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Effect of Radial Shock Wave on Abdominal Adiposity and Quality of Life for Obese Children

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Abstract

OBJECTIVE: This study was done to investigate the impact of Radial shock waves on abdominal adiposity and quality of life for obese children.
DESIGN: Randomized controlled study.
SUBJECTS:30children ranged from 8 to 12 years from both sexes, withbody math index (BMI)> 95 % to 99 % percentile were recruited.
METHODS: Group (A): Fifteen obese children were treated with only circuit exercise. (Group (B): Fifteen obese children were treated with circuit exercise and Radial shock wave, for three successive months.
Main outcomes: individuals in two groups were evaluated utilizing a reliable and valid weight-height scale, which measured both their height and weight, tape measurementto measure waist circumference, diagnostic medical sonography to assess subcutaneous abdominal fat and Pediatric Quality of Life Inventory (PedsQL) to assess quality of life. Allwere taken as outcome measures before and after the intervention.
RESULTS: In both the experimental and control groups, waist circumference, subcutaneous fat, as well as BMI all decreased significantly after treatment compared to baseline. Improvements in PedsQL scores for both children and their parents, as well as reductions in waist size and subcutaneous fat, were statistically significant after treatment. No significant difference in BMI percentile was found between groups post-treatment.
CONCLUSION: Adding shock wave to circuit trainingled to additional benefits in reducing central adiposity (waist circumference) and improving quality of life for both children and parents, compared to the control group.

Key words:shock wave, obese, quality of life, children.

1. INTRODUCTION

Childhood obesity is described as a large amount of body fat (BF). In terms of children and adolescents, there is no universally accepted threshold for what constitutes overweight or obesity (1).

Central obesity is a significant clinical and public health concern. The correlation between central obesity and metabolic risk factors is stronger than that between generalized obesity and central obesity. Central obesity is associated with an increased risk of type II diabetes mellitus, dyslipidemia, systemic arterial hypertension, as well as coronary artery disease, according to multiple studies (2).

To take action and maybe avoid the development of chronic diseases like type II diabetes and cardiovascular disease, it is essential to recognize children who are at a higher risk of acquiring obesity-related chronic diseases. Still up for debate, nevertheless, are the cardio-metabolic risk factors linked to adolescent as well as adolescents' abdominal obesity (3). The prevalence of childhood obesity is increasing in developed countries. In the United States, 11% of children are considered obese, and 25% are overweight. Adolescent obesity is associated with an adult obesity prevalence of over 70% (4).

Behavioral modification is the cornerstone of management, and the entire family should be involved. One must establish goals in accordance with the pubertal stage. Attaining a proper BMI allows one to reduce fat mass and control or avoid problems which is the primary objective. A stable weight should be maintained until the pubertal growth spurt happens for pre-pubertal children, which are defined as girls with a Tanner stage of 2 or less and boys with a stage of 3 or less. Reduce your BMI with a height spurt during your growth spurt. Loss of weight would be a benefit (5).

Incorporating regular physical activity (PA) into a healthy diet has several health benefits, including an improved lipid profile, insulin sensitivity, body composition, confidence, neurocognitive function, as well as cardio-respiratory fitness (CRF) (6).

Support from parents is essential for psychological adjustment. Most challenging is finding ways to motivate children to follow the management. The seriousness of the problem should be understood by parents. It is important to teach parents the value of a balanced diet and regular exercise. Making the necessary changes would be good for everyone in the family. Proper nutrition and regular physical exercise are two areas where parents should lead by example. Encouraging children to develop strategies for managing psychological problems brought on by their classmates is crucial. Although there are currently no drugs that target childhood obesity specifically, pharmacotherapy is necessary for disorders such as dyslipidemia and aberrant glycemic control when lifestyle changes alone do not alleviate symptoms. Weight Loss Procedures Although it is not yet standard practice, bariatric surgery is performed very selectively to treat childhood obesity (7).

2. PATIENTS AND METHODS

2.1. Study participants and ethics

The research was a controlled, randomized trial, performed on 30 obese children from both sexestook-part in this study after signing the consent form.The study extended from January to March2023. The ethical committee at Egypt's Cairo University's Faculty of Physical Therapy gave their approval to the study (NO:P.T.REC/012/003261).

