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An evidence-based approach in determining the type of exercise periodization in obese patients

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Abstract: During the COVID-19 pandemic, The Centers for Disease Control and Prevention CDC, stated that obesity prevalence increased by 52%. In Indonesia, the prevalence of obesity is 21.8%. Obesity triggers an increase in pro-inflammatory cytokines, which induces chronic inflammation both locally and systemically, which can cause health problems, such as cardiovascular disease, diabetes mellitus, metabolite syndrome, and an increased risk of infection. One of the components of obesity management is increasing physical activity. One of the domains of physical activity is exercise. Exercise with the appropriate frequency, duration, intensity, type, and periodization can influence cytokine modulation so that it can reduce systemic inflammation and increase physical fitness. This evidence-based case report (EBCR) aims to determine the type of exercise periodization in obesity management and its effect on health-related fitness. The process of searching for literature on EBCR uses the PRISMA method on 3 databases, namely: PubMed, EBSCOhost, and ProQuest. From the search results, it was found that the combination of endurance and strength training exercises with linear periodization 3 times a week, was found to be better in improving fitness in obese people. Linear periodization increases cardiopulmonary fitness with a relative mean difference of 17.8(0.3 to 35.3) %, maximal strength with 1 RM bench press and 1 RM leg press test also increased, and also reduce body fat percentage about 2.1(-4.8 to 0.5) %. Thus, the combination of strength and cardiorespiratory exercise with linear periodization gives a positive response to the components of health-related fitness in obese people.
Keywords: exercise training, exercise periodization, obesity, physical activity intervention.

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INTRODUCTION

Obesity is the accumulation of excess fat in the body, which occurs due to an imbalance in energy intake and energy expenditure processes that accumulate over a long period (Ministry of Health of the Republic of Indonesia, 2018). Based on RIKESDAS 2018, the prevalence of obesity in the Indonesian adult population has reached 21.8% and this figure is expected to continue to increase. Furthermore, the CDC revealed that during the 2018-2020 COVID-19 Pandemic, there was an increase in the number of obese people by up to 52% (Lange et al., 2021; Sideli et al., 2021). This condition occurred due to social restrictions and lockdowns. This social restriction and lockdown eliminated the habit of walking (light activity), reduced physical activity with moderate intensity reached 52.8% (López-Valenciano et al., 2021), diminished and irregular sleep time((Kurniarobbi et al., 2022). These changes in eating habits and also will increase calorie intake which is one of the factors causing obesity (Bennett et al., 2021). Increased adipose tissue in obesity can increase pro-inflammatory mediators that induce chronic inflammatory processes (Artemniak-wojtowicz et al., 2020).

Chronic inflammation in obese people will induce many complications, e.g. metabolic disorders (metabolic syndrome, diabetes mellitus, and hyperlipidemia), heart disease, stroke, gastrointestinal disorders (gastritis and GERD), musculoskeletal problems, increased risk of cancer, psychological

disorders and decreased quality of life (WHO Regional Office for Europe, 2022). There are many approaches to managing obesity, and one of them is by increasing physical activity (Wharton et al., 2020). Doing physical exercise is one way to increase physical activity. Physical exercise can inhibit the increase in pro-inflammatory cytokines. In someone who does endurance training (ET), there will be a change in the amount of CRP, IL-6, IL-10, and TNF-α (Gonzalo-Encabo et al., 2021). The change from IL-10 and CRP coincides with a reduction in body fat mass (Gonzalo-Encabo et al., 2021). The increase in pro and anti-inflammatory cytokines during exercise varies greatly, this depends on the type, duration, intensity, and frequency of the exercise (Pertiwi et al., 2022). Exercise can also increase energy expenditure, a combination of jumping exercises with bodyweight exercises can help improve cardiovascular fitness and prevent excess weight (Nasrulloh et al., 2021). Exercise will be able to have a positive impact on cardiorespiratory endurance, (Yuniana et al., 2023). This adaptive response is related to training principles, such as progression, overload, and periodization (Kasper, 2019).

