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Enas Sayed Abbas
Department of Pediatrics, National Nutrition Institute, Cairo, Egypt, enas.sayed09@yahoo.com

Safaa Al Hussein Tawfik
Department of Clinical Nutrition, National Nutrition Institute, Cairo, Egypt

Gehan Fouad Ahmad
Department of Pediatrics, National Nutrition Institute, Cairo, Egypt

Lamiaa Ibrahim Haroon
Physician Nutrition Specialist Department, National Nutrition Institute, Cairo, Egypt

Taghreed K. M. Elhady
Department of Clinical Nutrition, National Nutrition Institute, Cairo, Egypt

See next page for additional authors

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Telemedicine and Physical Visits: A Dynamic Duo in Obesity Management Among Adolescents, Egypt

Authors

Enas Sayed Abbas, Safaa Al Hussein Tawfik, Gehan Fouad Ahmad, Lamiaa Ibrahim Haroon, Taghreed K. M. Elhady, and Amira Said Nassar

ORIGINAL STUDY

Telemedicine and physical visits: A dynamic duo in obesity management among adolescents, Egypt

Enas S. Abbas [a,*], Safaa A.H. Tawfik [b], Gehan F. Ahmad [a], Lamiaa I. Haroon [b], Taghreed K.M. Elhady [b], Amira S. Nassar [b]

[a] Department of Pediatrics, National Nutrition Institute, Cairo, Egypt
[b] Department of Clinical Nutrition, National Nutrition Institute, Cairo, Egypt

Abstract

Childhood obesity, a serious global issue, leads to various health problems like diabetes, high blood pressure, high cholesterol, and psychological issues. In Egypt, inconsistent data shows a significant prevalence of obesity among adolescents, influenced by factors like sex, age, and lifestyle. The study aims to explore the effectiveness of telemedicine, in conjunction with physical visits, for managing obesity among adolescents in Egypt. Telemedicine, a cost-effective and engaging alternative to in-person visits, can help patients lose weight and provide a safe, remote alternative, expanding treatment access to hard-to-reach populations. The study is a controlled clinical trial on overweight or obese adolescents aged 15−18 using telemedicine and online communications for weight management over 12 weeks. It includes comprehensive nutritional assessments, dietary, behavioral, and physical interventions, and weekly counseling sessions. Patients followed up at 1, 4, 8, and 12 weeks by physical visits. The study presents the impact of telemedicine and physical visit interventions on overweight and obese adolescents. The overweight participants were 225 (26% of the total) and had lost weight by 12% (27 participants) and 7.5% (17 participants) after 2 and 3 months, respectively, which corresponds to a weight loss of 7.5%. The χ^2 for this group is 28.9. The obese participants were 640 (74%) and had lost weight 21.0% (68 participants) and 7.8% (26 participants) after 2 and 3 months, respectively, which corresponds to a weight loss of 5.3%. The *P* value for this group is 0.001, indicating a statistically significant difference. These results suggest the 3-month telemedicine and physical visit interventions were effective in significantly reducing the number of overweight and obese adolescents. However, these are aggregate results, and individual outcomes may vary. The long-term sustainability of these changes needs further assessment in follow-up studies. The intervention's success suggests that telemedicine could be a valuable tool for managing obesity among adolescents.

Keywords: Adolescent, Egypt, Obesity, Overweight, Telemedicine

1. Introduction

Childhood obesity is a serious medical condition that affects children and adolescents. It is particularly troubling because the extra pounds often start children on the path to health problems that were once considered adult problems: diabetes, high blood pressure, and high cholesterol. Childhood obesity can also lead to poor self-esteem and depression. The main contributors to childhood obesity are lifestyle issues, too little activity, and too many calories from food and drinks. Regularly eating high-calorie foods, such as fast foods, baked goods, and vending machine snacks, can cause your child to gain weight. Lack of exercise and too much time spent in sedentary activities, such as watching television or playing video games, also contribute to the problem [1].

According to the WHO, obesity and overweight are global problems that affect more than 1.9 billion adults and 39 million children under 5 years of age [2]. Children who have obesity are more likely to carry the condition over into adulthood [3]. The prevalence of obesity among adolescents in

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* Corresponding author at: Department of Pediatrics, National Nutrition Institute, Cairo 11562, Egypt.
E-mail address: enas.sayed09@yahoo.com (E.S. Abbas).

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Egypt is not consistent across different sources, methods, and samples of data. However, some studies have estimated that 13.5 and 10.8% of schoolchildren aged 6–12 are overweight and obese, according to Elshinawy *et al.* [4] and that 22.9 and 11.7% of adolescents aged 15–18 are overweight and obese by El-Gilany and El-Masry [5]. The Egypt Health Issues Survey 2015 reported that 38.8% of women and 18.6% of men aged 15–59 are obese [6]. These results indicate that obesity is a serious health issue that affects many adolescents in Egypt, and that it is influenced by various factors, such as sex, age, urbanization, lifestyle, and genetics.

They are at a higher risk of developing many health conditions, including asthma, sleep apnea, type 2 diabetes, high blood pressure, high cholesterol, heart disease, stroke, musculoskeletal disorders such as osteoarthritis, certain cancers, and fatty liver. In addition, children who have obesity are at a higher risk of experiencing bullying, social isolation, low self-esteem, and depression [3].

