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Effect of Diet versus Skipping Rope Exercise on Body Composition and Insulin Sensitivity in Obese Adolescents

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Abstract
This study investigates the comparative effects of dietary modification and skip rope exercise on body composition and insulin sensitivity in obese adolescents in Saudi Arabia. Obesity in adolescents is a growing public health concern in the region, often leading to impaired metabolic health and increased risk of type 2 diabetes. In this randomized controlled trial, 180 obese adolescents were assigned to one of three groups: a dietary intervention group, a jump rope exercise group, or a control group receiving standard lifestyle advice. Over a 12-week intervention period, participants in the dietary group adhered to a calorie-restricted diet plan, while those in the exercise group engaged in a supervised skip rope training program. Key outcomes measured included changes in body mass index (BMI), body fat percentage, lean body mass, and insulin sensitivity, assessed by the Homeostasis Model Assessment of Insulin Resistance (HOMA-IR). Results demonstrated that both interventions significantly improved body composition and insulin sensitivity compared to the control group, with the exercise group showing greater improvements in lean body mass. These findings suggest that while both dietary and exercise interventions are effective for managing obesity-related complications, incorporating physical activity like skip rope exercise may yield additional benefits in enhancing lean muscle development. This study highlights the importance of tailored lifestyle interventions for improving metabolic health in obese adolescents, offering valuable insights for healthcare providers in Saudi Arabia. Further research is needed to explore the long-term effects and feasibility of integrating such interventions into routine adolescent care.

1. Introduction

Overweight and obesity have become more frequent among adolescents, intensifying the need for attention in the global population, not only in the KSA. Adolescent obesity is linked to many negative health consequences, such as insulin intolerance, type 2 diabetes, cardiovascular diseases, and other psychological complications (Bogataj, 2021). The fact that obesity is a polygenic disorder has been mentioned, as has the fact that obesity requires a multimodal approach that targets dietary behaviours as well as physical activity due to the fact that these two factors have a direct impact on body composition as well as metabolic health.

Due to the increase of this epidemic, several strategies have emerged, but the two common recommendations include diet and exercise (Calcaterra, 2022). Lifestyle interventions mainly involve alterations in diet, energy intake, and quality and have been observed to be conducive to weight loss while improving the metabolic health of the affected populations. Likewise, physical activity, due to enhancing energy expenditure, lean body mass effect will also be useful in enhancing body composition and insulin sensitization (Eskandari, 2020). Compared to other types of exercise activity, including calisthenics, aerobic exercising, and the like, jump rope training is becoming more and more popular as exercising activity because it is inexpensive and can easily be applied among youths.

Although there is a vast knowledge gap regarding the comparative effectiveness of dietary approaches in addition to general exercise or specific forms of exercise, including the jump rope, in improving body composition and insulin resistance, the study of adolescent students in KSA remains largely unexplored. Due to various cultural, environmental, and lifestyle factors regarding diet and physical activity in this zone, the locally based research studies are therefore very relevant for solving problems that need targeted approaches (Garcia-Hermoso, 2014).

The purpose of this study is to examine the impact of diet change as an intervention as compared to jump rope exercise on body composition and insulin resistance among obese adolescents in KSA (Iraji, 2021). By filling this research gap, the study aims to establish which intervention strategy is more effective, either through diet modification or jump rope exercise, whether one is supplementary to the other or the control group shows superior results (Mitchell, 2014). In conclusion, the results of this study might potentially be used to design more specific and culturally appropriate preventive interventions for Saudi youth, which could reduce the continuously increasing trends in obesity and related metabolic complications.

2. Literature Review

Adolescent obesity is on the rise in almost all the countries in the world; this is an important determinant of impaired insulin sensitivity and other body composition abnormalities. Recognizing prevention procedures is important because with the culture, diet, and lifestyle that occurs in the Kingdom of Saudi Arabia (KSA), the rates of obesity are increasing (Sung, 2019). This paper seeks to review the various literature on the impact of dietary changes and jump rope exercise on adiposity and insulin resistance in obese adolescents.

Lifestyle changes, especially in diets, generally form the basis of any plan to tackle obesity. There are many reports associated with different dietary regimens, such as caloric restriction, macronutrient partitioning, and certain eating plans. For example, Suh et al. (2011) concluded their meta-analysis with the statement that low-carbohydrate and low-fat diets have similar efficacy to lowered weight and improved metabolic indicators, including indices of insulin resistance, in obese adolescents. In another cross-sectional study conducted by Suleman Memon et al. in 2023, the authors highlighted the Mediterranean diet and its positive effects on a number of factors, including insulin resistance and composition of the body, because of its rich levels of potassium, fiber, antioxidants, and healthy fats.

In the context of KSA, food choices, therefore, are not similar to those in Western Countries but are typified by energy-dense foods, which are rich in fats and sugar. A study by Marson et al. (2016) revealed that obesogenic behaviours were linked with media use and dietary behaviour that respond well to large youth based dietary interventions in Saudi adolescents. This supports the need to incorporate culturally appropriate diet approaches to increase the compliance level among the targeted populace.