Study design

Thirty obese children of both sexes were selected from Outpatient clinics at Armed Forces Hospitals. They were randomized into two equivalent groups (control group and study group).

Group (A): Fifteen obese children were treated with only circuit exercise (control group) for three successive months. While group (B): Fifteen obese children were treated with circuit exercise and shock wave (study group) for three successive months.

To be included in the study, subjects were evaluated using the following criteria:Children's age ranged from (8 to 12 before puberty) from both sexes (8). Obese children with BMI > 95 % to 99 % percentile (9).They received no specific diet. Exclusion criteria included: patients who hadgenetic, chromosomal, endocrine, or psychiatric disorders. Children who took antidepressant medications or cortisone. Participant in regular competition; sport activity.

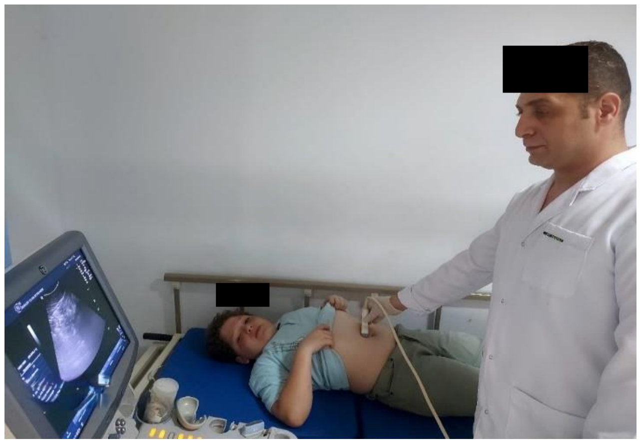
Randomization

To ensure total objectivity, computer-generated randomization cards were used and kept in sealed envelopes throughout the whole process. It should be noted that after the randomization process, no individuals were reported to have dropped out of the study.

2.2. Outcome measures:

1. Standard weight and height scale: was used for measurement of weight in kilograms (kg) and height in centimeters (cm). Validity and reliability of this scale was reported as directly measuring the force exerted by gravity on the body mass, providing a relatively accurate representation of the body weight. If the scale is well-maintained and calibrated regularly, it should provide consistent weight readings over time(10).To calculate BMI for children in a clinical or research setting, the standard formula used is the same as for adults, which is the weight of the child in kilograms divided by the square of their height in meters (BMI = weight in kg / height in m^2). For children, this value is then plotted on sex-specific BMI-for-age percentile charts. Standing on a conventional height and weight scale with their feet bared, each set of children was asked to provide their height and weight. The horizontal arm was placed on top of the vertex to measure height, while the weight was then determined on the scale (11).
2. Tape measurement: was used to measure waist circumference. An appropriate body measuring tape was used which was non-stretch, accurately calibrated, durable, portable, and ergonomic (12). The midway point among the iliac crest and the lower ribs was used to estimate waist circumference. All measurements were taken while the subject was standing upright (13).
3. Diagnostic medical sonography: Two transducers, one convex and covering 3.5–7.0 MHz and the other linear and covering 5.0–12.0 MHz, are part of the Philips EnVisor unit. It was used to assess subcutaneous abdominal fat (14).It was ensured that the transducer was held steadily and in full contact with the skin without exerting excessive pressure, which might compress the subcutaneous tissue and affect the accuracy of the measurements. The ultrasound device was activated to obtain clear images of the subcutaneous fat layer. The depth of the subcutaneous fat was visualized as the distance from the skin surface down to the linea alba. The focus and gain settings on the ultrasound machine were adjusted if necessary to enhance the visibility of these layers (15) (fig. 1).

4. Pediatric Quality of Life Inventory (PedsQL Version 4.0): was utilized to evaluate the individuals' quality of life (Appendix I). In order to measure HRQOL in children and adolescents (ranging from 2 to 18 years old), researchers developed the Paediatric Quality of Life Inventory (PedsQL Version 4.0). It includes several various elements of HRQOL. Physical, emotional, social, as well as school functioning are all part of these measures. Child Self-Report and Parent Proxy-Report: The PedsQL supports age-appropriate self-reporting by children as well as proxy reporting by parents. This dual perspective provides a more comprehensive understanding of a child's HRQOL(16).