Telemedicine and physical visits have emerged as a dynamic duo in obesity management among adolescents in Egypt. These two approaches have been found to be effective in addressing the challenges faced by adolescents with obesity. Telehealth has been identified as a useful tool in the management of pediatric obesity. It has been shown to be a feasible, cost-effective care delivery model for adolescents being treated for obesity, with efficacy comparable to or better than standard multidisciplinary in-person visits [7]. Telehealth technology presents an innovative, cost-effective, and engaging alternative to in-person visits, bypassing many logistical difficulties. Continuity of care is a key aspect in the treatment of obesity, and discontinuation or limitation of outpatient follow-up and activities that promote movement can negatively impact the management of obesity [8]. In this study, telemedicine, if properly regulated, could be an effective solution to continue the follow-up of obese patients, relying on a chronic model of care. Telemedicine interventions can successfully help patients with obesity lose weight and provide a safe, remote alternative. They may also expand treatment access to hard-to-reach populations.

2. Aim

This study aims to explore the effectiveness and feasibility of using telemedicine in conjunction with physical visits for managing obesity among adolescents in Egypt.

3. Objectives

(1) To assess the current state of obesity among adolescents in Egypt and manage their weight.
(2) To evaluate the effectiveness of telemedicine as a tool for delivering weight management interventions to adolescents.
(3) To provide recommendations for integrating telemedicine into the standard care pathway for obesity management among adolescents in Egypt.

4. Methodology

4.1. Study design and participants

The study design involves before and after a controlled clinical trial that focuses on a weight management intervention utilizing telemedicine and online communications over 12 weeks, supplemented with personal interviews. The study will be carried out on adolescents who are overweight or obese recruited from multicenter outpatient clinics of pediatrics in the period from June to August 2023.

According to specific inclusion criteria as healthy adolescents of both sexes, aged 15–18 years, adolescents with overweight (with BMI >85th and <97th percentile), or obesity (with BMI ≥97th percentile) according to WHO growth standards reference values of the age-specific and sex-specific. Access to the internet and consent from parents and adolescents. The exclusion criteria included secondary causes of obesity and adolescents with chronic diseases such as diabetes, chronic renal, liver, cardiac, gastrointestinal diseases, endocrine diseases, autoimmune diseases, and food allergies.

4.2. Procedures

The study employed weight loss programs that use a blend of real-time telemedicine modalities, including online chats, text messages, WhatsApp, phone calls, Messenger, and face-to-face healthcare interview visits in outpatient clinics over 12 weeks. Four healthcare visits were conducted, the first and last of which involved a comprehensive nutritional assessment, including anthropometric measurements (body weight, height, BMI, and waist circumference), physical assessment, dietary assessment (24-h recall and food frequency questionnaire), and laboratory evaluations (complete blood test, serum fasting blood sugar, and lipid profile) with complete standardized behavioral and dietary questionnaires before and after the 12-week weight management intervention. These visits are repeated monthly to monitor the participants.

Telemedicine interventions conducted as weekly counseling sessions with nutritional and behavioral educational content. The weight management intervention encompassed three pillars: dietary, behavioral, and physical. The weight management program executed by a multidisciplinary team of healthcare providers, including physicians, dietitians, and physiotherapists, to deliver the weight loss program intervention.

In the current study, we prepared three different healthy and well-balanced dietary regimens ranging from 1200 to 3000 kcal/day for each participant every week, based on their individualized caloric needs according to age, sex, and physical activity without restriction to ensure optimal growth and development during the adolescent period, in addition to healthy dietary meals, advices and proper dealing with relapse prevention and problem-solving. Physical activity programs are designed to encourage the physical activity of the studied individuals. Self-monitoring is conducted every week by each participant after building their health and nutritional education skills before starting the program intervention during the first physical visit.

4.3. Follow-up time point

All patients were followed up in the outpatient clinic at 1, 4, 8, and 12 weeks. During each follow-up visit, the anthropometric measures were recorded, in addition to weekly follow-up through telemedicine communications for nutritional and behavioral modification education.

4.4. Primary outcome

Our main outcome is that telemedicine can successfully assist patients with obesity in losing weight. Telemedicine interventions offer a safe, remote alternative and may broaden treatment access to hard-to-reach populations. Telemedicine is expected to remain a crucial part of future primary care, even after the current emergency has passed.

4.5. Secondary outcomes

Changes in dietary habits: evaluating whether the intervention leads to improvements in the adolescents' eating habits, such as increased consumption of fruits and vegetables and decreased consumption of unhealthy snacks.

4.6. Sample size calculation

Using noninferiority analysis, the sample size was calculated for the study based on the primary outcome. The sample is 785 cases with a power of 80% and an alpha error of 5%.

4.7. Statistical analysis

The data analysis software utilized was SPSS (2021): Statistical Package for Social Science, Computer Soft, IBM, SPSS Statistics Ver.28, 2021., SPSS Company, London, UK, version 28. Continuous data were expressed using mean ± SD, while the categorical variables were shown as numbers and percentages. The continuous variables (age, disease course, etc.) were compared using the t test. For categorical variables (such as sex, recurrence, etc.), the χ^2 test was applied. A two-sided level of 0.05 and 95% confidence intervals were used for all effect testing.

4.8. Ethical concerns

This study was approved through the Research Ethics Committee of the General Organization for Teaching Hospitals and Institutes (GOTHI). Confidentiality was guaranteed in handling the database and questionnaire forms according to the revised Helsinki Deceleration of Biomedical Ethics, ensuring ethical standards in medical research involving human participant. Informed consent from each parent or caregiver and assent from each adolescent was obtained prior to enrolling in the study and after properly orienting them with the study objectives and implications.

5. Results

Table 1 shows the distribution of participants across different locations. It appears that the participants are from 74% of the Egyptian governorates, and the studied participants are almost evenly split between urban (63%) and rural (37%) areas. This suggests that the study has a wide geographical coverage, which could enhance the generalizability of its findings. Also presents the sex distribution of the participants. It shows that the majority of the participants are female (75%), while males make up a smaller proportion (25%). This sex imbalance is

Table 1. The demographic data about the study sample.