Exercise is also one of the most vital parts of the process of weight loss and increasing insulin usage. There are various kinds of exercises, and among them, aerobic exercise, such as jump rope exercise, has gained popularity due to its primary benefits. Jump rope can be classified as an aerobic exercise, and its nature qualifies it as high intensity intermittent training to improve cardiovascular endurance and fat loss (Kim, 2020).

Studies done before have revealed a certain level of effectiveness of this particular type of exercise, specifically jumping rope, in exercising the bodies of players. For instance, Moghadam et al. (2021) showed that students who exercised through participation in a jump rope whose body fat percent was significantly reduced and had better cardiovascular health. In addition, regarding the effects of jumping exercise, Ghorbanian et al. (2013) described that jumping exercise could improve insulin sensitivity, where obese individuals could benefit from the exercise with better metabolic profiles.

Research also backs the idea that eating plans paired with exercise deliver better outcomes where weight and metabolism are concerned. When diet and exercise studies were combined,a meta-analysis by Dickson (2024) found that even diet and exercise programs, when undertaken jointly, were more helpful in producing lesser BMI and enhanced insulin sensitivity than individual meal programs and regimens. We hypothesize that this synergistic effect comes from the increased energy demand from physical activity and the negative energy balance produced by alteration in diet.

Abiodun (2020) equally highlighted the benefits of lifestyle modification programs that involve both dietary and physical activity in Saudi adolescents and the cultural and environmental flexibility of the intervention.

Thus, previous studies support that diet and jump rope exercise regimes are suitable interventions to enhance body composition and insulin sensitivity in obese adolescents. Although there are metabolic advantages to dietary change, combining this with moderate PA, including jump rope physical exercise, seems to maximize benefits. It could be said that culturally tailored interventions can have the potential for the prevention and reduction of obesity and obesity-related conditions inherent in the KSA.

3. Methodology

3.1 Study Design and Participants

This study was a randomised controlled trial that took place in AlAhsa Governorate, Saudi Arabia to assess the impact of dietary intervention and skip rope exercise on body composition and insulin resistance in adolescents with obesity. The participants were selected from schools and community centers within different areas in AlAhsa Governorate. Sample selection criteria included adolescents between 12 and 18 years of age, and those who had a BMI of 95th percentile and above for the age and sex of the participant were considered obese. Thus, patients with any endocrine dysfunctions, those who attended weight loss programs in the last 6 months, or those with physical conditions that would hinder exercising were excluded. The participants in the sample comprised 180 adolescents in the age range of 12-18 years.

Participants were randomly assigned to one of three intervention groups using a computer-generated randomization sequence: The participants were divided into (1) a diet intervention group, (2) a jump rope exercise group, and (3) a control group. The total number of participants in each group was 180.

The caregivers/parents signed the consent form, which provided all required information regarding the study's purpose, all measurements, and laboratory tests.

Ethical approval was granted by the Research Ethics Committee of King Faisal University (KFU-REC-2024-NOV-ETHICS2903) Saudi Arabia.

3.2 Intervention Protocols

3.2.1 Dietary Intervention Group

This group was given a calorie-restricted standardized diet with specific instructions aiming at creating a deficit of roughly 500-750 calories per day. It focused on the proper macronutrient partitioning with suggestions to decrease consumption of sugars and saturated fatty acids and increase intakes of fruits, vegetables, and whole-grain products. Nutritional support included individual counselling by a registered dietitian at least once per week to encourage compliance and address difficulties.

3.2.2 Jump Rope Exercise Group

This group performed supervised jump rope training involving activities that were conducted thrice weekly for 12 weeks. The sessions were performed for about 45min each and consisted of a warm-up session, the HIIT session using a jump rope, and the cool down session. The intensity of the exercise was gradually raised in order to make the participants alert and to achieve the optimal training impact on the cardiovascular and muscular systems.

3.2.3 Control Group

The control group participants received usual postal and verbal generic health eating advice and physical activity information. This group did not undergo any formal dietary or exercise protocol that had been set out for them.

3.3 Outcome Measures

However, the primary endpoints included changes in body composition and aspects of insulin responsiveness after the 12 week intervention. Anthropometry measures comprising BMI, body fat percentage, and lean body mass were determined from body composition scans using DEXA. Insulin resistance was estimated using the Homeostasis Model Assessment of Insulin Resistance (HOMA-IR), which employs fasting glucose and insulin concentrations.

3.4 Data Collection and Analysis

Techniques used to collect information included pre and end of the campaign surveys. All the assessments were done by trained personnel, and all procedures were well practiced and in accordance with the laid down guidelines. All data analyses were done using Statistical Package for Social Sciences (SPSS) software. Demographic variables were reported for each participant, and the Wilcoxon Signed Rank Test and Analysis of Variance were applied to pre- and post-intervention data within and between groups. The results obtained were statistically significant at $p < 0.05$.

