. A protocol for a randomised controlled trial of the bone response to impact loading or resistance training in young women with lower than average bone mass: The OPTIMA-Ex trial. BMJ Open. 2017;7(9):1–12.

29. Yli-Piipari S, Berg A, Laing EM, Hartzell DL, Parris KO, Udwadia J, et al. A twelve-week lifestyle program to improve cardiometabolic, behavioral, and psychological health in hispanic children and adolescents. J Altern Complement Med. 2018;24(2):132–8.

30. Borrero L, Miller SA, Hoffman E. The meaning of regular participation in vigorous-intensity exercise among men with Parkinson's disease. Disabil Rehabil [Internet]. 2020;0(0):1–7. Available from: https://doi.org/10.1080/09638288.2020.1836042

31. Silva de Sousa JC, Torriani-Pasin C, Tosi AB, Fecchio RY, Costa LAR, Forjaz CL de M. Aerobic Stimulus Induced by Virtual Reality Games in Stroke Survivors. Arch Phys Med Rehabil [Internet]. 2018;99(5):927–33. Available from: https://doi.org/10.1016/j.apmr.2018.01.014

32. Wong AM, Lin YC, Chou SW, Tang FT, Wong PY. Coordination exercise and postural stability in elderly people: Effect of Tai Chi Chuan. Arch Phys Med Rehabil. 2001;82(5):608–12.

33. King LA, Horak FB. Delaying mobility disability in people with parkinson disease using a sensorimotor agility exercise program. Phys Ther. 2009;89(4):384–93.

34. Hurkmans HL, Van Den Berg-Emons RJ, Stam HJ. Energy expenditure in adults with cerebral palsy playing Wii sports. Arch Phys Med Rehabil [Internet]. 2010;91(10):1577–81. Available from: http://dx.doi.org/10.1016/j.apmr.2010.07.216

35. Combs SA, Diehl MD, Staples WH, Conn L, Davis K, Lewis N, et al. Boxing Training for Patients With Parkinson Disease: A Case Series. Phys Ther. 2011;91(1):132–42.

36. Taylor LM, Maddison R, Pfaeffli LA, Rawstorn JC, Gant N, Kerse NM. Activity and energy expenditure in older people playing active video Games. Arch Phys Med Rehabil [Internet]. 2012;93(12):2281–6. Available from: http://dx.doi.org/10.1016/j.apmr.2012.03.034

37. Jackson K, Edginton-Bigelow K, Bowsheir C, Weston M, Grant E. Feasibility and effects of a group kickboxing program for individuals with multiple sclerosis: A pilot report. J Bodyw Mov Ther [Internet]. 2012;16(1):7–13. Available from: http://dx.doi.org/10.1016/j.jbmt.2010.09.002

38. Kho ME, Damluji A, Zanni JM, Needham DM. Feasibility and observed safety of interactive video games for physical rehabilitation in the intensive care unit: A case series. J Crit Care [Internet]. 2012;27(2):219.e1-219.e6. Available from: http://dx.doi.org/10.1016/j.jcrc.2011.08.017

39. Gordon C, Roopchand-Martin S, Gregg A. Potential of the Nintendo WiiTM As a rehabilitation tool for children with cerebral palsy in a developing country: A pilot study. Physiother (United Kingdom) [Internet]. 2012;98(3):238–42. Available from: http://dx.doi.org/10.1016/j.physio.2012.05.011

40. Bosch PR, Poloni J, Thornton A, Lynskey J V. The Heart Rate Response to Nintendo Wii Boxing in Young Adults. Cardiopulm Phys Ther J. 2012;23(2):13–8.

41. Howcroft J, Klejman S, Fehlings D, Wright V, Zabjek K, Andrysek J, et al. Active video game play in children with cerebral palsy: Potential for physical activity promotion and rehabilitation therapies. Arch Phys Med Rehabil [Internet]. 2012;93(8):1448–56. Available from: http://dx.doi.org/10.1016/j.apmr.2012.02.033

42. Gaffurini P, Bissolotti L, Calza S, Calabretto C, Orizio C, Gobbo M. Energy metabolism during activity-promoting video games practice in subjects with spinal cord injury: Evidences for health promotion. Eur J Phys Rehabil Med. 2013;49 (1):23–9.

43. Abdulsatar F, Walker RG, Timmons BW, Choong K. "wii-Hab" in critically ill children: A pilot trial. J Pediatr Rehabil Med. 2013;6(4):193–202.

