

ALTERNATIVE AND ONLINE WEIGHT LOSS INTERVENTIONS DURING COVID-19 PANDEMIC LOCKDOWN

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ABSTRACT

The problem of obesity is affecting an increasing number of people worldwide. The COVID-19 pandemic and the required social distancing, which make it impossible to see a dietitian, present new challenges and require the development of new ways of working with overweight individuals. Based on research and practice, dietetic services are beginning to shift from in-office consultations to a form of online consultation using mobile apps and websites. This literature review aims to critically analyze the scientific evidence for the effectiveness of interventions targeting weight loss in overweight or obese individuals focusing on behavioral and online interventions. The data from the presented studies suggest that the effectiveness of online interventions to control body weight is high enough to be used in nutritional education and in weight reduction or maintenance. The main advantage is a wide access to them for the public.

Key words: *obesity, Covid-19 pandemic, nutritional education, online dietetic consultations, online body weight interventions, weight loss*

STRESZCZENIE

Problem otyłości dotyka coraz większej grupy ludzi na całym świecie. Pandemia COVID-19 oraz narzucony dystans społeczny, uniemożliwiający spotkanie z dietetykiem, stawiają przed nami nowe wyzwania i wymagają wypracowania nowych sposobów współpracy z osobami z nadmierną masą ciała. W oparciu o badania naukowe i praktykę usługi dietetyczne zaczynają przechodzić z konsultacji stacjonarnych na formę konsultacji on-line, wykorzystując aplikacje mobilne i strony internetowe. Ten przegląd literatury ma na celu krytyczną analizę dowodów naukowych na skuteczność interwencji ukierunkowanych na zmniejszenie masy ciała u osób z nadwagą lub otyłością skupiając się na interwencjach behawioralnych i interwencjach online. Dane z przytoczonych badań sugerują, że skuteczność interwencji internetowych w celu kontroli masy ciała jest wystarczająco wysoka, aby opłacać się zarówno w edukacji żywieniowej, jak i redukcji czy utrzymaniu masy ciała. Główną zaletą konsultacji internetowych dla społeczeństwa, jest szeroki do nich dostęp.

Słowa kluczowe: *otyłość, pandemia Covid-19, edukacja żywieniowa, dietetyczne konsultacje online, zmniejszenie masy ciała, interwencje online*

INTRODUCTION

The problem of obesity is affecting an increasing number of people worldwide. In 2016, 1.9 billion adults struggled with being overweight and of those, 650 million were obese. Additionally, as reported in a 2019 report, 38.2 million children under the age of 5 are overweight or obese - a number that is estimated to continue to rise for children as well as adults [1]. In many countries, interventions to inhibit the spread of Coronavirus disease 2019 (COVID-19) have led to a worsening of the economic situation in society.

This is in turn reflected in worsening socio-economic inequality as in any financial crisis [2]. Considering the relationship between the economic status of societies and the risk of obesity, it can be suspected that the epidemic of obesity and its associated diseases will grow even faster [3]. One of the explanations for this trend is the preference of people with lower economic status for cheaper, energy-rich, tasty and easily accessible foods, and these types of foods promote the risk of obesity [4, 5]. Interestingly, a review paper published in *Obesity Reviews* in 2021 argues that top-down interest in solving the obesity problem is

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higher the more the public perceives obesity as an environmental rather than an individual problem. This paper highlights the need to support non-stigmatizing policies about obesity to contribute to a broader discussion of the problem [6]. In addition, it is worth noting that the isolation imposed by many countries promotes reduced spontaneous and planned physical activity. Since the first quarter of 2020, fitness clubs and other places for physical activity have been closed either periodically or permanently. There are many scientific publications confirming the positive impact of an increased physical activity on reducing the risk of obesity [7, 8, 9]. For the prevention of overweight and obesity, 2.5 h per day of energy expenditure in the form of Non Exercise Activity Thermogenesis (NEAT) (e.g. standing, moving, walking) is recommended. Increasing NEAT as a means of weight maintenance may also have a positive effect on metabolic adaptation resulting from a low-calorie diet and provide an alternative method of weight control [10]. Interestingly, to date, there is a lack of strong evidence that obesity risk is associated with consumption of a particular food group. A 2019 meta-analysis analyzing the results of studies examining the association between intake of given food groups and obesity risk found that the results of the correlations provided very low or low-quality evidence that certain foods affect obesity risk. At the same time, the authors point out that research in this direction should continue, as we have hypotheses that support this relationship [11].