	Frequency	Percent
Governorate	20	74.0
Urban	545	63.0
rural	320	37.0
Female	649	75.0
Male	216	25.0
Total	865	100

common in health-related research and could be due to various factors, such as differences in health-seeking behavior between sexes.

Both Table 2 and Fig. 1 presents the results of changes in the number of overweight and obese participants before and after a 3-month intervention. The number of overweight participants decreased from 225 (26% of the total) to 17 (7.5% of the total) after the intervention, corresponding to a weight loss of 7.5%. And the number of obese participants decreased from 640 (74% of the total) to 26 (7.8% of the total) after the intervention, corresponding to a weight loss of 5.3%. These results suggest that the combined telemedicine and physical visits intervention was effective in reducing the number of overweight and obese adolescents in this study. However, it is important to note that these are aggregate changes, and individual results may vary. Also, the long-term sustainability of these changes would need to be assessed in follow-up studies.

Table 3 shows the changes in weight, waist circumference, and BMI before and after a 3-month intervention. The average weight of the participants decreased significantly from 95 to 80 kg throughout the intervention. The *t* test value of 25.3 and the *P* value of 0.002 indicate that this change is statistically significant. Both male and female participants experienced a decrease in waist circumference. The change was statistically significant for both sexes, as indicated by the *t* test values (21.7 for males and 26.1 for females) and the *P* values (0.006 for males and <0.0001 for females). On the other hand, the BMI decreased for both overweight and obese participants. The change was statistically significant for both groups, as indicated by the *t* test values (16.7 for overweight and 22.9 for obese participants) and the *P* values (0.008 for overweight and less than 0.0001 for obese participants).

Table 2. Distribution of overweight and obese among the participants before and after a 3-month intervention and the percent of weight loss.

	Before [*n* (%)]	After 3 months [*n* (%)]	Weight loss (%)
Overweight	225 (26)	17 (7.5)	7.5
Obese	640 (74)	26 (7.8)	5.3

Table 3. The changes in weight, waist circumference, and BMI before and after a 3-month intervention.

	Before	After 3 months	*t* test	*P* value
Age (mean ± SD)	15 ± 2.1 year			
Weight (mean ± SD)	95 ± 17 kg	80 ± 15.3 kg	25.3	0.002
Waist circumference				
Male	68 ± 1.4 cm	66 ± 0.7 cm	21.7	0.006
Female	72 ± 2.3 cm	69 ± 1.5 cm	26.1	0.000
BMI				
Overweight	26 ± 0.8	22.1 ± 0.6	16.7	0.008
Obese	34 ± 1.1	29 ± 1.5	22.9	0.000

Table 4 is divided into two categories according to the BMI percentile of WHO growth standards reference values of the age specific and sex specific. In the overweight category, there were 225 participants, representing 26% of the total. After 2 months, 12% (27 participants) had lost weight, and after 3 months, 7.5% (17 participants) had lost weight. The χ^2 statistic for this group is 28.9. However, in the obese category, there were 640 participants, representing 74% of the total. After 2 months, 21.0% (68 participants) had lost weight, and after 3 months, 7.8% (26 participants) had lost weight. The *P* value for this group is 0.001, indicating a statistically significant difference.

In Figs 2 and 3, the pair of bar charts illustrates the alterations in waist measurements that are according to the recommendations from Childhood Obesity Task Force of the European Association for the Study of Obesity [9] among males and females, respectively, prior to and following a specific intervention or time frame. In the case of males, prior to the intervention or time frame, 15.10% exhibited an abnormal waist size, while 9.90% had a normal one. Following the intervention or time frame, the

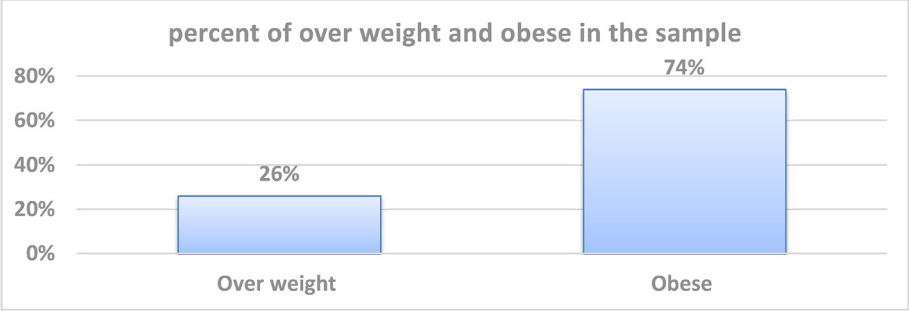

Fig. 1. Distribution of overweight and obese among the participants.

Table 4. Change in weight after 3 months among the adolescents.

	Weight before [*n* (%)]	Weight loss after 2 months [*n* (%)]	Weight loss after 3 months [*n* (%)]	χ^2
From >85th to <97th BMI	225 (26)	27 (12)	17 (7.5)	28.9
≥97th BMI	640 (74)	68 (21)	26 (7.8)	*P* value 0.001

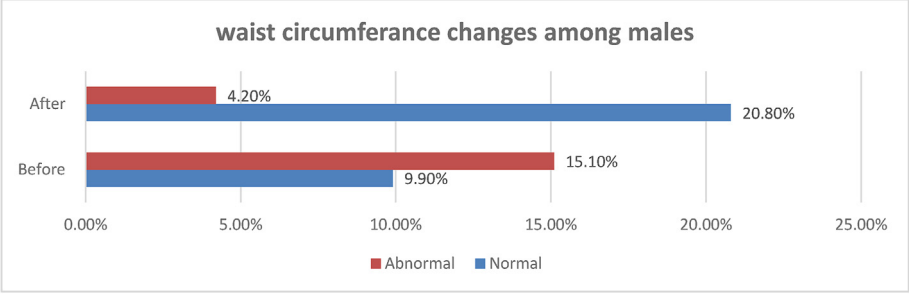

Fig. 2. Waist circumference changes before and after a 3-months intervention among males.