Progression is defined as; a gradual and systematic increase in training stress to maintain excess tissue which will induce an adaptation response (Kasper, 2019). While overloaded; the exposure of tissues to greater than accustomed to training stress, both of these can induce a positive adaptative response from our body (Kasper, 2019). There are many obstacles for obese patients to exercise, including; musculoskeletal pain, ankle injuries, chronic ankle instability, and neuromuscular instability (Baillot et al., 2021; Vuurberg et al., 2019). When a patient suffers from a musculoskeletal injury due to exercise, such as; an ankle sprain, then it will cause obstacles such as taking longer recovery time (Chikih et al., 2021). This affects exercise training program adherence in an obese patients (Baillot et al., 2021). Adherence in the field of obesity treatment is very important because good adherence significantly affects the percentage of total weight loss and excess weight loss (Hoffmann et al., 2022). Therefore, it is very important to arrange the exercise regimen carefully in such a way that exercise can ultimately benefit health (Pertiwi et al., 2022).

ACSM recommends that physical exercise in obese people should be done gradually; starting from an increase in frequency, volume, and intensity (Jonas & Phillips, 2009). The gradual increase in frequency, intensity, time and type of exercise is related to the exercise periodization (Evans, 2019). Periodization aims to control and maintain optimal training stimulus, adjust individual variability, minimize the risk of health problems, cardiac complications, and overtraining, and reduce the risk of musculoskeletal injury (Kasper, 2019; Naclerio et al., 2013), also helps patients not to get bored in undergoing an exercise program (Clemente-Suárez et al., 2021). In coaching, periodization is often implemented using micro cycles, mesocycles, and macrocycles (training cycles with modified intensity and increasing duration), with the type of periodization divided into; linear periodization, block periodization and reverse periodization, which adapts to the athlete and the competition. (Loturco & Nakamura, 2016; Mujika et al., 2018). In non-athletes or older adults, periodization programs help avoid health problems because the load on the neuromuscular system is varied to encourage adaptation while minimizing fatigue(Lorenz & Morrison, 2015).

Periodization can also be useful because it adds variety to an exercise by manipulating duration, sets, repetitions, exercise order, number of exercises, resistance, rest time, type of contraction, or exercise frequency (Lorenz & Morrison, 2015). However, until now there are no guidelines that regulate the type of exercise periodization for the obese patient to improve health-related fitness as a treatment for obesity in the clinical setting. So, this study aims to explore and find out the type of exercise periodization that is appropriate for the management of obese patients in the clinical setting, as well as its effect on health-related fitness.

METHODS

This study is an Evidence-Based Case Report (EBCR) with the clinical question; A 31-year-old man with a diagnosis of obesity who received a prescription for a physical exercise program asked about the type of exercise and how to determine the training load he would do, as well as its effect on his fitness condition. A literature search to answer clinical questions was carried out by identifying published literature in three databases, namely: PubMed, EBSCOhost, and ProQuest using single keywords or a combination of; obesity, exercise periodization, and physical fitness, with Boolean AND/OR. The inclusion criteria for literature selection were: (1) article published between 2016 and 2022, (2) the design was experimental, systematic reviews and/or meta-analysis, (3) using English with

available full text, (4) adult human subjects. The exclusion criteria were as the followings: (1) seminar articles, (2) subjects were geriatric, children or adolescents, and elite athletes.

Article selection was carried out using PRISMA (Preferred Reporting for Systematic Review and Meta-Analysis) (Gallagher et al., 2017). The screening for duplicate articles was carried out by two reviewers, starting with the title and abstract and then continuing with the full-text filtering stage. The reviewer screened the articles according to the inclusion criteria and if there were inconsistencies in the title and abstract selection stage, the article automatically enters the full-text selection stage. Selected articles were then critically reviewed based on evaluation standards from the Center of Evidence-Based Medicine, University of Oxford.

Data extraction on selected studies was started from the characteristics of the study consisting of the author, year of publication, research design, characteristics of the subjects (number of subjects), the studied exercise periodization, and research results (health-related fitness components).

RESULT AND DISCUSSION

To answer clinical questions, keywords are formulated as the following combinations (Table 1). The literature search was carried out on September 3, 2022. In the identification process, there were a total of 382 articles from the three databases, which then went through a screening stage based on inclusion and exclusion criteria, as well as evaluating the eligibility of abstracts and full manuscripts using the PRISMA method (Figure 1). Until the final stage of selection, only one article was selected and included to answer the clinical question. Then for one of the selected articles, a critical assessment process was carried out based on evaluation standards from the Center of Evidence-Based Medicine, University of Oxford, to assess validity and applicability (Table 3). Data extraction was carried out in selected studies, with the results of data extraction written in Table 2.

