Changes in physical fitness, jumping mechanics, and bone outcomes as a result of overweight in youth: The FitBone project

Emmanuel S da Rocha[1], Benjamín Anguita[2], Oscar Achiardi[2], Júlio B. Mello[3]

1. Neuromuscular Adaptations and Clinical Neuromechanics Group, Graduate Program in Health Technology, Pontifícia Universidade Católica do Paraná, Curitiba, Brasil

2. Laboratorio de investigación en Biomecánica del Movimiento Humano, Pontificia Universidad Católica de Valparaíso, Chile
3. Escuela de Educación Física, Pontificia Universidad Católica de Valparaíso, Chile
Email: emmanuel.srocha@pucpr.br

Summary

We examined how being overweight impacts physical fitness, jump biomechanics, and bone health. Overweight (OW) children displayed higher ground reaction force and jump height but had lower sprint performance compared to normal-weight (NW) peers. They also exhibited higher areal bone mineral density (aBMD) in the total body, arms, and spine, but not in the hips or feet, indicating possible biomechanical strain and bone health concerns.

Introduction

Childhood overweight can potentially influence physical condition and bone development [1]. These factors may be associated with bone mineral density and geometry due to biomechanical adaptations in activities such as jumping and running [2]. This study aims to compare physical fitness, mechanical parameters of jumping, bone geometry, and bone mineral density in adolescents with and without overweight.

Methods

The FitBone study, phase 1, is a cross-sectional analysis involving 35 children and adolescents. Assessments included anthropometric measurements (height and weight), physical fitness tests (hand dynamometry, 20-meter sprint, horizontal jump, and 2 kg medicine ball throw), biomechanical jump parameters (kinematic and kinetic analyses with countermovement and drop landing protocols), and DXA body composition scans. T-tests ($p<0.05$) were used to compare participants with and without overweight, defined by the fat mass index (FMI: fat mass in kg/height in m²).

Results and Discussion

The NW and OW groups showed significant differences in the sprint test in favor of the NW group, and the biomechanics jump parameters maximal raw ground reaction force, raw loading rate in favor of the OW, but the maximum jump height in favor of the NW group. The group with less body weight presents greater power, however, they experience a lower ground reaction force in non-normalized values, demonstrating a greater mechanical load in this task for the OW group.

Table 1. Differences in physical fitness, biomechanics jump parameters, and bone outcomes between overweight and normal-weight children

	Normal Weight		Overweight		
	ẋ	±SD	ẋ	±SD	p-value
Physical Fitness					
Sprint	3.88	0.39	4.32	0.58	**0,013**
Biomechanics jump parameters					
Max. Raw GRF (N)	996,97	202,75	1243,97	316,01	**0,013**
Raw Loading Rate (N)	29543,86	12401,44	38583,57	11288,48	**0,050**
Maximum jump height (cm)	31,23	6,92	26,29	4,59	**0,034**
Bone geometry (cm²)					
Total body area	1876,23	218,05	1860,08	220,29	0,838
Total body less head Area	1630,14	215,56	1620,42	208,80	0,900
Arms Area	361,05	64,73	329,08	59,30	0,167
Trunk Area	620,45	86,61	639,58	84,77	0,901
Spine Area	140,45	19,16	142,00	21,57	0,540
Hip Area	251,00	42,83	243,17	33,68	0,831
Legs Area	648,09	84,86	651,75	74,14	0,588
Areal bone mineral density (g/cm²)					
Total body	0,958	0,091	1,039	0,106	**0,027**
Total body less head	0,844	0,093	0,931	0,103	**0,018**
Arms	0,589	0,081	0,673	0,104	**0,014**
Trunk	0,820	0,106	0,895	0,101	**0,050**
Spine	0,860	0,108	0,9697	0,138	**0,016**
Hip	0,863	0,119	0,897	0,122	0,436
Legs	1,014	0,127	1,098	0,145	0,091

Regarding bone outcomes, no significant differences were found in bone geometry, indicating that the possible effect of mechanical overload may cause another type of adaptation in the bones [3]. However, in the aBMD, the OW group presented more bone density, except in the hip and legs. When experiencing greater mechanical load, the expectation would be greater bone density [3], especially in the lower limbs. However, our results indicate that being overweight, concerning bone health, does not have any type of positive effect.

Conclusions

Obese children showed reduced sprinting capacity compared to their normal-weight peers. While they exhibited higher ground reaction force and load rates during jumping, their jump height was lower. Despite these differences, no variations were observed in bone geometry or hip and leg aBMD.

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