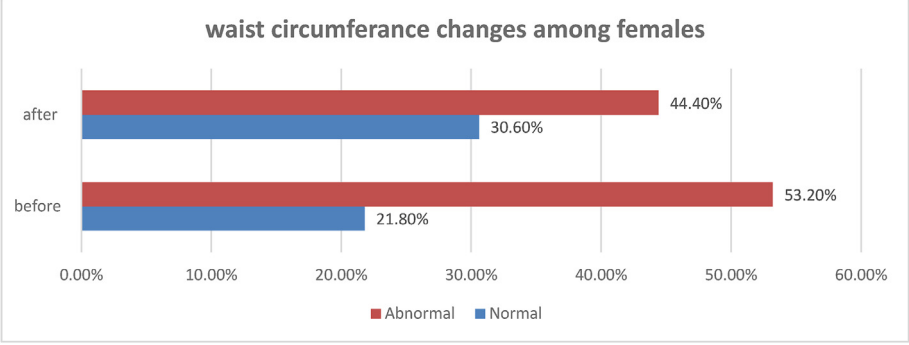

Fig. 3. Waist circumference changes before and after a 3-months intervention among females.

proportion with an abnormal waist size fell to 4.20%, while those with a normal waist size rose to 20.80%. As for females, before the intervention or time frame, 53.20% had an abnormal waist size, and 21.80% had a normal one. Following the intervention or time frame, the proportion with an abnormal waist size fell to 44.40%, while those with a normal waist size rose to 30.60%.

These charts imply that the intervention or time frame had a beneficial impact on both males and females, decreasing the proportion with abnormal waist sizes and increasing those with normal ones, with a more responsive in female adolescents.

Table 5 illustrates the correlation between BMI, classified as overweight and obese, and sex among adolescents after a 3-month period. Of the 216 males, 55.1% were overweight, and 44.9% were obese. In contrast, of the 649 females, 22.1% were overweight, and 77.9% were obese. The total adolescents population was 865, with 225 being overweight and 640 being obese. The χ^2 statistic of 12.4 and a *P* value of 0.01 indicate statistically significant differences between males and females, suggesting that sex may influence BMI among adolescents after 3 months.

Table 5. Sex-based differences in BMI among adolescents after 3 months.

	Relation between BMI and sex among adolescents after 3 months [*n* (%)]			χ^2
	Overweight	Obese	Total	
Male	119 (55.1)	97 (44.9)	216	12.4
Female	143 (22.1)	506 (77.9)	649	*P* value
Total	225	640	865	0.01

Table 6 shows that the percentage of individuals with anemia among both sex decreased from 31.8 to 7.6% among females and from 8.8 to 3.7% among males, a change that is statistically significant with a *P* value of 0.0001. Similarly, the percentage of individuals with a low WBCs count (*n*: 4500–11 000 cell/ml) decreased from 9.7 to 3.2%, also a statistically significant change with a *P* value of 0.04.

Table 6. Impact of an intervention on various health indicators.

	Before [*n* (%)]	After [*n* (%)]	*P* value
Anemia Hb < 12 g/dl female ($N = 649$)	201 (31.8)	49 (7.6)	0.000
<13 g/dl male ($N = 216$)	19 (8.8)	8 (3.7)	
Low WBCs count ($N = 4500–11\,000$ cell/ml)	9.7%	3.2%	0.04
Prediabetic FBS ($N = 70–100$ mg/l)	10.0%	8.0%	0.9
High cholesterol	389 (45)	199 (23)	0.001
High LDL	20 (2.3)	16 (1.8)	0.04
Low HDL	252 (29.1)	110 (12.7)	0.007
High TG	157 (18.2)	36 (4.2)	0.000

However, the percentage of prediabetic individuals (*n*: FBS 70–100 mg/l) decreased slightly from 10.0 to 8.0%, a change that is not statistically significant with a *P* value of 0.9. The data also shows statistically significant reductions in the percentage of individuals with high cholesterol (from 45 to 23%, $P = 0.001$), high LDL (from 2.3 to 1.8%, $P = 0.04$), low HDL (from 29.1 to 12.7%, $P = 0.007$), and high TG (from 18.2 to 4.2%, $P = 0.0001$). These results suggest that the intervention or period had a beneficial effect on these health indicators.

Fig. 4 shows before the intervention, 21.00% of individuals had one meal, 19.10% had two meals, 39.70% had three meals, 10.40% had four meals, 7.70% had five meals, and 2.10% had more than five meals. After the intervention, the data shows less than 1.6% of individuals having one meal, 8.20% having two meals, 13.20% having three meals, 11.30% having four meals, 52.80% having five meals, and 12.90% having more than five meals. This suggests a significant shift in meal frequency, with an increase in individuals consuming five meals and a decrease in those having three meals..