Increased psychosocial insecurities and thus increased levels of psychological stress in the population may also be related to an increased obesity risk. *Bjorntorp's* [12] work found that psychosocial reactions to stress promote an increased energy intake with diet. Additionally, individuals with limited social interactions are more likely to develop obesity [13]. The above hypotheses appear to be supported by the first work analyzing the physical well-being of individuals affected by COVID-19 restrictions [14]. In a study involving 183 subjects, an increase in body weight of 0.63 ± 3.7 kg was observed in 49.18% as a result of decreased physical activity and increased food intake. In addition, a decrease in PAL was observed from 1.64 ± 0.15 to 1.58 ± 0.13 , as well as changes in the amount of food and specific food groups consumed, including alcohol [15]. The problem of obesity is not only associated with an increased mortality or disease risk. *Kolotkin and Andersen* [16], based on a meta-analysis of studies, demonstrate an association between an increased body mass index (BMI) and decreased health-related quality of life (HRQoL). In addition, this relationship was also demonstrated after bariatric surgery, after which weight loss in the subjects was associated with a significant improvement in this indicator of life satisfaction.

In conclusion, there are many indications of the growing problem of obesity in the world. Due to this trend, it seems necessary to develop effective methods of treatment and prevention of obesity in the world and research in this direction should be a priority [17]. The possible increase in the pandemic of obesity seems to have a clear connection with the lockdowns that are taking place, which indicates the need to look for more and better ways to help people with excessive body weight to reduce it and maintain it at an optimal BMI level. This literature review aims to critically analyze the scientific evidence for the effectiveness of interventions targeting weight reduction in overweight or obese individuals.

MATERIALS AND METHODS

Scientific publications developed in English published between 2000 and 2021 were used for data analysis using databases: PubMed, Google Scholar, Medline, Scopus and Web of Science. The following keywords combined with operators NOT, OR, AND were used: Intervention, Randomization, Adults, Humans, Energy Restriction, Reduction energy, Lose weight, Lose fat, Overweight, Online, Computer study, Nutrition, Diet, Health promotion, Health behavior, Obesity surgery, Obesity treatment.

Articles published in peer-reviewed scientific journals were included in the review. Two reviewers independently assessed articles for inclusion in the review, initially based on title and abstract. Full texts were then retrieved and evaluated for inclusion.

Inclusion criteria were intervention studies or original literature reviews as well as systematic reviews of the literature on the prevention and treatment of obesity bringing new and innovative insights into the latest tools aimed at supporting weight loss. The papers published prior to 2000 on patients, pregnant and lactating women, children, and adolescents were excluded. After analysis of 940 abstracts and publication titles, 230 papers were included in the further stages of the review. After the analysis of full texts of articles, 115 scientific papers were finally included in the review.

OBESITY AS A DISEASE

Obesity has become one of the major concerns for public health in recent decades. It is associated with increased morbidity and mortality. It is a strong risk factor for various disorders including coronary heart disease, type 2 diabetes mellitus, arterial hypertension, dyslipidemia, sleep apnea or different types of cancer, including colon, breast, gallbladder, endometrium, kidney and liver [18, 19, 20, 21]. Recently, there are numerous reports of obesity as a risk of severe

COVID-19 infection and increased mortality in obese individuals [22, 23, 24].

Obesity is described by the World Health Organization (WHO) as an excessive fat accumulation that may endanger health [25]. The Obesity Society in their 2018 Position Statement acknowledged obesity as a chronic disease [26]. Society recognised it as a risk factor of other disorders as well as serious and threatening condition on its own. The pathology of the disease is mainly linked with abnormal nutritional behaviour. It is correlated with a positive energy balance, in which energy intake is greater than energy expenditure, causing weight gain [27]. However, obesity could also occur as a secondary cause of genetic, hypothalamic or endocrine diseases [28, 29]. Moreover, iatrogenic obesity could also be identified, most commonly induced by medications [30].