Table 1. Search Strategy (was conducted on September 3, 2022)

Database	Keywords	Amount
PubMed	((((((Obesity) AND (Exercise periodization)) OR (Obesity)) AND (physical fitness)) OR (Obesity)) OR (physical fitness)) AND (exercise periodization)	164
EBSCOHost	AB Obesity AND AB Exercise periodization OR AB Exercise periodization AND AB physical fitness	73
ProQuest	AB(Obesity) AND AB (exercise periodization) OR AB (exercise periodization) AND AB (physical fitness)	145

Based on the critical appraisal process (Table 3), the RCT study from (Streb et al., 2021) has validity and the results of this study discuss periodization and its effect on health-related fitness in obese patients. These studies are applicable and can be used to answer clinical questions (Streb et al., 2021). The study from Streb et al used two methods of exercise periodization, namely: linear periodization, and non-periodization. The total duration of the exercise program was 16 weeks which was divided into 3 mesocycle cycles, with 5 weeks duration for each mesocycle. The frequency of exercise was 3 times a week with a duration of exercise was 1 hour.

Table 2. Featured Article Characteristics

Author and year of publication	Research design	Research Characteristics	Results
(Streb et al., 2021)	RCT	1) 69 Subjects 2) Divided with a 1:1: 1 ratio into 3 groups: Periodization group (PG), Non-periodization group (NG), and control group (CG). 3) In the control group, there was no exercise,	1) Attendance reached 61% in the Periodization group and non-periodization groups. 2) There was no difference in the volume of aerobic exercise and resistance training between the Periodization group and non-periodization groups. 3) There was an increase in the strength of the upper body and lower body which was

Author and year of publication	Research design	Research Characteristics	Results
		only doing activities as usual. 4) The variables examined are cardiorespiratory fitness, muscle strength (upper-body maximal strength and lower-body maximal strength), and body composition (body mass, body fat percentage, and free fat mass)	almost the same in the PG and NG groups, before and after treatment. 4) Cardiorespiratory fitness increased significantly only in the PG group ($p<0.005$). 5) There was an increase in body mass in the NG and CG groups. 6) Conclusion: • Regardless of periodization, combination training equally increases upper and lower body strength. • Linear periodization was superior in improving cardiorespiratory fitness compared to the non-periodization group.

The exercise was divided into; 5 minutes of warm-up, 30 minutes of aerobic exercise (walking or running) followed by 20 minutes of resistance training which consist of 6 types of movements (barbell bench press, seated pec deck fly, low row, pull-down, guided squats, 45° leg press), and ended with 5 minutes of cooling down. The aerobic exercise intensity was measured using reserve heart rate (HRres). The increase of the intensity in the linear periodization group was divided based on the type of exercise. Specifically for aerobic exercise, the increase in exercise intensity is carried out every 1 mesocycle cycle, while the increase in the intensity of resistance training is done by motivating the subject to increase the intensity of the training load if the subject has been able to do the targeted repetitions in 2 consecutive training sessions. While the non-periodization group did the same type, duration, and intensity of exercise for 16 weeks, and the control group only did the physical activity as usual.

Table 3. Critical Appraisal

Variables	Description
Title	Effects of Non-Periodized and Linear Periodized Combined Training on Health-Related Physical Fitness in Adults with Obesity: A Randomized Controlled Trial
Author	Anne Ribeiro Streb, Robert Passos da Silva, Larissa dos Santos Leonel, Leonardo Trevisol Possamai, Aline Mendes Gerage da Silva, Tiago Turnes, Giovani Firpo Del Duca
1a. R- Was the assignment of patients to treatments randomized?	Yes, the author explains that there was a randomization process from research subjects into the research group.
1b. R- Were the groups similar at the start of the trial?	Yes, the author explains that there was no difference between the study groups
2a. A – Aside from the allocated treatment, were groups treated Equally?	Yes, the research group received the same treatment, namely the duration of the exercise program was 16 weeks, and 2 types of exercise (aerobic and strength training).
2b. A – Were all patients who entered the trial accounted for? And were they analyzed in the groups to which they were randomized?	No, dropout reached 50.7%. The author uses the method of per-protocol analysis. However, each subject who finished the study was analyzed based on the first allocated group.
3. M - Were measures objective or were the patients and clinicians kept “blind” to which treatment was being received?	Yes, the authors used a double-blind method for the patient and the person assessing the treatment outcome.