Fig. 5 compares the intake and types of snacks before and after a telemedicine and physical visits intervention for obesity management among adolescents in Egypt. It shows that the intervention increased the percentage of adolescents who took snacks from 38.5 to 86.5% and improved the quality of snacks by increasing the consumption of fruits and vegetables and the consumption of dairy products, but the grains consumption was

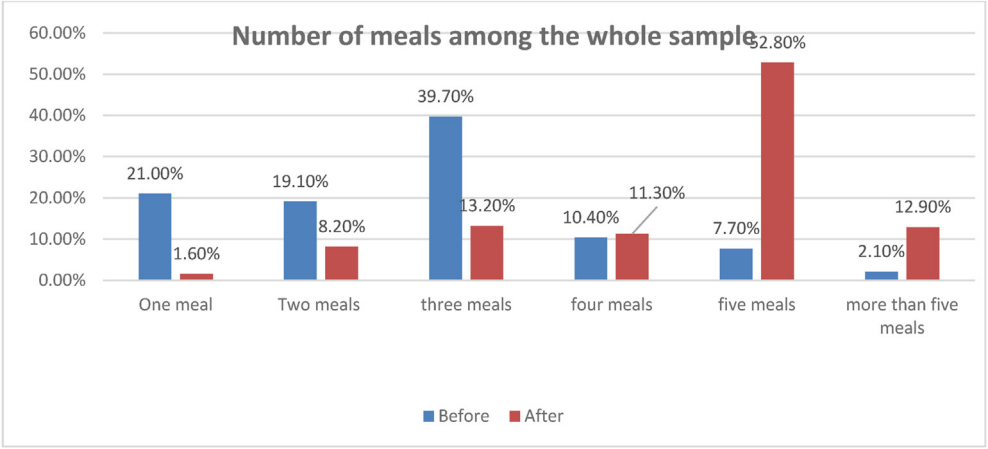

Fig. 4. Meals frequency among a sample population.

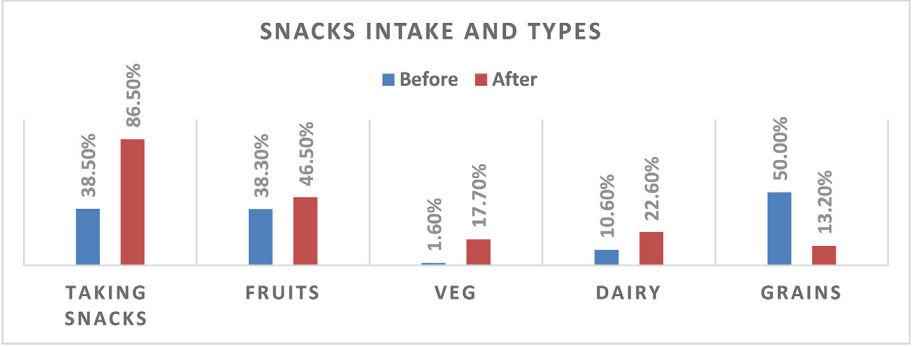

Fig. 5. Changes in snack consumption and types.

Table 7. Changes in dietary habits before and after an intervention.

	Before	After	*P* value
Water intake >6 cups/d	57%	98%	0.005
Soda intake	74.2%	33.9%	0.001
Caffeine intake	35.2%	30.6%	0.06
Healthy nuts intake	12.5%	34.8%	0.01

decreased. These results indicate that the intervention was effective in promoting healthier eating habits and preferences among adolescents with obesity in Egypt.

Table 7 shows a statistically significant change in water intake from 57% before to 98% after intervention, a change that is statistically significant with a *P* value of 0.005. Furthermore, data suggests a statistically significant decrease in soda consumption with a *P* value of 0.001, a nonsignificant decrease in caffeine intake with a *P* value of 0.06, and a statistically significant increase in healthy nut intake with a *P* value of 0.01 among adolescents. These results indicate that the intervention is effective in promoting healthier dietary habits among adolescents with obesity (Fig. 6).

The line graph titled "Sugar intake" provides a visual representation of the changes in sugar consumption among adolescents individuals before and after a specific intervention or period. The graph displays sugar intake levels from "no intake" to "more than 10 spoons." Each level of sugar intake is represented by two data points: "sugar intake before %" (depicted by the blue line) and "sugar intake after %" (depicted by the red line). The graph indicates a decline in sugar consumption across all levels of intake following the intervention or period, with the most significant decrease observed in the "more than 5 spoons" category. In the realm of obesity management, the reduction of sugar intake is a crucial approach. Excessive sugar consumption, especially through sugary beverages, has been associated with obesity and related health complications. Thus, the noticeable decrease in sugar intake postintervention implies a positive impact on obesity management (Fig. 7).

The graph shows that the percentage of individuals not engaging in any physical activity decreased from 35.5 to 7.2%. The percentage of individuals participating in 15–30 min of activity remained relatively stable, at around 46.7% before and 43.3% after the intervention. The percentage of individuals engaging in 30–60 min has a significant increase after the intervention, while the percentage of individuals engaging in more than 60 min of activity have a slight decrease. These results suggest that the intervention or period had a positive impact

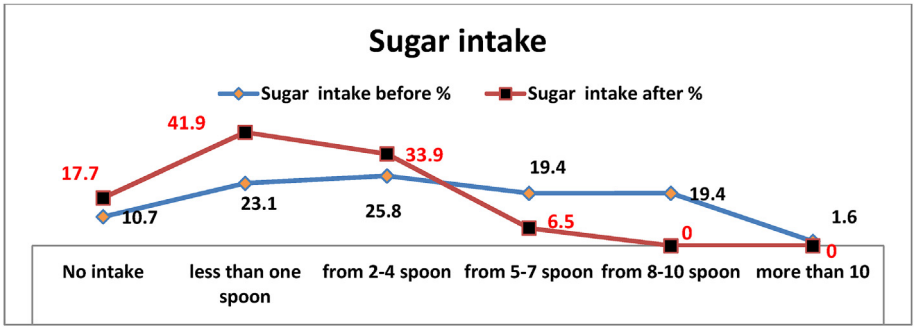

Fig. 6. Sugar intake among adolescents.