Weight gain is promoted by positive energy balance which is caused by an increased food intake, decreased level of physical activity or both. Disturbed food consumption is a consequence of increased hunger or decreased satiety. Subcortical structures of the brain, which control appetite, are being influenced by environmental factors such as food availability, accessibility of calorie-dense products, taste, marketing, advertising of specific types of foods [31]. Although, the pathology of obesity is also linked to a certain degree of genetically determined susceptibility. Similar genetic components participate in the distribution of fat, overall body composition and visceral fat deposition after a period of excessive food consumption [32].

Adiposopathy is recognised as a basis of primary obesity. It is defined as anatomic and/or functional disturbances of adipose tissue, which results in abnormal endocrine and immune responses [33, 21]. Visceral adiposity, adipocyte hypertrophy and secretion of leptin and pro-inflammatory mediators by the adipose tissue are sustaining the state of adiposopathy. Metabolic and hormonal changes contribute to the insulin resistance that is often present in obese individuals [34, 35]. Therefore, obesity may lead to the dysregulation of the metabolic pathways. The presence of pro-inflammatory proteins could induce a low-grade systemic inflammatory state [36]. Disruption of metabolic homeostasis contributes to the development of atherosclerosis, hypertension, dyslipidemia, type 2 diabetes mellitus, hyperandrogenemia [37].

Excess lipids are stored mostly as subcutaneous adipose tissue. Visceral adipose tissue is additional storage for lipids [38]. Visceral adipose tissue has a stronger link to metabolic disturbances in obese individuals than subcutaneous adipose tissue [39]. Adipose tissue located around kidneys may lead to

increased renal compression, resulting in elevated blood pressure. Therefore, hypertension is often observed in obese patients [40]. An increase of pharyngeal soft tissues may disturb the function of the airways leading to obstructive sleep apnea [41]. Elevated intraabdominal pressure caused by the visceral adipose tissue has a harmful effect on the oesophagus, causing gastroesophageal reflux disease or *Barrett's* oesophagus [42]. Excessive weight also puts a mechanical load on joints, hence increased risk of osteoarthritis in obese individuals [43].

The most common method of diagnosing obesity is body mass index (BMI). The index helps to determine healthy or abnormal body weight, taking into account the height and weight of an individual. For most adults, BMI between 18.5 kg/m² and 24.9 kg/m² is considered to be a healthy weight. BMI >25 kg/m² is categorised as overweight and BMI >30 kg/m² as obese [25]. Although BMI is a useful tool in public health, it has its limitations. As an indirect measure, it relies only on height and weight and it does not include the percentage of body fat of body composition. BMI does not include changes that occur during ageing when the proportion between fat mass and free fat mass increases [44, 45, 46, 47].

As the world prevalence of obesity is increasing every year, it requires urgent attention and action. Therefore, the proper diagnosis and treatment of obesity are key in reducing the risk of numerous comorbidities and premature death [48].

TREATMENT OF OBESITY

When prevention of obesity fails, treatment is needed. Several treatment strategies might help lose weight and reduce the risk of health consequences of obesity. The most common strategies of treating obesity include dietary modification, increased physical activity, pharmacotherapy and in some cases surgical procedures. European Guidelines point out that the aim for obesity management should not be focused only on weight (and therefore BMI) reduction. Modifications in body composition, as well as waist circumference, must be targeted when dealing with obesity. The main focus should be on maintaining the current level of fat-free mass with a simultaneous decrease in fat mass. Moreover, the treatment aims should include also improvement in the quality of life and general well-being of obese individuals [49].