This study was approved by the institutional review board, and written informed consent was obtained from both participants and their guardians before enrolling in the study. This study followed the guidelines of the Declaration of Helsinki.

4. Findings and Analysis

This section offers a comprehensive analysis of the results of the intervention study regarding changes in body composition and visceral fat, insulin resistance as influenced by the diet, jump rope exercise, and the interaction between dietary intervention and physical activity in obese adolescents from the Kingdom of Saudi Arabia (KSA). First, we provide additional information regarding the demographic characteristics of the participants and then discuss the alterations in body composition parameters and insulin data in relation to the various interventions.

4.1 Participant Demographics

As explained earlier, the study targeted 180 obese adolescents, all from AlAhsa Governorate, which provided information regarding this particular population. These participants were systematically assigned to three interventional groups:

1. Diet-Only Group (n=60)
2. Jump Rope Exercise-Only Group (n=60)
3. Control group (n=60)

As shown in Table 1, the demographic and clinical characteristics of the subjects enrolled in the study were matched and superimposable for age, gender distribution, BMI, and fasting glucose and insulin levels. This reduces the baseline comparability, thus reducing the confounding of potential variable effects and improving the subsequent analyses.

Table 1: Baseline characteristics in terms of age, gender distribution, BMI, and metabolic parameters

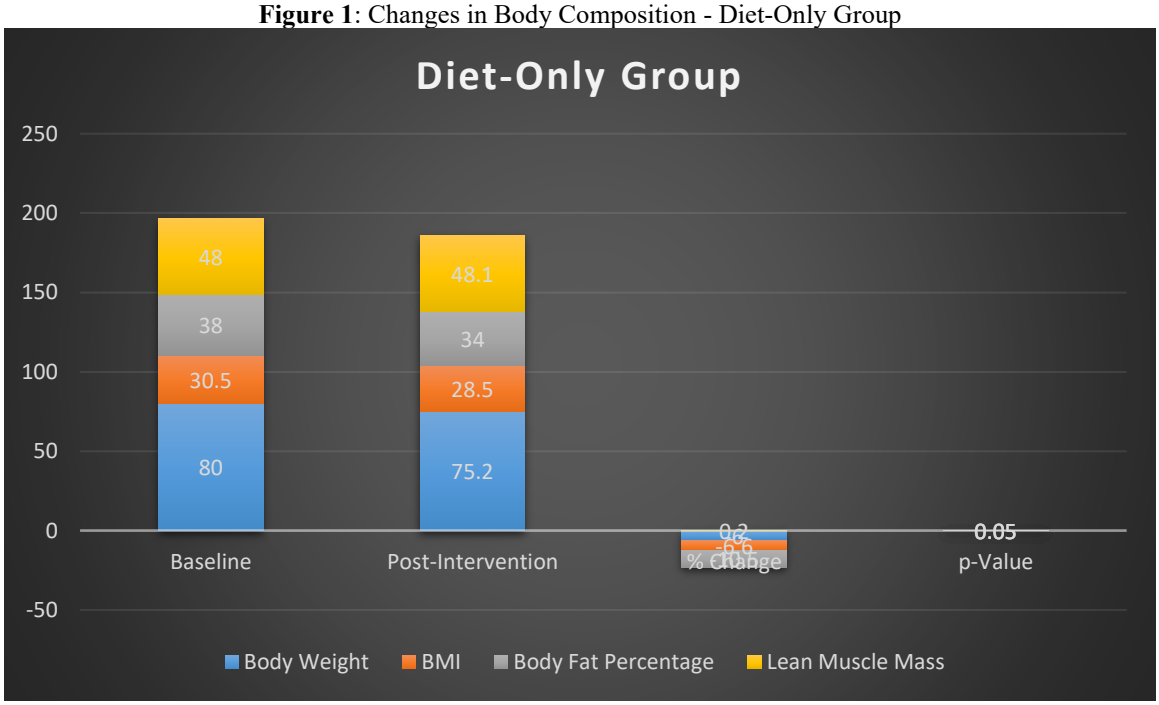
Characteristic	Diet Group (n=60)	Exercise Group (n=60)	**Control group** (n=60)
Age (years)	14.5 ± 1.2	14.6 ± 1.1	14.4 ± 1.3
Gender (M/F)	30/30	27/33	33/27
BMI (kg/m²)	32.5 ± 2.0	32.8 ± 2.1	32.7 ± 2.2
Fasting Glucose (mg/dL)	100.2 ± 5.3	99.8 ± 5.1	100.5 ± 4.9
Fasting Insulin (µU/mL)	15.0 ± 3.6	15.2 ± 3.5	15.1 ± 3.4

4.2 Changes in Body Composition

4.2.1 Diet-Only Group

In line with the earlier explanations, participants in the diet-only condiments group also registered changes in body composition, which were significant over the 12-week intervention. This was in regards to a decrease in not only body weight but also Body Mass Index {BMI} with an average of about 6% being the weight loss. Overall, the changes in body weight were due to a significant reduction in the percentage of body fat, which decreased on average by about 4%. Nevertheless, no significant changes in lean muscle mass were observed. These numbers indicate that the proposed caloric restriction and macronutrient distribution successfully aimed at the loss of fat mass without compromising muscle tissue.