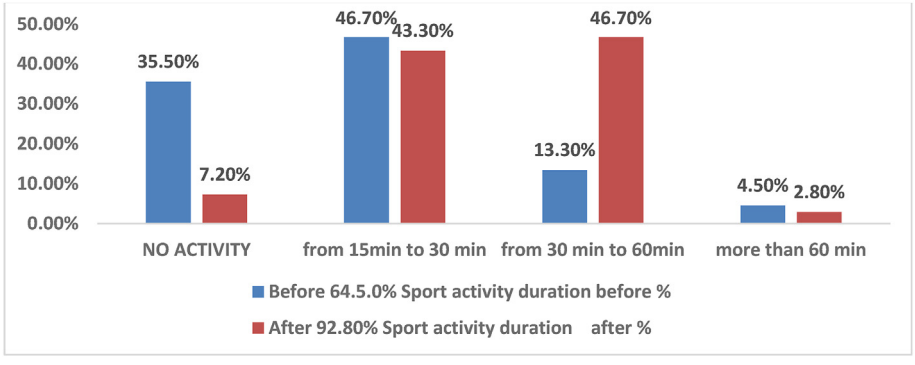

Fig. 7. Changes in physical activity duration before and after an intervention.

Table 8. Changes in lifestyle before and after an intervention.

	Before	After	*P* value
Eating outside	83.9%	53.2%	0.001
Eating with family	66.4%	72.5%	0.6
Smoking	10%	17.8%	0.08
Fruits per day	44.0%	87.3%	0.002
Vegetables per day	52%	91.3%	0.0024
Dairy product per day	36%	47%	0.03

on increasing the duration of sports activity among the population.

Table 8 shows the percentage of individuals eating outside significantly decreased from 83.9 to 53.2% ($P = 0.001$). On the other hand, the percentage of individuals eating with family slightly increased from 66.4 to 72.5%, but this change was not statistically significant ($P = 0.6$). Interestingly, the percentage of individuals who smoke increased from 10 to 17.8%, but this change was also not statistically significant ($P = 0.08$). In terms of dietary habits, the percentage of individuals consuming fruits per day significantly increased from 44.0 to 87.3% ($P = 0.002$), and the same trend was observed for vegetable consumption, which increased from 52 to 91.3% ($P = 0.0024$). The percentage of individuals consuming dairy products per day also saw a significant increase from 36 to 47% ($P = 0.03$). These results suggest that the intervention or period had a significant impact on these lifestyle and dietary habits, with increases in family meals, fruit, vegetable, and dairy product consumption, and a decrease in eating outside.

6. Discussion

Telemedicine, first implemented in the 1950s, is a rapidly evolving tool for healthcare systems around the world. Technological advancement and increasing access to information technology have made the implementation of telemedicine more feasible. Recent provisions by healthcare governing bodies have increased reimbursement for and the use of telemedicine globally. The article titled “The role of telemedicine in healthcare: an overview and update” published in *The Egyptian Journal of Internal Medicine* [10], provides a comprehensive review of the pros and cons of adopting telemedicine. The article highlights many benefits of telemedicine to conventional, in-person healthcare encounters for both patients and providers. These include decreased travel cost and time, decreased time spent in waiting rooms, decreased risk of transmission of communicable diseases, decreased overall encounter time consumption, increased convenience, and more [10].

Telemedicine also facilitates seamless transitions of care between healthcare teams, connects isolated people groups with healthcare providers, and helps address regional healthcare infrastructure and provider shortages by connecting patients with healthcare teams from any location. However, there are also drawbacks specific to telemedicine. These include the lack of accessibility and advancement of imaging technology required to replace in-person physical examinations, nonuniversal access to the required devices and networks across the general patient population, and the risk of technical difficulties such as network connection disruptions.

Adolescents are often the most frequent users of technology and are usually the first to adopt new technologies, such as the internet, mobile phones, social media, and other devices. Unlike previous generations who had to learn to use technology later in life, today's adolescents are born into the digital age [11]. On the other hand, obesity in adolescents is a chronic, long-term condition that can be influenced by various factors, including genetic predisposition, socioeconomic status, metabolic rate, lifestyle habits, and certain endocrine disorders, diseases, and medications [12]. The prevalence of overweight and obesity among adolescents aged 5–19 has increased significantly, from just 4% in 1975 to over 18% in the WHO report 2021 [13]. Obesity during childhood often persists into adulthood and is associated with cardiometabolic and psychosocial comorbidities, as well as premature mortality. Egypt Family Health Survey 2021 reported the prevalence of overweight among children aged 5–19 years was 16% in females higher than the males (13%), while the prevalence of obesity was the same 7% in both males and females [14].

In our sample, the distribution of adolescents among the various locations is displayed as the big Cairo governorates appear to account for 74% of the participants, with the studied participants being split nearly evenly between urban (63%) and rural (37%) areas. This implies that the study covered a large geographic area, which might improve the findings' capacity to be applied generally and displays the participants’ sex distribution, as well. It demonstrates that females make up 75% of the participants, with males making up a lower percentage (25%).

This sex disparity is prevalent in health-related studies and may result from a number of variables, including variations in the ways of health care. The changes in weight, waist circumference, and BMI of adolescents before and after a 3-month intervention are statistically significant.

According to this current study, telemedicine, which relies on a chronic model of care, could be a useful tool for maintaining the follow-up of obese patients if it is appropriately regulated. Interventions involving telemedicine can effectively aid obese individuals in losing weight and offer a secure, distant substitute. They might also make treatment more accessible to communities that are difficult to reach. In our results, the impact of a 3-month intervention on the number of overweight and obese participants found initially, there were 225 overweight participants, making up 26% of the total. After the intervention, this number dropped to 17 (7.5%), indicating a weight loss of 7.5%. Similarly, the number of obese participants was 640, making up 74% of the total fell to 26 (7.8%), corresponding to a weight loss of 5.3%. These findings imply that the intervention, which combined telemedicine and physical visits, was successful in decreasing the number of overweight and obese adolescents in this study.