How large was the treatment effect?	The treatment effect of the intervention showed using the difference before and after the intervention in the group and also between the treatment groups. Linear periodization increased cardiorespiratory fitness by an average of 17.8 points and a strength of 11.4-16.3 points.
How precise was the estimate of the treatment effect?	The author uses a 95% Confidence Interval and 0.05 significance level. This study has a narrow margin of error so this is quite accurate in describing the actual population.
Will the results help me in caring for my patient? (External Validity/Applicability)	This study has the same subject as my clinical patient, so it can be used as a consideration in determining the type of periodization and type of exercise program in a clinical setting.

In this study, the results showed a significant increase in cardiorespiratory fitness in the linear periodization group from (27.8 ± 1.3) to (32.0 ± 1.4) with a relative mean difference percentage of about 17,8%, as well as an increase in upper-body maximal strength and lower-body strength. Significant maximal body strength increase was also found in the non-periodization groups. On the examination of body composition, there was an increase in body mass in the control group from 97.6±63.4 kg to 99.1±62.9kg ($p<0.05$) and the non-Periodized group from 92.5±65.4kg to 93.5±65.4kg ($p<0.05$), while in the linear periodization, there was a decrease in body weight from 94.3±65.5kg to 93.5±65.7kg.

Body fat percentage was decreased in the linear Periodization group reaching 0.9(-2.1 to 0.3) and in the non-periodization group 1.0 (-2.1 to 0.1). Fat-free mass in the three treatment groups was increased but it was not statistically significant (Streb et al., 2021). The study of Maryam Tayefi et al stated that body fat percentage is one indicator of metabolic disorders in obese patients. High body fat percentage increased the risk of metabolic abnormalities with an OR of 1.82 (95% CI, 1.42-2.34) (Tayefi et al., 2019). People with obesity have low cardiorespiratory fitness (Hung et al., 2014). Cardiopulmonary fitness is inversely related to body composition, especially fat percentage. Increased body fat, induces an increase in inflammatory mediators that result in oxidative stress, and can progress to endothelial dysfunction and metabolic disease (Oktay et al., 2017).

The study by Streb et al found that a combination of strength and aerobic exercise with linear periodization increased cardiorespiratory fitness with a mean difference of 4.2mL/kg/min, which was beneficial in reducing the risk of metabolic disease. Another study showed that combined weight training with aerobics can reduce body weight and body fat percentage in overweight people (Nurhadi et al., 2022). This is in line with the study of Jonathan Myers et al, which revealed that an increase in cardiorespiratory fitness by 4.8 mL/kg/min can reduce the risk of metabolic disease by 56% (Nylén et al., 2019). Thus, a physical exercise program with linear periodization in obese patients is considered to be better than physical exercise without periodization, in preventing complications in obese patients through the mechanism of increasing cardiopulmonary fitness and reducing fat percentage.

Another important finding of Streb et al; is about the importance of determining the type of exercise periodization at the beginning of exercise, to improve the fitness of obese people. The authors also say that adherence to training and weekly frequency of obese adults need to be considered as challenges in exercise prescription (Streb et al., 2021).

