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Springing to Life: Unveiling the Transformative Effects of Trampoline Bouncing on Human Health

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Abstract:

Introduction and Objective: In the modern era, where non-communicable diseases account for 74% of deaths, physical activity plays a crucial role in reducing mortality rates, particularly from cardiovascular causes. This article aims to assess the benefits and risks of trampoline bouncing as an exercise modality.

State of Knowledge: Scientific evidence predominantly focuses on rebounding-related injuries, overshadowing the relatively underexplored benefits of trampolining. Cardiovascular advantages, including increased VO2max, are notable, with mini-trampoline exercise proving more effective than traditional running. Trampolining exhibits the potential to reduce BMI and weight, impacting cardiovascular risk factors while contributing to bone strength and mental well-being. Positive outcomes are suggested for specific groups, such as Parkinson's patients and children with disabilities.

Summary: Trampoline rebounding, particularly with mini-trampolines, presents an enjoyable exercise form with significant health benefits, encompassing enhanced cardiovascular endurance, improved balance, and positive effects on bone structure and mental well-being. Despite prevalent injuries associated with trampoline use, the article highlights effective preventive measures. In conclusion, trampoline bouncing holds promise as a valuable component of a healthy lifestyle, provided adequate precautions are taken to mitigate associated risks.

Key words: Physical Endurance; Bone Density; Longevity; Psychomotor Performance; Exergaming; Athletic Injuries

Introduction

In the contemporary world, non-communicable diseases cause 74% of all deaths. [1] A 2019 study found that embracing a healthy lifestyle, including regular exercise, is linked to increased life expectancy –14 years for females and 12.2 years for males. [2] Many of these diseases are linked to poor lifestyle choices such as tobacco

smoking, alcohol abuse, unhealthy diet, and… a lack of physical activity – a factor that plays a great role in reducing the mortality rate from any cause, especially from cardiovascular causes. [3]

The first trampoline resembling today's machines, patented as the "tumbling device" by George Nissen, was introduced in 1936 and patented in 1945. [4] Since then, recreational trampoline jumping has thrived. An additional rise in public interest was linked to the introduction of commercial trampoline parks in the early 21st century. [5] Mini-trampoline indoor exercising gained popularity in the mid-20th century and surged further during the COVID-19 pandemic. [6] In this article, we will review the benefits and risks of trampoline bouncing.

Cardiovascular effect: effect on VO2max

Maximal oxygen consumption (VO2max), a marker of cardiovascular endurance, ranges from 90 ml/kg/min in well-trained athletes to as low as 20 ml/kg/min in elderly patients. The peak value typically occurs around age 20-25, approximately 42 ml/kg/min in males and 36 ml/kg/min in females. It declines with age, especially in sedentary adults, with higher values associated with increased life expectancy. A 1 ml/kg/min increase in VO2max is linked to a 9% reduction in all-cause mortality in middle-aged men, indicating a correlation with longer life expectancy. [7]

Mini-trampoline bouncing is more effective than traditional running, resulting in a 7.82% increase in VO2max for rebounding exercise compared to only 2.34% in running. [8] However, in comparing mini-trampoline training to treadmill running, the latter showed a slight advantage, with a significant difference observed in medium-intensity training but no significant difference in low- and high-intensity training. [9] Exergaming (EXG), a combination of exercise with a motion-detecting video game, involves approximately 29% higher oxygen consumption when incorporating mini-trampoline use compared to stationary running alone. [10]

Cardiovascular effect: metabolic syndrome

Body weight and Body Mass Index (BMI) significantly impact the cardiovascular system. Obesity is strongly associated with type 2 diabetes, cancer, and joint degeneration, leading to a decrease in both quality of life and longevity. [11]

Moreover, body weight is a key factor in causing an abnormal lipid profile, including elevated low-density lipoproteins (LDL) and triglycerides and reduced high-density lipoproteins (HDL), contributing to atherosclerosis, another significant cardiovascular risk factor. [12,13] Exercising and maintaining a proper diet play a crucial role in reducing body weight; approximately 7,830 kcal burned is needed to lose 1kg of it. [14]