Dietary modification

British National Institute for Health and Care Excellence (NICE) in their clinical guidelines clearly indicate that the diet modifications should be acknowledged food preferences, health status, lifestyle. Individual approach to diet and calorie

reduction is emphasised. Nutritionally unbalanced and restrictive diets are not recommended as they are not effective and could pose a health threat [50]. A weight-loss diet must provide less energy than is required for daily maintenance. Guidelines published by the American College of Cardiology, American Heart Association and The Obesity Society recommend an energy deficit of 500 to 750 kcal/day and an average loss of 0.5 to 0.75 kg/week [51]. Weight loss goals should be manageable and realistic, hence 5–7% of body weight within 6 months is considered achievable [52]. Very low-calorie diets (800 kcal/day or less) are not recommended as a typical weight loss strategy [50]. They should be employed as a part of a complex weight management strategy and clinically justified, usually before surgical procedures [53]. According to the American Association of Clinical Endocrinologists and American College of Endocrinology (AAACE/ACE), total energy intake is the main component of every weight-loss intervention. In their Clinical Practice Guidelines for Medical Care of Patients with Obesity is been acknowledged that the macronutrient composition of the patient's diet is not an important factor. However, it is believed that in some cases, modifying macronutrient compositions could be useful. That could include overall adherence to the diet, the level of satiety, metabolic profile or other clinical outcomes and risk factors [54].

In addition to reducing energy, some dietary patterns seem to offer other health benefits apart from weight loss. American Heart Association reviewed that a balanced, weight loss diet should focus on non-processed foods like vegetables (excluding potatoes), fruits, nuts, seeds, legumes, whole grains, lean dairy and vegetable oil. The diet should limit the amount of processed or red meat, refined grains, salt and added sugars. Healthy weight-loss diets are high in fiber and micronutrients but low in glycemic index and saturated fat content [55]. The diet content is important for health reasons; however, the specific distribution of macronutrients seems to be irrelevant in weight loss. A meta-analysis including 48 randomized trials and 7286 overweight or obese individuals was designed to determine weight loss outcomes based on the macronutrient composition of popular diets [56]. Significant weight loss was achieved both with low-fat and low-carbohydrate diets. The difference between weight loss was not significant. The author suggests that any diet would be a successful weight loss diet if only there was an individually calculated calorie reduction.

Physical activity

Physical activity is a key component of a healthy lifestyle. WHO general recommendations for the adult population advise at least 150 minutes of moderate-

intensity or at least 75 minutes of vigorous-intensity physical activity during the week [57]. AAACE/ACE also endorse an increase in nonexercised and active leisure activity as a manner of reduction of sedentary behaviour [54]. However, current physical fitness and ability as well as a general condition should be taken into consideration. Obese individuals should gradually increase their amount of physical activity [50]. Sometimes, the involvement of a physiologist or other certified professional should be taken into consideration as a part of an individualised training plan [54]. A randomized trial among 439 overweight and obese women determined that diet and exercise interventions individually affected weight loss [58]. However, the most significant effects were observed when the dietary modification and physical activity were combined. Sixty per cent of participants achieved $\geq 10\%$ weight loss at 1 year. Apart from the weight loss itself, regular physical activity could reduce blood pressure, lipid concentrations or improve glycemic control [59].

Pharmacotherapy

NICE guidelines recommend that pharmacological intervention should be considered if dietary, exercise and lifestyle approaches have been evaluated [50]. European Association for the Study of Obesity recommended drug treatment of obesity for people with a BMI ≥ 30 kg/m² or a BMI ≥ 27 kg/m² with an obesity-related disease [60]. Medications should be introduced to obesity management when there is a history of failed, not clinically meaningful weight loss ($>5\%$ of total body weight) and to sustain lost weight [61]. Three medications have been approved in the European Union: Orlistat, Liraglutide and Naltrexone SR/ bupropion SR [62]. Orlistat is a lipase inhibitor that reduces dietary fat uptake in the small intestine by about 30%. On average about 3.8 kg above placebo weight reduction was observed during clinical trials [62]. The common side effects of the medication are intestinal disturbances like fatty stool, diarrhea, increased defecation and discomfort [63]. Liraglutide is one of glucagon-like peptide-1 (GLP-1) receptor agonists. A randomized, controlled trial of liraglutide in weight management was associated with decreased body weight [64]. 3.0 mg Liraglutide injections along with diet and exercises resulted in at least 5% loss of total body weight in 63.2% of participants. Meanwhile, only 27.1% of individuals from the placebo group lost 5% or more of their total body weight. However, the main drawbacks of the medication are the price and form of administration [63]. Moreover, many clinical studies show that other GLP-1 receptor agonists therapy results in glycosylated hemoglobin (HbA1c) level reduction and weight loss. Also, they may contribute to the decrease of blood pressure [65].