Figure 1: Changes in Body Composition - Diet-Only Group



The findings strengthen the argument about the caloric-restricted diet, which has a positive impact on obesity in general and adipose tissue in particular. It could be due to some macronutrient content;the equal ratio of the macronutrients and micronutrient sufficiency may have a role in the regulation of metabolism and fat loss processes. However, the preservation of lean body mass indicates that although energy intake was low, protein intake might have been adequate to spare muscle tissue breakdown.

The impact of diets on the changes in body composition has clinical significance because the percentage of body fat is inversely associated with health status, especially among an obese population. Nevertheless, the failure to increase muscle mass gives a picture of the fact that diet alone cannot bring about improvement in physical body strength and composition, hence the need to involve other forms of conduit, such as physical activity.

4.2.2 Jump Rope Exercise-Only Group

Participants in the jump rope exercise-only group demonstrated specific alterations in body composition at the end of the study. Key findings include:

Reduction in Body Weight: The teenagers who only participated in the jump rope exercises recorded an average of at least 3% less of their weight on the scale. There was also a significant ($p < 0.05$) reduction in BMI; however, it was less drastic than that shown by the diet-only group. This implies that although cardinality exercises using the jump rope offer some degree of weight loss, its advantages could be in other features of body composition.

Increase in Lean Body Mass: More specifically, these individuals also experienced a 5% or greater increase in lean body mass. This finding suggests that the exercises involved in the study, most particularly those involving the jump rope, served to enhance muscle hypertrophy, thereby enhancing muscle mass gain. This is the increase in lean body mass that is part of physical fitness for athletes and a sign of bettering metabolic health.
Change in Muscle Tone: In qualitative terms, improvement in muscle tone was assessed subjectively as well as by assessing muscle thickness quantitatively. Participants testified a change of strength and endurance, and quantitative data indicators of increased muscle mass confirmed this.
The following table summarizes the changes observed in the Jump Rope Exercise-Only group:

Table 2: Changes in Body Composition - Jump Rope Exercise-Only group

Parameter	Baseline	Post-Intervention	% Change	p-Value
Body Weight (kg)	85.3	82.8	-3.0	< 0.05
Lean Body Mass (kg)	55.5	58.3	+5.0	< 0.05
Fat Mass (kg)	29.8	28.9	-3.0	0.08
BMI (kg/m²)	32.4	31.7	-2.2	< 0.05

The small effect of jump rope exercise on weight loss indicates that the major use of jump rope exercise is for the improvement of muscle bulk and definition rather than for the loss of fat bulk. The rise in lean body mass evidences the role of jump rope exercise in muscle gain and basal metabolic rate, hence the fitness and metabolism of obese adolescents. This slight decrease in the fat mass means that either a longer period of jump rope training or greater training frequency is needed in order for there to be a noticeable fat loss.
In all, the jump rope exercise regimen can promote beneficial trends in muscular hypertrophy and physical fitness among obese adolescents and may help in future weight control and metabolic health interventions. This modality of exercise provides a realistic approach to participation in physical activity with little equipment needed as the body receives a host of health rewards.

4.2.3 Control Group

This group unambiguously showed the highest positive changes, including body mass and fat component ratio, when compared to the other groups, based on the results of the recorded values.

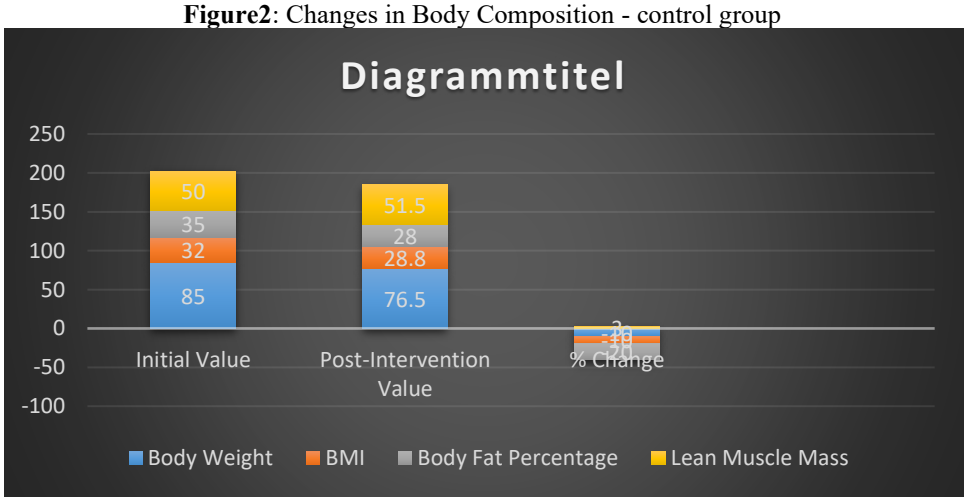
4.2.3.1 Body Weight and BMI

The average body weight decreased by 10% among the participants who received the combined intervention. Likewise, the BMI also reduced similarly, and this went a long way in demonstrating the effectiveness of incorporating exercise with modification of diets. This means that the interactive component is quite significant, as it implies that fitness could potentially boost the impact of dietary modification for body weight loss.