44. Siegmund LA, Naylor B. JB, Santo S. AS, Barkley E. JE. The effect of a peer on VO2 and game choice in 6-10 year old children. Front Physiol. 2014;5 JUN(June):1–9.

45. Y. Z, Y. Z, Q. L. Effects of twenty-four move shadow boxing combined with psychosomatic relaxation on depression and anxiety in patients with type-2 diabetes. Psychiatr Danub [Internet]. 2015;27(2):174–9. Available from: http://www.embase.com/search/results?subaction=viewrecord&from=export&id=L605232904%5Cnhttp://resolver.ebscohost.com/openurl?sid=EMBASE&issn=03535053&id=doi:&atitle=Effects+of+twenty-four+move+shadow+boxing+combined+with+psychosomatic+relaxation+on+depres

46. Barry G, Tough D, Sheerin P, Mattinson O, Dawe R, Board E. Assessing the Physiological Cost of Active Videogames (Xbox Kinect) Versus Sedentary Videogames in Young Healthy Males. Games Health J. 2016;5(1):68–73.

47. Wollseiffen P, Ghadiri A, Scholz A, Strüder HK, Herpers R, Peters T, et al. Short Bouts of Intensive Exercise During the Workday Have a Positive Effect on Neuro-cognitive Performance. Stress Heal. 2016;32(5):514–23.

48. Matrosly M, Matrosly H, Hasnan N, Davis GM, Husain R. Exergaming boxing versus heavy-bag boxing: Are these equipotent for individuals with spinal cord injury? Eur J Phys Rehabil Med. 2017;53(4):527–34.

49. Rourke K, Wilson CJ. How adolescents perceive that community-based exercise improves their well-being. Australas Psychiatry. 2017;25(5):456–9.

50. Park J, Gong J, Yim J. Effects of a sitting boxing program on upper limb function, balance, gait, and quality of life in stroke patients. NeuroRehabilitation. 2017;40(1):77–86.

51. Janyacharoen T, Srisamai T, Sawanyawisuth K. An ancient boxing exercise improves physical functions, balance, and quality of life in healthy elderly persons. Evidence-based Complement Altern Med. 2018;2018:4–7.

52. Janyacharoen T, Yonglitthipagon P, Nakmareong S, Katiyajan N, Auvichayapat P, Sawanyawisuth K. Effects of the applied ancient boxing exercise on leg strength and quality of life in patients with osteoarthritis. J Exerc Rehabil. 2018;14(6):1059–66.

53. Domingos J, Radder D, Riggare S, Godinho C, Dean J, Graziano M, et al. Implementation of a Community-Based Exercise Program for Parkinson Patients: Using Boxing as an Example. J Parkinsons Dis. 2019;9(3):615–23.

54. Areeudomwong P, Saysalum S, Phuttanurattana N, Sripoom P, Buttagat V, Keawduangdee P. Balance and functional fitness benefits of a Thai boxing dance program among community-dwelling older adults at risk of falling: A randomized controlled study. Arch Gerontol Geriatr [Internet]. 2019;83(April):231–8. Available from: https://doi.org/10.1016/j.archger.2019.04.010

55. Neubauer BE, Witkop CT, Varpio L. How phenomenology can help us learn from the experiences of others. Perspect Med Educ. 2019;8(2):90–7.

56. Blair SN. Physical inactivity: The biggest public health problem of the 21st century. Br J Sports Med. 2009;43(1):1–2.

57. Pudkasam S, Polman R, Pitcher M, Fisher M, Chinlumprasert N, Stojanovska L, et al. Physical activity and breast cancer survivors: Importance of adherence, motivational interviewing and psychological health. Maturitas. 2018;116:66 –72.

58. Amado D, Del Villar F, Leo FM, Sánchez-Oliva D, Sánchez-Miguel PA, García-Calvo T. Effect of a multi-dimensional intervention programme on the motivation of physical education students. PLoS One. 2014;9(1):1–6.

59. Voyer D, Jansen P. Motor expertise and performance in spatial tasks: A meta-analysis. Hum Mov Sci [Internet]. 2017;54(February):110–24. Available from: http://dx.doi.org/10.1016/j.humov.2017.04.004

60. Brito CJ, Aedo-Muñoz E, Miarka B. Judo performance: kinanthropometric importance for technical tactical and biomechanics. Rev Bras Cineantropometria e Desempenho Hum. 2020;22:1–7.

Citation: Sáa Molina J, Mahecha S. Therapeutic Boxing: Narrative Review About Boxing as Therapeutic Tool. *SVOA Orthopaedics 2024,* 4:4, 73-84. doi. 10.58624/SVOAOR.2024.04.074