Fig(1): applying the ultrasonography

2.3. Treatment procedures:

Group (A): Fifteen obese children were treated with only circuit exercise (control group) for three successive months. The warm-up lasted for five minutes and included walking and stretching. Every practice included 10 minutes of stretching as a cooling-down. There were five different weight-bearing strength exercises in the main circuit: push-ups, squats, crunches, side lunges as well as face-down leg/arm raises. The cardio component was walking in place. Every session lasted 30 minutes and consisted of three sets(17).

Walk in place

A tall stance was assumed with feet hip-width apart and the core engaged. Heels were lifted off the ground one foot at a time, mimicking a walking motion, as if taking a step, without actually moving forward. Arms were swung naturally back and forth, replicating the movement during walking. Throughout the exercise, a comfortable pace was maintained, with emphasis placed on maintaining good posture (figure. 2a), (18).

Push-ups

A high plank position was first assumed, with hand placement directly under the shoulders, shoulder-width apart, and legs extended straight engagement was achieved by pulling the belly button towards the spine, and the glutes were tensed simultaneously to create a straight line extending from the head down to the heels. The elbows were then bent to lower the chest towards the ground, with instructions specifying that the elbows be kept tucked close to the body, pointing slightly backwards, and lowering continued until the chest nearly touched the floor, achieving a 90-degree bend at the elbows (figure.2b), (19).

Fig. (2): (a) walk in place, (b) push up exercise

Squat

The squat exercise was conducted as follows: Participants assumed a shoulder-width stance with toes pointed slightly outward (around 15-30 degrees) and engaged their core by pulling the belly button towards the spine. A hinging motion at the hips and knees was initiated simultaneously, with the glutes pushed back as if sitting in a chair while maintaining the back straight and the chest lifted. The descent was performed until the thighs were parallel to the ground or as low as was comfortably possible without compromising form, ensuring the knees tracked in line with the toes and did not cave inward or outward(figure.3a),(20).

Fig. (3): (a) Squat exercise, (b): Crunches exercise

Crunches

Crunches were performed starting with the participants lying flat on their back on a mat or exercise surface. Their knees were bent, and their feet were kept flat on the floor. Hands were placed behind the head with elbows pointed outward. Care was taken to ensure that the neck was not pulled on by the hands. During the lifting phase, core muscles were engaged, and an exhale was initiated as the upper back was lifted off the ground. The torso was curled towards the hips, aiming to bring the chin closer to the chest while imagining the lower back being pressed into the mat to maintain a natural spinal curve(figure. 3b), (21).

Side lunges

In the exercise of side lunges, the following steps were followed: the feet positioned hip-width apart and the core engaged by pulling the belly button towards the spine. During the lunging movement, a large step was taken to the side with one leg, with care taken to keep the toes pointed forward. The body was then lowered by bending both knees aiming for a 90-degree angle at each knee. It was important that the front knee did not extend past the toes and tracked directly over the ankle. Pressure through the front heel was used to push the body back up to the starting position, and this movement was alternated on both sides (figure. 4a),(22).

Face-down leg/arm raise

The starting position for the face-down leg/arm raise was achieved by individuals positioning themselves on all fours with their hands placed shoulder-width apart directly under the shoulders, and knees set hip-width apart directly under the hips. A flat back was maintained in a neutral position, creating a straight line from the head to the hips, while the core was engaged by pulling the belly button towards the spine (23). One arm was extended straight out in front, kept at shoulder height and aligned with the ear. Simultaneously, the opposite leg was extended straight out behind, with toes pointed and the ankle flexed. This position was held for a few seconds, (fig. 4b), (17).

While group (B): Fifteen obese children were treated with circuit exercise and shock wave (study group).

During the procedure, the children in the study group were subjected to radial shock wave therapy. Specifically, the abdomen and flanks of the obese children in the study group were targeted with approximately 2000 shots, using a 120 mJ pulse energy setting (figure.5) This treatment was administered over 12 sessions, occurring weekly. During these sessions, the children were monitored and asked to report any discomfort, including late-onset pain, as well as other potential side effects such as erythema (skin redness) and edema (swelling). It was noted that the application of the therapy was painless, and none of the participants reported discomfort or any adverse effects during the sessions (24).