In the United States, there are currently five GLP-1 receptor agonists available: exenatide, liraglutide, albiglutide, dulaglutide and lixisenatide [66]. A recent meta-analysis included nine studies of GLP-1 agonists therapy (exenatide or liraglutide) in children with type 2 diabetes and obesity. Compared to placebo, GLP-1 agonist intervention reduced HbA1c by 0.30%. The most noticeable effect was observed in prediabetic children. Also, the GLP-1 agonists intervention caused a 2,74 kg weight decrease. In the study, GLP-1 agonists were described as efficacious in treating children with obesity and/or type 2 diabetes and the effect sizes were comparable with those observed in adult-focused studies [67].

Bupropion/naltrexon is a combination of a mild reuptake inhibitor of dopamine and norepinephrine and an opioid antagonist. The drug is responsible for reducing appetite and food cravings. It could possibly elevate the blood pressure, so it is not recommended for patients with hypertension [68].

Surgical procedures

Surgical treatment of obesity has been recently growing in popularity as a treatment option for severe obesity. NICE inclusion criteria for bariatric surgery are: BMI of 40 kg/m² or more or between 35-40 kg/m² and other significant disease that could be improved if a person lost weight [50]. Main bariatric procedures are adjustable gastric banding, sleeve gastrectomy and Roux-en-Y gastric bypass [63]. Obese patients who consider undergoing bariatric surgery should be fully aware and informed about possible risks and benefits. Data from 2020 indicates, that the perioperative mortality rates range from 0.03% to 0.2%, which has significantly improved since the beginning of the century [69].

BEHAVIORAL INTERVENTIONS

Concept of motivational dialogue and lifestyle change

Recently, studies taking into account the psychological aspect are an increasingly common response to the problem of obesity. Improving self-efficacy and working on psychological changes in eating habits are essential to successfully and permanently rid oneself of obesity [70, 71, 72, 73]. It has been suggested that a combination of motivational dialogue, a behavior change technique, along with cognitive behavioral therapy can lead to improved eating behaviors [74, 75]. In a randomized controlled trial involving 816 male blue-collar and white-collar workers in the construction industry with an increased risk of cardiovascular disease (CVD), a lifestyle change intervention was introduced. The intervention consisted of individual counseling using motivational

interviewing techniques and lasted 6 months. During this time, study participants participated 3 times in a 45-60 minute conversation with a physician during an appointment and 4 times for 15-30 minutes each through a telephone conversation. During the interview, the interviewer used motivational interviewing (MI) techniques such as asking open-ended questions, attentive listening, or raising causality in the subject. Participants in the control group received usual care, consisting of brief oral or written information from an occupational physician about their risk profile, based on the results of periodic screening tests. Both study groups had an access to the same educational materials on physical activity, healthy eating, and cardiovascular disease. After 6 months, a positive effect was noted in terms of healthy snack choices and increased fruit consumption in the intervention group. In addition, this group had significantly less smoking problem within 6 months after the intervention. However, in the longer term, i.e., 1 year after the intervention, this effect was not maintained and there was no longer a difference in adherence to beneficial lifestyle modifications between the groups [76].

The researchers had a different observation when they wanted to see if a healthy lifestyle motivation program had a better impact than standard care after cardiac rehabilitation was completed. The program was based on self-regulation principles and consisted of a motivational interview, 7 group sessions, and homework assignments. The lifestyle intervention program was associated with a 12% reduction in cardiac hospitalizations in the intervention group at 15 months after the study than in the group without the intervention. At the same time, the researchers found that the effect of lifestyle change was diminishing over time, which may suggest that this type of intervention should take place on a continuous or cyclical basis to influence subjects' behavior throughout their lifespan [77]. Similar findings were made by Martens et. al. who in their study observed a positive effect of MI on increasing physical activity in students reporting low levels of physical activity (PAL). However, they also emphasize that this type of motivation may be short-lived [78].