These results depend on the combination of telemedicine and physical visits every month for follow-up. This is supported by the study titled "A review of telemedicine interventions for weight loss" [15], which examines weight loss interventions that utilize real-time telemedicine. The study concludes that these interventions can effectively assist patients with obesity in losing weight by providing a safe, remote alternative, potentially expanding treatment access to hard-to-reach populations. These interventions typically involve weekly counseling and educational sessions or serve as a supplement to a primarily web-based intervention. The study also highlights the importance of self-monitoring in achieving successful outcomes and identifies videoconferencing as a potentially useful modality for capturing the interpersonal connection associated with in-person care.

Another study, "Weight loss outcomes with telemedicine during COVID-19" [16], investigates weight loss outcomes and weight management interventions among patients who were overweight or obesity during the COVID-19 pandemic. The study reveals that patients who were followed for 6 months via video or video plus in-person visits experienced clinically significant weight loss. The study also provides detailed demographic and baseline health data for the patients involved in the study. These studies underscore the potential of telemedicine in enhancing obesity management and weight loss. However, the study "Mobile health and telehealth interventions to increase physical activity in adolescents with obesity" [17], the study reviews the benefits and challenges of mobile health (mHealth) and telehealth-based physical activity interventions targeted at adolescents. It discusses the utilization of wearable activity trackers, text messages or apps, and video consultations with exercise specialists. And discuss the limitations of telehealth and telemedicine effect without the physical visit [17].

On the other hand, the study "Managing obesity in lockdown: survey of health behaviors and telemedicine" [18] presents the findings of an online survey conducted during COVID pandemic. It evaluated the correlation between changes in dietary and lifestyle habits and body weight and the benefits of receiving weight management care remotely through telemedicine during lockdown.

The study found that patients who received obesity care via telemedicine were more likely to lose weight and increase their exercise participation. While 40% of respondents reported consuming more sweet or salty processed snacks, 33% reported fewer vegetables and fruits, and 65% reported more homemade foods. Simultaneously, 40% of respondents reported a reduction in exercise, and 52% reported a decline in mood. Changes in these eating patterns, as well as in exercise habits and mood, were significantly associated with weight changes [19].

Additionally, our study identifies the impact of telemedicine on dietary behavior changes in the adolescents who participated in the study as, according to the data, the proportion of people who ate outside dramatically dropped from 83.9 to 53.2% ($P = 0.001$). However, when it came to eating habits, the proportion of people who consumed fruits climbed from 44.0 to 87.3% ($P = 0.002$) per day, and the same trend was seen when it came to the consumption of vegetables, which increased from 52 to 91.3% ($P = 0.0024$). There was also a noteworthy rise in the proportion of people who consumed dairy products daily, rising from 36 to 47% ($P = 0.03$). These results indicate that the intervention or period had a significant impact on these healthy lifestyles and dietary habits, with increases in family meals, fruit, vegetable, and dairy product consumption, and a decrease in eating outside.

Human physical activity is nevertheless a potentially modifiable factor of health and disease despite some heredity [19]. Adolescence is a crucial period in which to establish habits for long-term health because both physical activity tendencies and obesity tend to follow childhood to adulthood [20]. In the current study, the proportion of people who do not do any physical activity dropped from 35.5 to 7.2%. Before and after the intervention, 46.7% of people engaged in 15–30 min of physical exercise, which is a fairly steady percentage.

After the intervention, there was a high rise in the percentage of people who exercised for 30–60 min,

but there was a minor decrease in the percentage of people who exercised for more than 60 min. These findings imply that the period or intervention had a beneficial effect on the population's increased engagement in sports for longer periods.

Ours supported by the study "A digital health program targeting physical activity among adolescents with overweight or obesity: open trial" [21] aimed to assess the feasibility and acceptability of a 12-week, incentive-based, mobile health physical activity program with text-based health coaching, goal setting, and self-monitoring for adolescents with overweight or obesity. The study found that the program was well-received by participants, with all mean ratings of text-based coaching, Fitbit use, and the overall program being above 5 on a 7-point scale. Additionally, 85% of participants expressed a desire to continue wearing the Fitbit. The program also had high adherence, with participants wearing the Fitbit on an average of 91.1% of days and meeting their weekly goals for an average of seven out of 11 possible weeks. Significant improvements were observed in tracked daily active minutes and steps, and a significant decrease in body fat percentage was noted across the 12-week study [21].

On the other hand, the study dis-support our result about the long-term effectiveness of a smartphone app combined with a smart band on weight loss, physical activity, and caloric intake in a population with overweight and obesity aimed to evaluate the long-term effectiveness (12 months) of a multicomponent mobile health intervention – combining a smartphone app, an activity tracker wristband, and brief counseling, compared with a brief counseling group only – on weight loss and improving body composition, physical activity, and caloric intake in Spanish sedentary adults with overweight or obesity. After 12 months, the intervention group showed net differences in weight, BMI, waist–height ratio, body adiposity index, waist circumference, and hip circumference. Both groups lowered daily caloric intake and increased adherence to the Mediterranean diet, with no differences between the groups [22].

One measure of the effectiveness of the telemedicine plus in-person visits combination in managing obesity was demonstrated by the laboratory indicators, which showed that the percentage of anemic individuals in both sexes fell from 31.8 to 7.6% in females and from 8.8 to 3.7% in males. This change was statistically significant, with a P value of 0.0001. Likewise, the proportion of people with low WBC counts (4500–11 000 cells/ml) dropped from 9.7 to 3.2%; this shift was similarly statistically significant, with a P value of 0.04. With a P value of 0.9, the percentage of prediabetic people (n: FBS 70–100 mg/l) declined marginally from 10.0 to 8.0%. This change is not statistically significant. The percentage of those with high cholesterol (from 45 to 23%, $P = 0.001$), high LDL (from 2.3 to 1.8%, $P = 0.04$), low HDL (from 29.1 to 12.7%, $P = 0.007$), and high TG (from 18.2 to 4.2%, $P = 0.000$) has also significantly decreased, according to the statistics.