Fig. (4): (a) Side lunges exercise.(b): Face-down leg/arm raise exercise

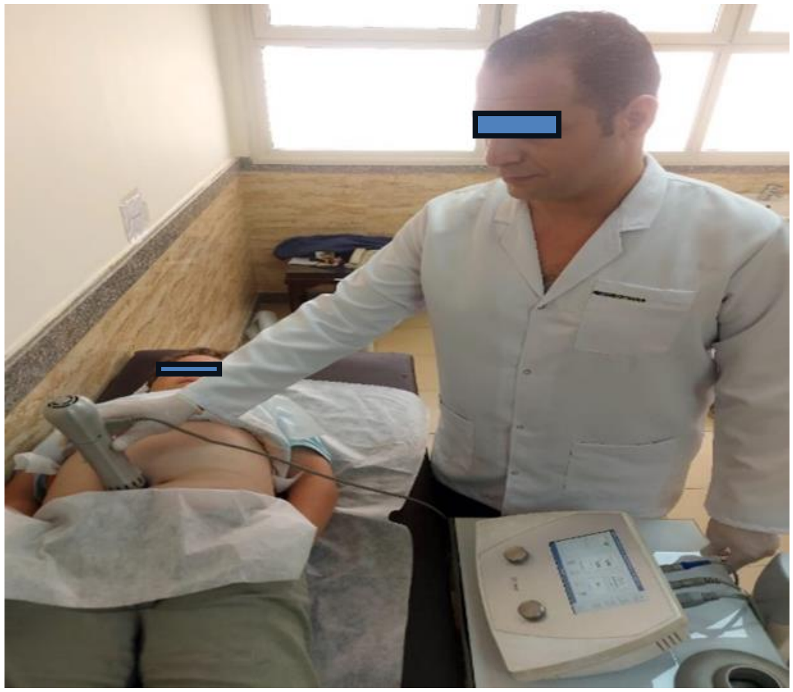


Fig (5): ESWT application

3. Statistical analysis

To compare the subject characteristics among the groups, an independent t-test was used. To compare the distribution of the genders, a chi-squared test was used. The Shapiro-Wilk test was used to ensure that the data followed a normal distribution. The homogeneity of variances among groups was tested using Levene's test. To study the therapy impact on BMI percentile, waist circumference, subcutaneous fat, as well as PedsQL score, a mixed MANOVA was used. For following multiple comparison, post hoc tests were conducted utilizing the Bonferroni correction. All statistical tests were set to have a significance level of $p < 0.05$. All statistical analysis was carried out using SPSS version 25 for Windows, which is a program developed by IBM SPSS in Chicago, IL, USA.

Sample size calculation

This study employed a two-tailed test, and the researchers determined the sample size using the G*power program 3.1.9 (G power program version 3.1, Heinrich-Heine-University, Düsseldorf, Germany). The t-tests, which measure the difference in means among two separate groups, were used to determine the sample size. Pilot testing with 4 participants in each group was conducted. In order to conduct their analysis, the investigators chose an alpha value of 0.05 for the type I error while the power was 0.80 (1-βeta). Waist circumference was also used to select the effect size of $d = 0.533$. Researchers used these standards to decide that a total of 30 people, 15 from each group, would be a sufficient sample size.

4. Results

- *Subject characteristics*:

The study and control groups' participant characteristics are shown in Table (1). When comparing the groups according to age, weight, height, and gender distribution, no significant difference was found ($p > 0.05$).