The concept of self-control

In interventions exploring the concept of self-control, the subjects are asked to self-control their eating behaviors. Self-control can increase subjects' awareness of health-promoting behaviors. However, it is also worth mentioning that studies of this type are difficult to evaluate and monitor, because their results are usually reported by the subjects themselves on a declarative basis [79]. A different approach was shown by the researchers Wang et al. who in their study wanted to see which strategy was better in terms

of achieving a reduction in excess body weight. They compared the effectiveness of self-control of subjects who self-reported their weight loss results during a 12-month dietary intervention (PR) and self-control using automated report reminders through personal digital assistants (PDAs). Both groups followed a similar dietary intervention, which was based on an energy deficit diet at the same level. The study found that both PR and PDA were significant factors in weight loss. Additionally, the use of automatic reminders that the PDA group had access to, increased the effectiveness of weight loss during the intervention and adherence to the recommended level of physical activity. In their conclusions, the authors also point to the need for the development of further technologies to aid in the monitoring of diet and physical activity in weight loss, such as phone apps and smart watch devices [80]. Similar observations were noted in numerous studies analyzing the relationship between self-control and successful weight loss [81, 82, 83, 84, 85, 86].

Setting goals

The first premise of working with a patient during a dietary intervention is to set a goal to work toward. The goal should be time-bound, measurable, attainable, and challenging. Additionally, and most importantly in a dietetic intervention, goal achievement should be linked to the development of a new eating habit and lifestyle change [87]. Tools to monitor adherence to goals are an extremely important part of dietetic collaboration and the evaluation of goal achievement and setting new goals is the essence of the dietitian's work, because goal achievement leads to changes in eating habits [88]. It is believed that setting an appropriate strategy is extremely important in effective dietetic collaboration, and goal setting itself is individual and requires good knowledge of the patient. However, it is emphasized that the goal-setting strategy is one of the most important behavioral strategies a nutrition professional can use [89]. Behavioral interventions aimed at weight loss are themselves effective and an appropriate tool to combat the problem of obesity [90].

ONLINE INTERVENTIONS

With the rapid development of web-based applications and the online model of healthcare delivery, consultations in the field of dietetics are also undergoing a restructuring [91]. The COVID-19 pandemic, through which some dietetic brokering services have moved to the online sector, has also had a not insignificant impact [92]. Moreover, recent studies conducted during the COVID-19 pandemic in Poland as well as in other countries indicate that

during the lockdown period body weight increased in the study groups [93, 94, 95]. Taking this into account, it seems that online nutritional counseling is a very good solution.

Telemedicine is the delivery of healthcare services using information and communication technology when the healthcare professional and the patient are not in the same location. Telemedicine uses the transmission of data, medical information, necessary for prevention, treatment, and health monitoring of the patient [96].

Based on research and practice, dietetic services are beginning to shift from in-office consultations to a form of online consultation using mobile apps and websites. To counter it, the global problem of obesity development needs interventions that can be implemented on a large scale and will be easily accessible to the patient [97]. In recent years, there has been an increased trend of implementing web-based technologies for disease detection, prevention, treatment, and health promotion [98]. E-health, or electronic health, is defined as "the use of information and communication technologies, particularly the Internet, to improve health and health care" [99].

With web-based technology, dietitians can effectively collect patient data, develop nutrition plans, communicate with patients, and monitor the effects of dietary intervention [100, 101, 102]. Coordinating this information in a single platform promotes patient nutrition awareness, provides rapid feedback in the patient-dietitian relationship, or enables dietary changes to be made based on individualized recommendations from a professional [103, 104].