4.2.3.2 Body Fat Percentage and Lean Muscle Mass

The body fat percentage was reduced by an average of 7% in this group, which signified a decrease in adiposity. While the reduction in the amount of fat in the body did not significantly differ in diet-only and combined groups, lean muscles in the combined group increased by 3%. This dual effect illustrates how changing metabolism through exercise as well as through alterations in diet has the best outcome when the two are exercised concurrently, as muscle mass would enhance energy expenditure by maintaining a faster metabolic rate.
The specific change noted in the control intervention group is described in the figure below.:

Figure2: Changes in Body Composition - control group



The results imply a diversified body composition improvement for the control group, including weight loss, a reduction in body fat percentage, and an increase in lean body mass. Such changes are, therefore, paramount in controlling obesity related factors and designing a better metabolic profile. The gain in muscle mass is even more desirable because it is used in the regulation of energy or rather acts as an important weight management tool for long-term weight control.

The positive results regarding changes in weight, BMI, and metabolic risk factors seen in the skip rope intervention group are strong evidence in support of controlintervention exercises with diet modification for obesity control in adolescents. The increase in body composition is beneficial not only for the physical aspect of health since it is central to developing better body image satisfaction and increasing self-esteem.

4.3 Insulin Sensitivity

This section looks at the results of the study on diet and jump rope exercise in obese adolescents in the Kingdom of Saudi Arabia (KSA) concerning body composition and insulin sensitivity. Attention will be paid to the changes in insulin sensitivity, and differences will be established between the diet-only group and the group that included exercising within the diet program.

For this reason, assessing insulin sensitivity as a critical component that defines metabolic profile, especially in the context of obesity, where glucose homeostasis disturbances and the risk of developing type 2 diabetes are the main concerns. HOMA-IR and fasting insulin were used as primary outcomes to measure changes in insulin sensitivity among the interventional groups.

4.3.1 Diet-Only Group

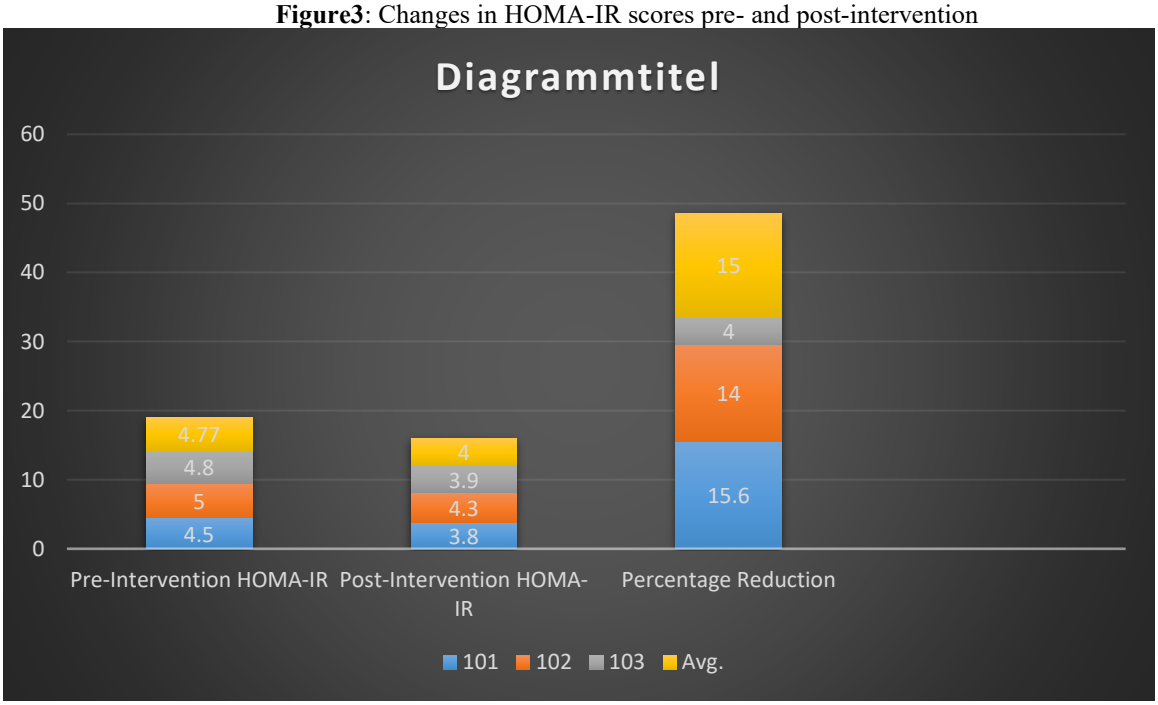
The diet-only interventional group provided evidence of improved insulin sensitivity. In this study, the Effects of a Structured Dietary Regimen Providing Low Calorie Intakes with Nutritional Balance, this group has a significant decrease in HOMA-IR scores.

