THE IMPACT OF A HEALTHY LIFESTYLE AND DIET ON INSULIN RESISTANCE IN ADOLESCENTS – A CASE STUDY

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Abstract

To evaluate the effectiveness of lifestyle and dietary interventions in reversing insulin resistance and reducing the risk of type 2 diabetes in adolescents. A 16-year-old male with asthma and overweight status, calculated for a BMI of 27.7 kg/m², was markedly insulin-resistant (HOMA-IR: 8.2). A three-month intervention with a calorie-controlled diet providing 2,330 kcal/day and an appropriately sequenced aerobic and resistance training was instituted. The intervention normalized the metabolic parameters: insulin level 37.7 µIU/mL to 7.27 µIU/mL and HOMA-IR from 8.2 to 1.5. The results show that the loss of weight, change in diet, and exercise are very important in improving sensitivity to insulin, especially in overweight adolescents, even those with comorbid conditions such as asthma. Lifestyle intervention is very effective in reversing early metabolic disturbances among adolescents. Early detection, multidisciplinary management, and sustained behavioral change hold the key to prevention of long-term complications such as type 2 diabetes.

Keywords: adolescent, lifestyle, insulin, HOMA index, overweight status.

INTRODUCTION

The known risks of a sedentary life style are: gaining excessive weight, the development of cardiovascular diseases, increase in insulin resistance and diabetes.(2). Physical exercises have been studied to enhance insulin resistance (11) and play an anti-inflammatory role in the body (5). Some aerobic exercises, like walking and cycling are quite beneficial for obese people or those suffering from metabolic disorders. (9) Some evidence shows that the addition of resistance training to aerobic exercise has an even greater impact on the body. (10)

Insulin resistance (IR) is characterized by a suboptimal response of tissues to insulin action (4), preventing tissues from easily using glucose from the blood. This

mechanism leads to increased insulin production by the pancreas in an attempt to help cells and tissues use glucose and maintain normal blood glucose levels. (4)

Increased insulin resistance is associated with several diseases, including type 2 diabetes, cardiovascular diseases, and metabolic disorders. (14)

Paraclinically, insulin resistance is assessed by determining the HOMA index (The Homeostasis Model Assessment of IR - HOMA-IR).(6),(1) This is the ratio between the insulin secreted by the pancreas and blood glucose. The values are going to determine the degree of resistance: a value less than 2 is normal, a value above 2 indicates moderate risk of developing type 2 diabetes, and a ratio above 5 represents high risk in diabetic individuals. (3)

The incidence of type 2 diabetes in the pediatric population is increasing, with cases almost doubling in the United States. (7,13).

Case Presentation

A male adolescent, 16 years and 10 months old, with a known history of bronchial asthma, was presented to the "Sf. Ioan" Clinical Emergency Hospital for Children in Galați, with symptoms of respiratory viral infection-nasal congestion, productive cough, mild expiratory dyspnea-for three days.

Personal medical history: Bronchial asthma under treatment with Salbutamol inhaler, Fluticasone propionate inhaler, and Montelukast tablets.

Family medical history: Nonsignificant.

Clinical findings:

- Weight: 96 kg
- Height: 186 cm (BMI: 27.7 kg/m², classified as overweight)
- Examination results:
    - Congested oropharynx.
    - Nasal obstruction with productive cough.
    - Lungs: Vesicular breath sounds bilaterally with occasional wheezing. SpO$_2$: 98% on room air.
    - Abnormal cardiovascular, gastrointestinal, renal, or neurological systems

Lab data at the outset:

Basic work-up for the viral infection showed normal complete blood count and no evidence of inflammation. An allergy panel was also done which revealed positive results for Dermatophagoides pteronyssinus, Dermatophagoides farinae, and cat and

dog epithelia. However, since the patient is overweight, further metabolic tests were ordered:

- **Lipid profile:**
    - Total cholesterol: 146 mg/dL (normal <170 mg/dL).
    - HDL cholesterol: 41 mg/dL (normal ≥41 mg/dL).
    - LDL cholesterol: 82 mg/dL (normal 60–100 mg/dL).
- **Glucose metabolism:**
    - Blood glucose: 87.6 mg/dL (normal 70–110 mg/dL).
    - Insulin: 37.7 µIU/mL (normal 2.6–24.9 µIU/mL).
    - HOMA-IR: 8.2 (normal <2).

ȘThe increased insulin and HOMA-IR values placed the patient in the high-risk zone for diabetes type 2. Hence, medical advice regarding lifestyle interventions like diet and exercise were given and reassessment after three months was recommended.

Lifestyle intervention:

The patient was on a systematic diet, where the caloric intake was approximately 2,330 kcal/day, and he was forbidden from consuming fast foods, carbonated beverages, and processed sugars. The target weight was established between 68 and 81 kg, associated with physical exercises, including cardio and resistance exercises.

Follow-up:

After three months of following the recommendations, the patient returned for reevaluation. The results were as follows:

- **Blood glucose:** 81 mg/dL.
- **Insulin:** 7.27 µIU/mL.
- **HOMA-IR:** 1.5.

These results reflect the complete normalization of glucose metabolism and a significant reduction in the risk of type 2 diabetes.

Table 1: Changes in glucose metabolism parameters following lifestyle and dietary modifications.

Parameter	Glucose	Insulin	HOMA-IR
Initial values	87.6 mg/dL	37.7 µIU/mL	8.2
After 3 months	81 mg/dL	7.27 µIU/mL	1.5

DISCUSSION

This case underscores how the diagnosis of insulin resistance in adolescents is of utmost importance since it is a forerunner of T2DM and other metabolic disorders.