Table 1. Comparison of subject characteristics between control and study groups:

	Control group	Study group			
	Mean±SD	**Mean±SD**	**MD**	**t- value**	**p-value**
Age (years)	9.87 ± 1.36	9.93 ± 1.53	-0.06	-0.13	0.90
Weight (kg)	45.23 ± 3.81	45.50 ± 4.49	-0.27	-0.17	0.86
Height (cm)	133.80 ± 6.89	132.40 ± 5.85	1.4	0.6	0.55
Sex, n (%)					
Girls	7 (47%)	8 (53%)		χ^2 =0.13	0.72
Boys	8 (53%)	7 (47%)			

SD, Standard deviation; MD, Mean difference, χ^2, Chi-square test, p value, Probability value

<u>Impact of treatment on BMI percentile, waist circumference, subcutaneous fat and PedsQL score:</u>

The results of the mixed MANOVA showed that the treatment and time factors interacted significantly (F = 23.19, p = 0.001). F=279.82, p = 0.001 indicates a statistically significant main impact of time. F=5.18, p = 0.002 indicates that the therapy had a statistically significant main impact.

Within group comparison

Compared to pre-treatment levels, both groups' post-treatment BMI percentiles, waist circumferences, and subcutaneous fat decreased significantly (p > 0.05). The control group experienced a change of 0.64 percent in BMI percentile, 1.85 percent in waist circumference, and 5.56% in subcutaneous fat, whereas the study group experienced changes of 1.96 percent, 8.21 percent, and 20.94% in those same measures (Table2).

Both groups' PedsQL scores improved significantly after treatment compared to before (p > 0.001). Results showed that the study group's PedsQL child and parent scores improved by 36.50% and 36.78%, respectively, compared to the control group's 35.63% and 19.60% (Table 3).

Between group comparison

Before treatment, there was no statistically significant difference between the groups (p > 0.05). After treatment, there was a significant difference between the two groups in terms of waist circumference, subcutaneous fat, as well as PedsQL scores for both children and parents in the study group compared to the control group (p < 0.01). After treatment, the groups' BMI percentiles did not differ significantly (p > 0.05). (Table 2-3)

Table 2. Mean BMI percentile, waist circumference and subcutaneous fat pre and post treatment of control and study groups:

	Pre treatment	Post treatment			
	Mean±SD	**Mean±SD**	**MD**	**% of change**	**p value**
BMI percentile (%)					
Group A	97.19 ± 1.46	96.57 ± 1.50	0.62	0.64	0.04
Group B	97.45 ± 1.51	95.54 ± 2.78	1.91	1.96	0.001
MD	-0.26	1.03			
	p = 0.63	***p = 0.22***			
Waist circumference (cm)					
Group A	79.20 ± 2.18	77.73 ± 2.63	1.47	1.85	0.03
Group B	77.93 ± 3.17	71.53 ± 3.46	6.40	8.21	0.001
MD	1.27	6.20			
	p = 0.21	***p = 0.001***			
Subcutaneous fat (mm)					
Group A	31.13 ± 5.10	29.40 ± 4.34	1.73	5.56	0.004
Group B	32.47 ± 3.74	25.67 ± 3.29	6.80	20.94	0.001
MD	-1.34	3.73			
	p = 0.42	***p = 0.01***			

SD, Standard deviation; MD, Mean difference; p value, Probability value

Table 3. Mean PedsQL score pre and post treatment of control and study groups:

PedsQL	Pre treatment	Post treatment			
	Mean±SD	**Mean±SD**	**MD**	**% of change**	**p value**
Child score					
Group A	59.13 ± 3.36	80.20 ± 3.38	-21.07	35.63	0.001
Group B	60.88 ± 2.65	83.27 ± 2.55	-22.39	36.78	0.001
MD	-1.75	-3.07			
	p = 0.12	***p = 0.009***			
Parent score					
Group A	63.27 ± 3.90	75.67 ± 5.29	-12.40	19.60	0.001
Group B	62.92 ± 4.87	84.63 ± 2.33	-21.71	34.50	0.001
MD	0.35	-8.96			
	p = 0.83	***p = 0.001***			

SD, Standard deviation; MD, Mean difference; p value, Probability value

5. **Discussion**:

This study was done to investigate the impact of adding shockwave to circuit training on obese children.