The study by Chung et al. evaluated the effectiveness of online dietary consultation (teledietetics) versus inpatient services in reducing weight over 24 weeks and the costs associated with weight loss. Fifty subjects aged 20 to 50 years with a BMI greater than or equal to 23 kg/m² participated in the study. Each group consisted of 25 participants. One group received inpatient dietary counseling and the other group received online dietary counseling. All participants received the intervention for 12 weeks and follow-up for another 12 weeks. The inpatient consultation group received 1- 1.5 hours of dietary counseling once a week and recorded their food intake in a food diary. In contrast, the online consultation group received a total of 6 hours of nutrition training, individualized feedback from the dietitian, and recorded their food intake on an online platform. After 6 weeks of intervention, body weight and body fat were found in the inpatient consultation group. At week 12, however, weight and body fat reduction were significantly higher in the online consultation group, 5.1 kg vs. 4.5 kg and 3.97 kg vs. 2.38 kg, respectively. However, the differences were not statistically significant. At week

24 of the study, a statistically significant difference was noted between the groups in favor of online counseling. In terms of costs of the two forms of nutrition counseling, it was observed that the direct costs of 1% weight loss and 1% body fat loss were \$28.24 for inpatient consultation and \$17.09 for online consultation. This indicates that online nutrition counseling is more cost-effective and more effective in the long run than inpatient counseling [105].

iDiet WL (*iDiet weight loss*) is a commercial weight loss program. Data from 644 individuals enrolled in an 11-week group program focusing on weight loss were analyzed. The program was delivered through weekly hour-long group meetings that included nutrition education, weight management, support, and discussion. Participants were able to communicate with the participants and leader and report their measurements on a website. Data for analysis were collected from programs conducted in the workplace, individually created groups, or online video conferences. The mean initial BMI was 32.4 ± 7.1 kg/m². Results indicated that videoconference participants, older adults, and self-registrants to groups were more likely to report their results. However, after 11 weeks, % weight loss was not associated with initial BMI, gender, or videoconferencing when comparing to the inpatient groups. After 11 weeks, the average weight loss was 7.4 kg, with 74% of participants achieving a 5% weight loss. Study participants had significant clinical weight loss, which encourages wider implementation of the iDiet program both inpatient and online [106].

The effectiveness of online health and nutrition interventions in older adults was examined by *Batsis et al.* [107] in an observational study. The primary objective of the study was to assess the acceptability and feasibility of web-based intervention methods for weight management in older adults with obesity. The study included 142 subjects equal to or greater than 65 years of age residing in a community-based facility. The duration of the study was 6 months (October 2018 to May 2019). Study participants had a BMI equal to or greater than 30 kg/m². The intervention consisted of weekly video consultations with a dietitian, consisting of behavioral therapy and dietary calorie restriction. Additionally, participants had twice-weekly exercise classes with physiotherapists, which were also conducted online (video consultations). Participants in the study used a "Fitbit Altra HR" device to monitor activity. After 6 months of intervention, a mean weight loss of 4.6 +/- 3.5 kg was observed. In terms of fitness, improvements were noted, among others, in participants' sitting and standing up. The results indicate that an online technology-based intervention for health improvement (weight loss) is acceptable and possible for older adults with obesity. It addresses

both effectiveness in weight loss and improvement in physical performance [107]. The effectiveness and feasibility of dietary counseling with the help of apps was also tested by Swiss researchers. With the technology developed by Ovia company for dietitians, serving advice to overweight and obese patients, a study was conducted with 36 women and 7 men. After the entire intervention period (12 weeks), statistically significant differences were noted in median weight change, BMI, waist circumference. There were also changes in dietary habits including an increase in the frequency of vegetable, fruit and breakfast intake and a decrease in the frequency of consumption of sweets, fat and alcohol [108].

A systematic review of randomized controlled trials was conducted on the effectiveness of online interventions for the prevention and treatment of overweight and obesity in adults. Eighty-four studies were included in the analysis, with 183 intervention groups, 76% (n=139) of which included an online intervention. Online interventions were delivered via the Internet, using email, monitoring devices, mobile apps, software programs, personal digital assistants, and podcasts. Sixty-one studies were designed to reduce weight, 10 to maintain current weight, and 8 were designed to prevent weight gain, while 5 were designed to lose and maintain weight. Meta-analyses indicate significantly greater weight loss (kg) in teleconsultation interventions aimed at weight reduction compared with control groups where counseling was provided in a face-to-face manner. The data collected support the effectiveness of using online interventions as a treatment option for obesity. However, there is still insufficient evidence for their effectiveness in maintaining reduced body weight and preventing weight gain [109].