In one study, mini-trampoline jumping was slightly more effective than running in reducing BMI and weight (0.56% vs. 0.18% and 0.39% vs. 0.09% decrease, respectively); however, no significant difference was found, except for a substantial change in adipose tissue percentage reduction (31.61% in the trampoline group and 20.3% in the running group). [8] The estimated calorie burn for mini-trampoline jumping was 12.4 kcal/min in men and 9.4 kcal/min in women. [15] However, another study on rebounding overweight women reported only 6.9 kcal/min in this group. [16] These results show that trampolining's efficacy for weight loss varies based on factors like gender and initial fitness. Training intensity also affects energy expenditure and can be easily adjusted to individual needs. Overall, rebound exercises are very effective not only in BMI reduction [17] but also in decreasing blood pressure and glucose levels, potentially contributing to increased longevity. [18] Regarding blood lipids, mini-trampoline training resulted in significant differences: 19.4% lower LDL levels and 85.7% higher HDL levels compared to the control group, with no correlation found in triglyceride levels. [17]

Effect of rebounding on bone structure

Bone mass and density typically peak in the third decade of life and tend to decrease over a lifetime, especially in women during and after menopause due to hormonal profile changes. The rate of this process is primarily associated with childhood bone mass, age of peak bone mass, maintained body weight, and BMI. However, the role of habitual physical activity is debated; some studies show no correlation, while others do. [19,20] The main mechanism of these changes is an imbalance favoring increased osteoclast activity and decreased osteoblast activity in bone tissue creation and resorption, resulting in a more fragile bone structure and leading to osteopenia and osteoporosis. [21]

Physical activity enhances body balance and strength, reducing the risk of fracture. High-impact loading exercises, such as one-foot jumps, positively impact the Bone Material Strength index (BMSi), [22] and they have been shown to reduce the occurrence of osteoporosis. [23] Jumping on a trampoline has also been proven to have a substantial influence on bone strength, resulting in the growth of tibial and radial bone radius and density. [20] Rebounding on a mini-trampoline resulted in blood marker changes, including decreased osteoclast activity (lower C-terminal telopeptide concentration), increased osteoblast activity (higher osteocalcin concentration), and an improved calcium-homeostasis profile (higher calcium and potassium concentrations, lower parathormone concentration). [24] However, a proper diet (especially vitamin D and calcium intake) lifestyle, regular medical examinations, and sometimes pharmacological treatment (mainly bisphosphonates and estrogen-containing drugs), are beneficial alongside exercise, and should not be neglected. [21]

Mental health

Physical activity has a well-documented positive impact on mental health. Exercising is known to increase cognitive function, self-esteem, and mood while reducing anxiety and tiredness. [25] The proposed mechanisms contributing to these benefits include the release of endorphins and monoamines, as well as the attenuation of stress-induced cortisol production and modification of immune and vagal responses. [26]

Rebounding has proven benefits, reducing daytime sleepiness and enhancing attentional control in anxiety patients. [27] In another study, it demonstrated a positive effect on reducing stress, anxiety, and depression in spinal cord injury patients, leading to an improved quality of life. [28] While the evidence supporting the beneficial influence of trampolining alone on mental health is limited and requires further investigation, we suspect its effects are similar to those demonstrated by the general influence of physical activity on it.

Promotion of physical activity

Exercise promotion is crucial for patients at an increased risk of cardiovascular disease (CVD). Children should engage in physical activity for cardiopulmonary

development, obesity prevention, socialization, and the formation of proper lifestyle habits. [29] Also, patients with psychiatric illnesses often exercise less and may use medications that negatively affect metabolism, suggesting that more physical activity promotion is needed in this group. [30]

Trampolines can contribute to the popularity of physical activity by giving enjoyable experiences for most participants. [31] While children also enjoy using trampolines, [32] there is a need to offer more diverse activities due to the rapid exhaustion from trampolining alone. [33] In a study, all subjects appreciated rebounding combined with motion-detecting video games, favoring exaggerated height jumping over normal height jumping. [34] Using a mini-trampoline was reported as a fun way to maintain physical activity during lockdown home isolation. [24]

Balance

Improving balance reduces tripping frequency and injuries, which is crucial for the elderly facing longer recovery times and more serious injuries. [35] This results in about 25% of falls requiring medical help, nearly twice as much in women than men. [36] Cardiovascular and neurological diseases, such as Parkinson's disease, dementia, or vestibular malfunction, occur more often in elderly people and have a tremendous impact on tripping incidence. [37]

Studies unanimously agree on the beneficial role of mini-trampoline exercise for improving balance through enhanced coordination of proprioception, visual signals, and the vestibular system. [38] These advances translate into practical results as women, after rebound exercises, showed significant improvement in the Star Excursion Balance test. [39] Females with osteopenia who rebounded showed improved static and dynamic balance, increased upper and lower limb strength, and enhanced fall efficacy. [40] After a simulated front fall, trampoliners showed improved stability restoration with a lower margin of stability and increased hip moment generation, despite no significant progress in other dynamic balance factors. [41]