This research, a three-month randomized controlled trial at the Armed Forces Hospitals' Outpatient clinics, explored the effects of circuit exercise and shock wave therapy on obese children. It involved thirty obese children, aged 8 to 12 years, who were diagnosed based on their BMI (95th to 99th percentile) and randomized into two groups. The control group (fifteen children) engaged in circuit exercises, while the study group (also fifteen children) received both circuit exercises and shock wave therapy, using the Z-Wave™ ESWT system. Children with certain health conditions or medication use were excluded. The study utilized standard weight and height scales, BMI charts, waist circumference tape measurements, and the Philips EnVisor ultrasound device for assessments. These tools were validated by recent studies. Evaluations, including physical measurements and quality of life assessments via the Pediatric Quality of Life Inventory (PedsQL Version 4.0), were conducted at the study's start and end, aiming to ensure the interventions' effectiveness and reliability.

Selecting children in the 8 to 12 age range, specifically before puberty, ensures a more homogeneous study group in terms of growth and hormonal status. This period is crucial for establishing habits and interventions that can have long-term health implications. Moreover, the physiological and metabolic responses to exercise and shockwave therapy can be more uniformly assessed before the onset of puberty-related changes (25).

Regarding BMI, a significant decline was found in BMI percentile of control group after treatment when compared to pretreatment, there was no significant difference in BMI percentile between control and study groups post treatment.

Circuit training, enhances metabolic rate not only during the activity but also in the hours following the session, a phenomenon recognized as excess post-exercise oxygen consumption (EPOC). This increased metabolic rate facilitates more significant energy expenditure, contributing to the reduction of body fat (26).

Additionally, circuit training promotes the development of lean muscle mass, which in turn augments basal metabolic rate (BMR), indicates that the body burns more calories at rest. This is particularly beneficial for obese children;whose elevated body fat percentage often correlates with a lower proportion of muscle mass. Because it takes greater amounts of energy to keep muscle tissue than fat tissue, increasing muscle mass through circuit training can eventually lead to better energy utilization and fat loss (27).

In alignment with the current study, Shejin and Vivekanandhan(28).The impacts of a circuit training program on obesity (% of body fat), vital capacity, and flexibility among overweight and obese male students aged 10-14 from. Thirty participants were randomly selected based on BMI scores, with a BMI above 26 indicating eligibility. A significant decrease in obesitywas observed in the experimental group compared to the control group.

In accordance with the current study, Gątarski et al. (29) investigated the spectrum of changes in overweight and obese children following an 8-week circuit training program. Their research involved 83 children aged 9-12, all exhibiting excessive body weight as assessed by the OLAF scale. The findings revealed a significant reduction in body weight indicating the beneficial effects of the short-term circuit training program on body composition

The present study differs from Engel et al. (30), which investigated the outcomes of micro-sessions of multi-joint functional high-intensity circuit training that were 6 minutes long and conducted in a classroom setting. The mean age of the children participating in their 4-week randomized controlled trial was 11. Although one group performed 6-minute functional HIIT four times weekly during their regular school classes, the other group did not. There were no statistically significant changes in the groups' mean height, mass, or body mass index (BMI) between the beginning and end of the study. The observed difference from the current study could be attributed to the short-term intervention.

The mechanism through which radial shock wave therapy affects adipose tissue involves the mechanical stimulation of fat cells and the surrounding connective tissue, which may enhance the breakdown of localized fat deposits. This process, known as mechanotransduction, could lead to improvements in local adiposity without necessarily impacting the overall distribution of body fat or significantly altering the body's energy balance (31).

In alignment with the current study, Modena et al. (32) assessed the effectiveness of Shock Wave Therapy (SWT) in treating cellulite in the gluteus as well as posterior thigh regions. The assessment was conducted at baseline, after 6 and 10 sessions. Eligible participants were women aged 18 to 45 with a BMI of up to 29.9, non-smokers, and without priorimpairments, presenting with varying degrees of cellulite severity. The study findings demonstrated that the results, particularly observed during the 3-month follow-up after treatment cessation, were maintained. Notably, there were no significant changes in weight as well as BMI during or after the treatment period, indicating the efficacy of SWT in cellulite reduction without affecting body weight or BMI.

Regarding waist circumference,the waist circumference of the control group decreased significantly after treatment when compared to baseline. After treatment, the waist circumference of the study group was significantly less than the control group.