The clinical and laboratory findings of the patient presented in this case were indicative of a severe metabolic disorder with high insulin and a HOMA-IR index fourfold higher than the upper limit of normal. These results raise a high alert for immediate action, as insulin resistance if left unattended in adolescents will result in the progression of metabolic syndrome, cardiovascular disease, and overt diabetes.

1.1. Role of Lifestyle Interventions

The significant improvement in the metabolic parameters of the patient after three months of lifestyle modification shows that the body has the ability for metabolic recovery if appropriate interventions are given. The structured approach to weight management-a balanced, calorie-controlled diet and regular physical activity-directly targeted the major contributors to insulin resistance: excess adiposity and physical inactivity. It is consistently shown that even moderate weight loss, as low as 5–10% of body weight, can significantly improve insulin sensitivity by reducing visceral fat, decreasing inflammatory markers, and improving glucose uptake by skeletal muscles. (2, 5,9)

The patient's avoidance of fast food, sugary drinks, and processed foods aligns with evidence that diets high in refined carbohydrates and unhealthy fats exacerbate insulin resistance. On the other hand, nutrient-dense whole foods like vegetables, lean proteins, and complex carbohydrates can favorably influence glucose metabolism. (10) Regular physical activity, particularly the combination of aerobic and resistance training as utilized in this patient, enhances insulin sensitivity by both increased muscle glucose uptake and reduced hepatic glucose production. (4, 14)

1.2. Overweight and Asthma as Co-morbidities

The case also highlights the association between asthma, overweight, and insulin resistance. Asthma, a chronic inflammatory disease, shares common pathways with metabolic syndrome, including low-grade systemic inflammation, which may contribute to the development of insulin resistance (12). It has been demonstrated that bronchial asthma and obesity can synergistically interact by their effects on increasing pro-inflammatory cytokines, leading to increased insulin resistance and, consequently, the development of type 2 diabetes mellitus.(8) Furthermore, overweight adolescents

with asthma often reduce their physical activity due to dyspnea or fear of exacerbations, further compounding the risk of metabolic dysfunction. These interrelated factors could be addressed only by a holistic approach that would target the metabolic and respiratory aspects of the patient's health.

1.3. Normalisation of Parameters and Clinical Implications

The post-intervention results revealed normalization of insulin levels (37.7 µIU/mL to 7.27 µIU/mL) and HOMA-IR (8.2 to 1.5), indicating a drastic reduction in the patient's risk of developing T2DM. These improvements also remind one that early metabolic derangements in adolescents are reversible. This case points to the fact that insulin resistance is not only manageable but often reversible through non-pharmacological approaches if waylaid at an early stage. The Role of Healthcare Providers.

This case also identifies the invaluable contribution of general practitioners in spotting the susceptible adolescent and the prompt initiation of interventions. Periodic monitoring of glucose metabolism in overweight adolescents, especially when associated conditions such as asthma are also present, contributes to an early identification of insulin resistance. Besides, giving appropriate life-style advice and securing follow-through will lead to long-term success.

1.4. Long-term Outcomes

It will be important for this patient to continue these lifestyle changes beyond a three-month intervention to maintain metabolic health and prevent the recurrence of insulin resistance. Adolescence is a critical life stage where lifelong habits can be established, and improvements made during this period are likely to have a considerable impact on health outcomes in adulthood. Additionally, this case underscores the potential for scalable interventions that can be implemented at the community level to combat the rising prevalence of insulin resistance and T2DM in the pediatric population.

1.5. Broader Implications for Public Health

This case also shows the increasing demand for public health strategies to promote healthy eating and active lifestyles in children and adolescents. Since childhood obesity is on the rise worldwide, addressing lifestyle factors early in life is of paramount importance to avoid a cascade of metabolic diseases. Health care systems, schools, and families must collaborate to provide an environment that supports healthy behaviors and prevents the onset of metabolic disorders.

CONCLUSION

This case points to the impact that a healthy lifestyle and balanced diet could have in reversing insulin resistance and minimizing the risk of long-term complications in adolescents. At the start of the presentation, this patient's metabolic disturbance was profound-insulin high and with a high index of insulin resistance -both known to be predictive of the future development of type 2 diabetes mellitus. These findings signal the need for early identification and intervention, especially when the teenager has certain risks, including overweight conditions or other asthma comorbidities.

This adolescent was able to achieve remarkable improvements in metabolic health through structured and personalized interventions, including a calorie-controlled, nutrient-rich diet and regular physical activity, within an astoundingly short period of three months. This goes to show the capacity of the body to regain balance when given the right tools and changes in lifestyle.

This case further reiterates the role that healthcare professionals can play in early identification of warning signals for insulin resistance and informing patients and their families on the importance of preventive steps. The patient was able to improve not only immediate health markers but also dramatically reduce long-term risk associated with chronic metabolic diseases by addressing the case through the promotion of sustainable lifestyle changes rather than pharmacological interventions.

This case poignantly reminds one that healthy lifestyle, proper nutrition, and physical activity are cornerstones in the management and prevention of insulin resistance. The changes required are multidisciplinary-from health professionals, dieticians, and fitness experts-to ensure success over the long term. In adolescents, such

changes might be the pathway to healthy adulthood, avoiding a cascade of health complications and improving the quality of life.

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