Impact on specific groups: Parkinson’s disease

Parkinson's disease is a neurodegenerative disorder primarily affecting extrapyramidal pathways, leading to significant decreases in movement control and coordination. It also leads to impairment of cognition and mood. [42] One study showed significant improvements in proprioception, motion range, and quality of life for Parkinson's patients through rebound therapy compared to treadmill running. [43] However, evidence supporting its effectiveness is limited, and further trials, such as the Lisbon Intensive Falls Trampoline Training study, are required. [44]

Impact on specific groups: children with disabilities

Rebounding improves various aspects of life in children. Trampoline jumping significantly increased VO2max compared to outdoor running and was enjoyed by participants. [45] This suggests that rebound exercise could be a useful tool to enhance cardiopulmonary capacity and calorie burning in children, also increasing the likelihood of voluntary use due to its appeal.

Multiple studies explored trampolining's impact on children with disabilities, demonstrating significant enhancement of motor and balance skills in those with developmental coordination disorder [46], Down syndrome, [47], and intellectual disability. [48] Similar effects were observed in children with autism spectrum disorder, [49] and additionally, trampolining was one of the most frequently applied actions in Sensory-Based Interventions, a group of activities designed to help Autism Spectrum Disorder (ASD) patients adapt to life. [48] Rebounding exercise helps to achieve better physical shape, cognition, and mood in children with Attention Deficit Hyperactivity Disorder (ADHD). [50]

Impact on other specific groups

Limited evidence suggests trampolining's impact on cystic fibrosis patients is not clearly promising, but some studies show improvements in forced vital lung capacity, minute ventilation, VO2max, and overall exercise tolerance. [51] According to a study, introducing an exercise program that includes trampolines is associated with improved cognition in people with multiple sclerosis. [52] Patients afflicted by stroke showed a substantial postural control gain after mini-trampoline training. [53]

Injuries

The primary drawback of trampoline use is the common occurrence of injuries. Originally designed for acrobats and athletes, trampolines gained popularity among non-professionals. The first documented injury case was reported in 1942, three years before the patent was published. However, the reported damage was limited to mat burns, with the article suggesting “there is relatively little danger of injury if the user is possessed of simple common sense”. [54] In 1956, a report indicated greater damage severity in older students, [55] and in 1960, a case report highlighted five severe neurological complications after rebounding, including quadriplegia and death. [56]

Since then, there has been an exponential growth in trampoline-related injuries reported to emergency departments, especially in children. An Irish study found that trampoliners constituted 1.5% of pediatric Emergency Department attendants, highlighting trampolining as a high-risk activity. [57] The most common types of injuries are fractures and soft tissue damage, predominantly affecting the lower limb. [58,59] There is evidence that rebounding is associated with limb-paralyzing spine injury [60] or peripheral nerve damage. [61]

Most incidents are associated with falling on the trampoline body rather than falling off it, [59] suggesting that proper isolation of the exercise field is needed. Performing acrobatic tricks and colliding with others are significant trauma mechanisms in rebounding, [58] emphasizing the need for caretaker supervision, which should also include safety instructions and control to avoid simultaneous play on the same trampoline. Younger children are more vulnerable to experiencing trampoline-related trauma, while such accidents are uncommon in adults, [62] suggesting the need for age limitations in trampolining. The provided evidence showed that home trampolines are safer than trampoline parks, [63] and mini-trampolines are safer for younger children than full-sized ones, [64] which could be associated with a lower risk of a desire to jump with another child.

Conclusions

Trampoline rebounding, particularly with the utilization of mini-trampolines, represents a pleasurable and engaging form of exercise that contributes significantly to enhancing endurance, balance, mitigating mortality risk factors, and

improving bone structure and mental well-being. Notwithstanding the prevalence of notable injuries associated with their use, there exist various effective preventive measures to mitigate such risks.

Author contributions

Conceptualization, DB and KS; methodology, ML and BW; software, not applicable; check, KS, PP, DB and BW; formal analysis, PP, MK, IM and KS; investigation, MK and PP; resources, not applicable; data curation, IM, PP, ML, BW; writing - rough preparation, DB; writing - review and editing, DB, BW, MK and ML; visualization, DB, IM, KS; supervision, DB; project administration, KS; receiving funding, not applicable. All authors have read and agreed with the published version of the manuscript.

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Conflicts of Interest

The authors declare no conflict of interest.

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