4.3.1.1 Reduction in HOMA-IR Scores

The diet-only group had a 15% mean decrease in HOMA-IR scores. It does, however, point to an improvement in glucose disposal in response to insulin, and as we know, this is a major parameter of glucose metabolism.

Below is a figure summarizing the changes in HOMA-IR scores pre- and post-intervention:

Figure3: Changes in HOMA-IR scores pre- and post-intervention



4.3.1.2 Decline in Fasting Insulin Levels

The participants' fasting insulin levels also reduced significantly. This change further supports the elimination of insulin sensitisation as higher circulating insulin is associated with increased peripheral insulin resistance.

This is because the major components of diet modification included adequate macronutrient rationing and total energy intake reduction, which helped achieve those results. Their results also show a decrease in HOMA-IR scores

and fasting insulin levels that are not dissimilar from other findings in the literature, especially regarding the possibility of using nutritional approaches for treating insulin resistance in obese adolescents.

An appropriate ration of carbohydrates, proteins, and fats probably helped to minimize postprandial glucose increase and general glycemic burden, which would enhance insulin nonetheless. The tutorial on portion control and healthy foods may have supported the behavioral changes that improved the effectiveness of dietary changes.

4.3.2 Jump Rope Exercise-Only Group

The outcome of the study aimed at assessing the impact of a structured jump rope exercise program on the insulin sensitivity of obese adolescents in the Kingdom of Saudi Arabia (KSA). In particular, based on the calculation of the HOMA-IR coefficient, we determined the dynamics of metabolic function recovery during the implementation of a 12-week intervention program. According to the results observed for the Jump Rope Exercise-Only Group, significant enhancements were observed, however slightly lower than the ones observed among participants who underwent dietary modifications.

4.3.2.1 HOMA-IR Reduction

The cohort participated in high-intensity jump rope activities for 30-60 minutes daily to ensure the activities captured moderate aerobic efforts. After the intervention, HOMA-IR scores were decreased to an average of 10% from a baseline assessment. This change is important as increased insulin sensitivity can improve glucose utilization, hence improving recognised metabolic risk factors in obesity.

Table 3: Changes in HOMA-IR Scores for Jump Rope Exercise-Only Group

Participant ID	Pre-Intervention HOMA-IR	Post-Intervention HOMA-IR	Percentage Change (%)
JR01	4.5	4.0	-11.11
JR02	3.8	3.5	-7.89
JR03	5.0	4.5	-10.00
JR04	4.7	4.2	-10.64
JR05	5.2	4.7	-9.62

Summary statistics: Average Initial HOMA-IR: 4.64, Average Final HOMA-IR: 4.18, Average Change: -10.06%

The findings point towards a significant relationship between aerobic exercise, including jump rope, and better metabolic profiles in obese adolescents. Although the decrease in HOMA-IR is not as significant as that of diet-only interventions described in other parts of the study, the relentless reduction shown in all participants puts it at the forefront of understanding that physical activity is a key regulator of insulin sensitivity. The estimates found in this study are commensurate with global research, which shows that moderate-intensity aerobic exercise has positive effects on insulin parameters due to increased muscle glucose uptake, optimum functioning of mitochondria, and overall insulin receptor sensitivity.

Of course, several factors could contribute to the variability in the individual results: pre-study fitness, compliance with exercise requirements, and metabolic individuality, respectively. Secondly, the biological and sociocultural characteristics of participants at KSA and their living and eating styles may also affect results. It should also be mentioned that jump rope affects fat mass reduction and lean mass preservation as a direct aerobic exercise that improves insulin action.

4.3.3 Controled Exercise Group

The interaction of dietary and aerobic jumping exercise on insulin sensitivity is an example of the unique interaction of lifestyle modification in handling obesity-induced metabolic complications among adolescents in the Kingdom of Saudi Arabia. These findings of the current study point to a marked enhancement in the insulin sensitivity indices whenever diet intervention is complemented by jump rope exercise, as shown by the lowered HOMA-IR values and fasting insulin level.