In accordance with the current study, Lee, Yoon et al.(33)investigated the impacts of high-intensity circuit training on obesity indices in inactive female college students. The exercise program entailed 40 minutes of circuit training at 60%–80% heart rate reserve, conducted three sessionsa week for 4 weeks. Body composition was assessed pre and post the exercise intervention. The findings showed a significant decline in waist circumference ($P = 0.003$), with WC reducing from 76.89 cm pre-exercise to 75.15 cm post-exercise. These findings suggest that high-intensity circuit training could serve as an effective exercise modality for reducing waist circumference in inactive female college students.

Compared to before treatment, the control group's subcutaneous fat decreased significantly after treatment. Subcutaneous fat decreased significantly in the treatment group when compared with the control group.

Radial shock wave therapy enhances blood flow to treated areas, which can improve the delivery of oxygen and nutrients necessary for metabolic processes, including lipolysis, the breakdown of fat cells. Increased blood flow also facilitates the removal of waste products from metabolism, potentially improving the overall metabolic efficiency of adipose tissue reduction Dedes et al.,(34).

In agreement with the current study, Michelin et al. (35) investigated the effects of defocused and radial shock wave therapy on lipedema treatment and its impact on subcutaneous adipose tissue (SAT). The study included fifteen consecutive patients diagnosed with lipedema stage II (types 2, 3, and 5). Various outcome measures were assessed before treatment (T0), at the end of treatment (T1), and at 1 (T2) and 6 (T3) months after radial shock wave treatment. Tissue thickness was measured using an electronic caliper. The SAT assessment revealed a reduction in subcutaneous echogenicity and an improved organization and visualization of connective tissue bundles at each follow-up time point across the three regions examined (trochanteric region, distal thigh, and leg)

In disagreement with the current study, Troia et al. (36) investigated whether SWT combined with an Aerobic Exercise Program (AEP) could reduce the severity of cellulite in the gluteal region and the proximal posterior of the thigh. The study involved 45 healthy women with their age ranged from 18 to 32, randomized to three groups based on cellulite severity and physical activity levels: two experimental groups and one control group. Experimental group 1 underwent the AEP, while experimental group 2 received the AEP combined with a Radial SWT protocol. Both experimental groups performed 6 interventions over three weeks. Contrary to the expected outcomes, after SWT, there was an increase in subcutaneous adipose tissue from 34.16 mm before SWT to 35.03 mm after 3 weeks of SWT. This increase in subcutaneous adipose tissue may be associated with a rise in cellulite severity. The difference may attribute to different region from which subcutaneous adipose thickness was measured. As in the current study we measure abdominal region while in that study they measure gluteal region and posterior thigh.

The PedsQL child score within the control group significantly improved after treatment when compared to before. After receiving treatment, children in the study group had significantly higher PedsQL scores than children in the control group.

Scheffers et al. (37) found similar results when they studied the impact of a high-protein diet and 12-weeks of leg-focused resistance training upon the quality of life of children with Fontan syndrome. The study comprised twenty-eight paediatric. Both the parent and child versions of the validated Child Health Questionnaire (CHQ) were used to measure health-related quality of life prior to and following the intervention. The child form, CHQ-CF45, consisted of 45 items across 11 categories, and the parent form, CHQ-PF28, consisted of 28 items across 13 domains. There were three areas where parents' perceived quality of life improved significantly when compared to the control period: bodily pain, overall perception of health, as well as health change.

The addition of radial shock wave therapy to circuit training might facilitate greater physical improvements than exercise alone, such as increased muscle tone and reduced subcutaneous fat. These physical changes can significantly impact children's self-perception and social interactions, areas heavily weighted in the PedsQL measurement. Improved body image and physical capabilities can lead to increased participation in social and physical activities, reducing feelings of isolation or embarrassment that often accompany obesity in childhood beadle, (38).

The limitations of this studywas that it does not rigorously monitor or regulate participants' nutritional consumption and extracurricular physical activities. Also, the study was limited by the inability to use MRI to measure intraperitoneal and visceral fat, due to cultural concerns and parental restrictions.

6. Conclusion

Adding shock wave to circuit trainingled to additional benefits in reducing central adiposity (waist circumference) and improving quality of life for both children and parents, compared to the control group

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Conflicts of interest: For this article, none of the authors have disclosed any potential conflicts.

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Patient consent statement:
Prior to the start of data collection, all participants provided their written, informed consent.

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