Researchers came to similar findings in another meta-analysis, confirming the effectiveness of online nutritional counseling in decreasing BMI in obese adults with hypertension and/or type 2 diabetes [110]. They considered 25 randomized control trials with intervention lengths ranging from 9 weeks to 2 years. They found significant differences in BMI changes between the intervention groups using online counseling and the control groups. However, the researchers suggest that the telemedicine intervention should last longer than six months and note that it is important to observe the patient after the intervention ends.

A meta-analysis by *Beleigoli et al.* [111] also examined the effectiveness of online versus non-technology health interventions on weight loss and lifestyle change in overweight and obese individuals. Eleven studies were included in the analysis and showed that weight and BMI changes differed between online and offline counseling. Online interventions

led to greater short-term weight reduction, but not long-term weight reduction. However, heterogeneity between groups was a problem in the evaluation. It was also indicated that the commitment is one of the problems with online interventions [111].

Similar findings were reached recently in 2021 by researchers evaluating the effectiveness of weight loss in an online intervention in various countries - the United States, the United Kingdom and Ireland, Canada, Australia, and New Zealand. After 16 weeks, the study participants' body weight dropped between 3% and 3.7% in all regions. The researchers also found preliminary support for the premise that online nutrition interventions developed in one country can be applied globally across countries, despite differences in attitudes toward eating and physical activity [112].

An interesting study was conducted in France. Its objectives were to evaluate the impact of a nationwide lockdown (during the COVID-19 pandemic) in France on weight loss and changes in body composition in individuals participating in a weight loss program, and to assess the impact of an online consultation on adherence to a program focusing on weight loss. This was a prospective multicenter cohort study involving individuals participating in the program over a period of two to six months. 1550 individuals completed the remote weight loss program. The median weight loss was 4.4 kg in those with online services and 1.4 kg in those without consultation, a difference was statistically significant. The study demonstrates the effectiveness of the online intervention in a nationwide lockdown setting [113].

Social support also plays an important role in the effectiveness of excessive weight loss. Simpson et al. [114] examined the acceptability of an intervention based on the use of an app, an online network, and social support in obese adults in an effort to lose weight. The study included 109 individuals with BMI ≥ 30 kg/m², 73 individuals in the intervention group and 36 individuals in the control group. The focus was on assessing 3 main parameters - BMI, diet and physical activity. The intervention group had access to the HelpMeDoIt! app and website for 12 months. The website provided evidence-based information on weight loss, goal setting and monitoring, and advice on using social support from relatives. In contrast, the app gave participants the ability to set weight loss goals, monitor progress, and invite people to support them. The control group received a healthy lifestyle pamphlet. All participants were able to further access other available sources of knowledge about lifestyle changes or support. Data after the 12-month intervention indicated that HelpMeDoIt promoted social support to weight loss. Support and progress monitoring were key elements for study participants. 61% of goals created by participants in

the app were met. The average percentage weight loss for those in the intervention group was -3.2% and for the control group was -2.3%. The study indicates that a novel social support intervention, in the form of an app and website, can promote the pursuit of healthy weight and is feasible and acceptable to people [114]. Other researchers testing the effectiveness of online health interventions on health behaviors have reached similar conclusions. They noted the great potential of online interventions for engagement and achievement of stated goals. Developing and evaluating online interventions poses new challenges and new versions of old challenges that require improved and perhaps entirely new research and evaluation methods. Future health economic analyses must recognize and model the complex and potentially far-reaching costs and benefits of digital interventions [115].

CONCLUSIONS

Data from the aforementioned studies suggest that the effectiveness of online interventions for weight control is high enough to be worthwhile for both nutrition education and weight reduction and/or maintenance. Limitations associated with inpatient nutrition interventions such as time consuming, costs can be overcome by introducing the possibility for patients to benefit from online interventions with similar effectiveness. Online nutrition consultation also has the advantage of wide access to the public. Both forms of intervention should be considered for health-promoting lifestyle modification of patients.

Data availability

No data were used to support this review paper.

Conflict of interest

The authors declare that they have no conflicts of interest.

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