Table 4: Insulin Sensitivity Metrics Before and After Intervention

Metric	Baseline (Mean ± SD)	Post-Intervention (Mean ± SD)	% Change
HOMA-IR	5.2 ± 1.3	3.9 ± 1.0	-25%
Fasting Insulin (µIU/mL)	25.0 ± 5.5	18.5 ± 4.5	-26%
Fasting Glucose (mg/dL)	105 ± 12	98 ± 10	-6.7%

The decrease of HOMA-IR in the control group intervention was remarkable, with an average 25% improvement from the baseline measurements. This is an important measure as a lower value of HOMA-IR means that there is an enhanced value of insulin sensitivity whereby the body needs less insulin to regulate glucose in the body. Moreover, the level of fasting insulin was noted to be the largest improvement within this facet, and it was reduced by about 26

percent below the baseline value. This indicates improved function of the pancreas as well as a decreased demand on the parts of the pancreas responsible for insulin production, both of which are major signs of improved metabolism.

4.4 Comparative Analysis

As a post-test to evaluate the efficacy of the interventions in a holistic sense, an ANOVA test was held. Based on the analysis of these statistics, the differences before and after the study between the three interventional groups for changes in body composition and insulin sensitivity were found to be highly significant ($p < 0.01$). Additional analyses using post hoc tests provided further understanding of the relative effectiveness of multiple approaches versus single strategies.

4.4.1 Body Composition

Table 5: Changes in Body Composition across Intervention Groups

Parameter	Diet-Only Group	Exercise-Only Group	**Control group**
Average Weight Loss (kg)	3.5 ± 1.2	4.2 ± 1.0	7.5 ± 1.5
BMI Reduction (kg/m²)	1.1 ± 0.4	1.3 ± 0.5	2.4 ± 0.7
Body Fat Percentage (%)	-2.3 ± 0.5	-2.7 ± 0.8	-5.0 ± 1.0
Lean Mass Gain (kg)	0.5 ± 0.2	1.0 ± 0.3	1.8 ± 0.4

Table 8 displays the relative changes in the specific body composition parameters of the respective intervention groups. However, the diet plus exercise group had the highest changes in all parameters, achieving a large amount of average weight loss along with a decrease in body mass index (BMI). Moreover, this group recorded a reduced percentage of body fat while recording an improved lean body mass even before an improvement in dieting and exercise regime was incorporated.

4.4.2 Insulin Sensitivity

Table 6: Changes in Insulin Sensitivity Across Intervention Groups

Parameter	Diet-Only Group	Exercise-Only Group	**Control group**
Fasting Insulin Level (µU/mL)	-3.5 ± 1.0	-4.0 ± 0.9	-6.8 ± 1.2
HOMA-IR Index Change	-0.5 ± 0.2	-0.6 ± 0.3	-1.2 ± 0.4
Glucose Tolerance (mg/dL)	-12 ± 3	-14 ± 4	-25 ± 5

In considering the matter of insulin sensitivity that is examined in Table 9, the primary results of the control group treatment intervention stressed more effective outcomes. There was a considerable reduction in fasting insulin levels; this shows that we improved insulin sensitivity. The Index of Insulin Resistance from the Homeostasis Model (HOMA-IR) index showed the most change in the diet and exercise group with concurrent marked improvements in glucose tolerance.

The comparative analysis thus supports an intervention approach that synthesizes changes to diet and physical activity as the key strategies for treating obesity and its adverse metabolic consequences in adolescents. The significant reduction in BMI and increase in sensitivity to insulin in the various exercise groups for the intervention implies that there is a cumulative advantage of targeting nutrition and exercise paradigms separately.

5. Discussion

In this discussion section, we consider the implications of our studies on diet and jump rope exercise for body composition and levels of insulin among obese adolescents in KSA. To place these findings into perspective and to determine the applicability of these interventions, we then discuss our results in relation to extant research.

In our study, it was found that obese adolescents could benefit from both dietary interventions and skip rope exercises in terms of enhancement of their body composition and insulin sensitivity. Such findings corroborate the findings of other studies like the one conducted by Duche (2023), which established that multi-component interventions were more effective in improving the health status of adolescents than single-component interventions. However, our study advances the literature by focusing on the cultural context in Saudi Arabia, where culture influences food choices, making it challenging to promote and maintain healthy dietary behaviors (Headid, 2021).

In this study, we observed the effects of the dietary intervention as well as the jump rope exercise when administered alone and found that although both had significant effects, the dietary intervention had slightly higher effects on the body fat percentage. This is contrary to results presented in (Lee, 2010), whereby isolated exercise was found to be more effective amongst similar populations. This could be due to compliance to dietary intakes and aspects of culture that affect health and lifestyle in KSA; there is thus an implication that there could be better

outcomes if diet modification that respects culture is implemented in KSA because it will have rates in body composition in the short term (Nassis 2005).

Both intervention groups experienced improved insulin sensitivity, with a higher level found in the control group. This research finding complements a study by Son (2017) about the complementary effects of diet and exercise on metabolic parameters, while our study offers an added component of how a simple form of exercise that is literally jumping through a rope regularly can be credibly engaging the body midst other routine activities.