This improve also been achieved in many studies, such as a systematic review and meta-analysis titled "Weight loss and serum lipids in overweight and obese" aimed to quantify the impact of weight loss on lipid parameters in overweight or obese. The study incorporated 73 randomized controlled trials involving 32 496 patients, asses the decrease in triglyceride and low-density lipoprotein cholesterol levels and an increase in high-density lipoprotein cholesterol levels over 6 and 12 months [23].

Related to anemia, the study "A patient blood management perspective on anemia in the obese patient" discussed the significant role of inflammation and iron deficiency in causing anemia in obese patients. It also highlighted that obesity surgery could lead to substantial blood loss, increased demand for blood transfusions, and long-term nutrient deficiency. The study advocated for patient blood management programs as they have been instrumental in enhancing patients' clinical outcomes while reducing costs [24]. These studies offer crucial insights into the intricate relationship between obesity management, anemia, and lipid profile.

While telemedicine has demonstrated potential in the management of obesity, it is not without its challenges. A significant hurdle is the lack of access to and advancement of imaging technology necessary for conducting physical examinations remotely. This can be a substantial obstacle, particularly in obesity management, where physical assessments and measurements are crucial. Moreover, not all patients possess the necessary devices and network access for telemedicine. This digital divide can hinder certain demographics from reaping the benefits of telemedicine services, thereby limiting its overall effectiveness.

Our study depended on the integration of telemedicine and in-person visits, which demonstrated considerable potential in obesity management. Telemedicine interventions, often involving real-time video conferencing, can effectively aid obese patients in weight reduction by offering a secure, remote alternative, potentially broadening treatment access to populations that are difficult to reach. This approach can facilitate seamless transitions of care between healthcare teams. However,

the efficacy of weight-management programs is enhanced with more frequent visits, which might be challenging to facilitate with telemedicine alone due to various factors like technical problems or scheduling conflicts. Therefore, merging telemedicine with regular physical visits can help overcome these challenges and enhance the effectiveness of the intervention.

Another constraint is the risk of technical issues, such as disruptions in network connectivity. These can interfere with the provision of care and may potentially deter patients from persisting with the telemedicine intervention. Additionally, while telemedicine can bridge geographic gaps by connecting patients with healthcare providers from any location, it may not fully resolve the shortage of healthcare providers trained in obesity medicine and interdisciplinary treatment teams. Geographic barriers, especially in rural areas, can still present challenges. Finally, the efficacy of weight-management programs is enhanced with more frequent visits, which might be difficult to facilitate with telemedicine due to various factors like technical problems or scheduling conflicts. Despite these limitations, telemedicine continues to be a valuable instrument in obesity management, and ongoing advancements in research and technology may help alleviate these challenges in the future.

The methodology is approved by a study exploring weight loss outcomes during the COVID-19 pandemic [16]. It was found that patients who were monitored for 6 months via a combination of video and in-person visits experienced clinically significant weight loss. This suggests that a hybrid model, merging the convenience and accessibility of telemedicine with the personalized care of physical visits, can be effective in managing obesity. Furthermore, the use of telemedicine in conjunction with physical visits can also lower the cost of care by reducing travel and related expenses. Despite the promising results, more research is needed to fully understand the benefits and challenges of this combined approach in different populations and settings.

6.1. Conclusion

Our research indicates that the amalgamation of telemedicine with in-person consultations can be beneficial in managing obesity. The study evaluated the effectiveness of a telemedicine and physical visits intervention for obesity management among adolescents in Egypt. The intervention consisted of telemedicine consultations and physical visits with a nutritionist for 3 months. The study found that the intervention resulted in significant reductions in weight, waist circumference, BMI, and the number of overweight and obese participants. The study also found that the intervention improved the dietary habits and blood parameters of the participants. The study concluded that telemedicine and physical visits are a dynamic duo in obesity management among adolescents in Egypt and that telemedicine helps bridge the gap of distance by connecting patients in remote locations with physicians. Telemedicine can be an effective and feasible tool to deliver obesity care to adolescents.

6.2. Recommendations

Telemedicine interventions, especially those that incorporate real-time video conferencing, can assist obese patients in losing weight by providing a secure, remote alternative. This method can broaden treatment accessibility to populations that are difficult to reach and enable smooth transitions of care among healthcare teams. However, the success of weight-management programs is amplified with more frequent consultations, which might be challenging to arrange with telemedicine alone due to various factors like technical issues or scheduling conflicts. Therefore, a combined model that merges the ease and accessibility of telemedicine with the personalized attention of physical consultations is advocated. This approach can also decrease the cost of care by minimizing travel and associated expenses. Despite the encouraging outcomes, additional research is required to comprehensively understand the advantages and challenges of this integrated approach in diverse populations and environments.

Institutional Review Board (IRB) Approval Number

IN000130.

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Ethical approval

The protocol for this study was approved by the Ethical Committee of the General Organization of Teaching Hospitals and Institutes (GOTHI). The Declaration of Helsinki outlines the ethical criteria for medical research involving human participants, which were followed in this study. Before enrolling in the study, parents or caregivers provided informed consent.

Author contributions

EA contributed significantly to the concept and design, data analysis and interpretation, manuscript writing, and project methodology. ST had made substantial contributions to the conception and interpretation of data. GA contribute data analysis, LH, TE, and AN collaborated data collection, statistical analysis and manuscript writing. All authors reviewed and approved the final manuscript.

Conflict of interest

There are no conflicts of interest.

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