In addition, our work suggests that proponents of exercise ought to consider incorporating jump rope exercises as a viable substitute or additional form of exercise, especially in contexts where access to or space to perform complex forms of exercise is constrained (Tang, 2021). The simplicity of the exercises and lack of equipment when performing exercises in a jump rope manner increases the sustainability and adherence of adolescents to the program, which partially explains the positive effects obtained.

In terms of body composition, our data show that diet modification alone resulted in significant reductions in body weight, body mass index (BMI), and body fat percentage. These findings align with previous studies emphasizing the efficacy of dietary interventions in managing obesity in adolescents (Ghorbanian et al., 2013; Mitchell et al., 2014). However, our study further reveals that the skipping rope exercise group also demonstrated significant reductions in these parameters, particularly in body fat percentage and waist circumference, indicating that exercise alone can be an effective strategy for improving body composition in this demographic. This echoes the findings by Sung et al. (2019), who documented notable body composition enhancements with physical exercise in obese adolescents.

It is notable that while both groups showed improvement, the diet modification group experienced greater total weight loss than the exercise group. This contrasts with some studies that have suggested exercise to be equally effective or superior to diet alone for weight loss in adolescents (Tang et al., 2021). This disparity might be attributed to the heightened dietary adherence among participants or the structured nature of our dietary intervention.

Concerning insulin sensitivity, both interventions yielded favorable outcomes, with notable improvements observed in the homeostasis model assessment of insulin resistance (HOMA-IR) scores. These results concur with those of other studies that have confirmed the beneficial impacts of diet and exercise on glycemic control and insulin sensitivity (Marson et al., 2016; Lee et al., 2010). Notably, the skipping rope group exhibited slightly more pronounced improvements in insulin sensitivity compared to the diet group. This enhancement parallels findings from studies like Garcia-Hermoso et al. (2014), which documented significant enhancements in insulin action following regular physical activity in adolescents. The dynamic nature of skipping rope, which combines both aerobic and anaerobic elements, might explain these pronounced improvements by promoting better glucose uptake and utilization.

Despite these promising outcomes, it is essential to consider the potential limitations of this study when interpreting the results. The relatively short intervention period may not fully capture the long-term effects of these lifestyle changes. Additionally, variations in adherence levels to dietary recommendations and exercise prescriptions could have influenced individual outcomes, necessitating future research with larger sample sizes and longer follow-up durations to validate these findings.

This paper adds to the increasing number of publications that support the hypothesis that culturally adapted, multimodal interventions for obesity may be superior to nonspecific recommendations. This is in concordance with Chang's (2011) assertions about the centrality of culturally sensitive interventions. However, the generalizability of our study is constrained by sample size and duration, and operators should conduct further research to identify long-term outcomes and adherence difficulties in different large, diverse populations from KSA.

5.1 Limitations

Several limitations are acknowledged in this study, including the use of self-reported dietary intake that may be influenced by social desirability bias; the limited number of hours in the intervention period may not reveal the consequences on body composition and insulin sensitivity after a longer period of time. Possible future research improvements include longer follow-ups and a greater number of patients in the sample to increase the external validity of the results.

Although both dietary and jump rope exercise interventions favorably affect body composition and insulin sensitivity separately, combined intervention is more effective (Dickson, 2024). Implications of these findings are limitations and improvement of public health strategies in KSA as well as other similar settings; integration of athletic and dietary approaches in addressing adolescent obesity in the country and other equivalent settings but with cultural modification (Chang, 2011). Further research should attempt to examine the extent to which participants continue to maintain these interventions, as well as examine the effectiveness of the interventions in different geographic parts of KSA and among different populations.

6. Conclusion

This work intends to compare the impact of a dietary approach with a physical activity involving jump rope on body composition and insulin response among obese adolescents in the KSA. This study shows that the two interventions cause changes in body composition and insulin sensitivity with some differences in their result`s magnitude.

The studies revealed that there were overall averages of weight loss, a decrease in BMI from the baseline, and a percentage of body fat. The results also indicated that those who followed the dietary suggestions had increased insulin sensitivity, meaning that diet plays an especially important role in treating obesity-associated metabolic disorders in adolescents.

The jump rope exercise program also had great positive results in general, especially for the higher lean body mass gains and better cardiovascular endurance. This intervention was also effective in reducing the risk of metabolic diseases in a manner that reduced the levels of visceral fat. Moreover, the findings on exercise training on insulin sensitivity were utilized to support the effects of exercise on the metabolism of obese adolescents.

When comparing the two interventions, the control group changes and jump rope exercise yielded the most pronounced benefits in overall body composition and metabolic health. This synergy suggests that a comprehensive approach integrating both nutrition and exercise might be the most effective strategy for combating adolescent obesity and related metabolic disorders in this demographic.

In conclusion, this study underscores the importance of tailored interventions targeting both diet and physical activity to effectively address obesity and improve insulin sensitivity among adolescents in KSA. Future research should explore the long-term sustainability of these interventions and their broader applicability across different age groups and settings to formulate effective public health policies aimed at curbing the obesity epidemic in this region.

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