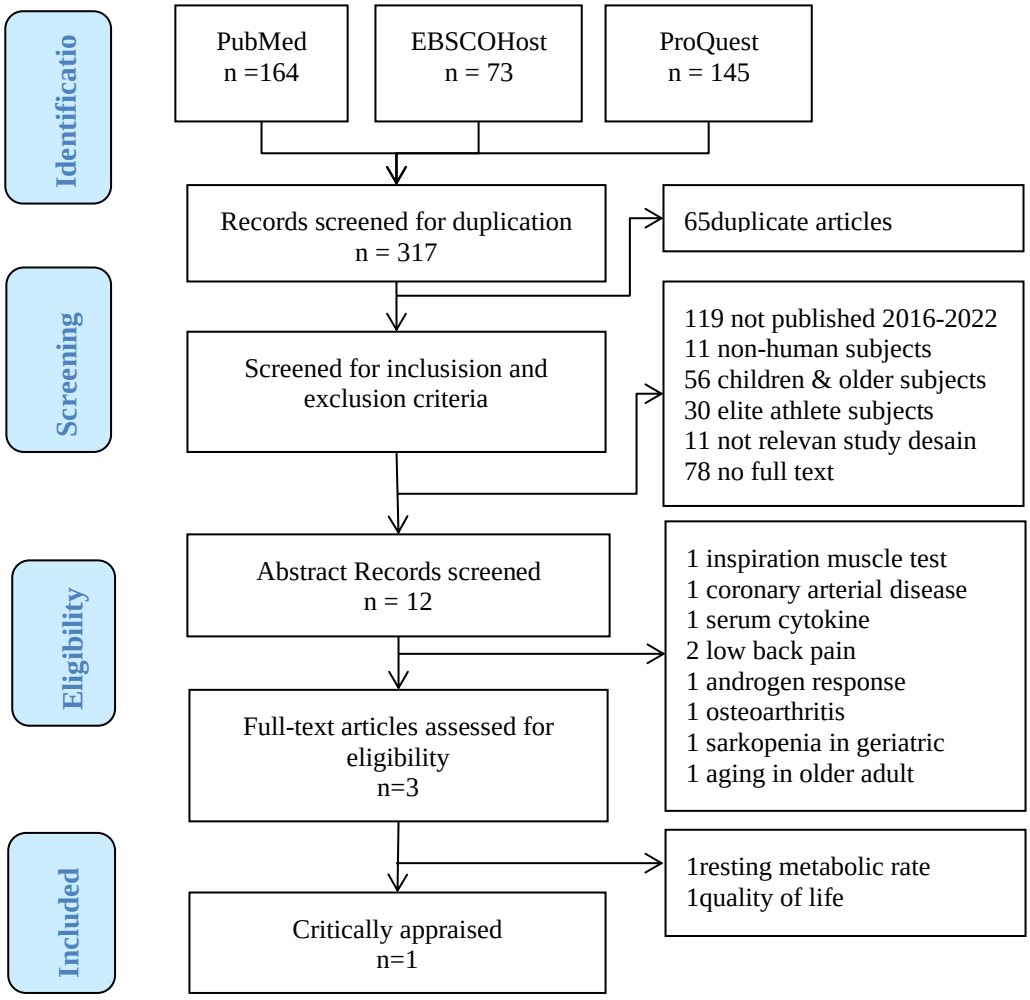

Figure 1. *Prisma Flow Chart*

This is following the study of Daniel Collado et al who said; at least fourteen key factors that must be identified and communicated with the client or patient to improve adherence to physical exercise, namely; (1) characteristics of the training program, (2) professional involvement from various disciplines, (3) supervision, (4) technology, (5) initial exploration of participant characteristics, barriers, and facilitators, (6) participant education, expectations and knowledge adequate information about risks and benefits, (7) enjoyment and absence of unpleasant experiences, (8) integration in daily life, (9) social support and engagement, (10) communication and feedback, (11) information and monitoring available progress, (l2) self-efficacy and competence, (13) active participation of participants and (14) goal setting (Collado-Mateo et al., 2021).

From this evidence base case reports, we get several new perspectives on physical exercise programs for obese people in clinical setting (exercise as medicine), such as; (1) physical exercise program with linear periodization in obese patients is considered better, because linear periodization can increase the components of cardiorespiratory fitness and muscle strength simultaneously, (2) linear periodization also affects body composition through weight loss and body fat percentage decrease, (3) in strength training, the volume of exercise is an important key in causing an increase in the component of muscle strength, (4) full body compound movement exercise is preferred for obese people, (5) combined endurance and strength training or commonly known as concurrent training with linear periodization is considered effective in obese patients, (6) adherence to the training program is a challenge in prescribing exercise, which must be identified and communicated early on, (7) obesity management should include increased physical activity with structured frequency, intensity, time and type. In this evidence-based case report (EBCR), we report on a young adult male who is obese and requires physical exercise to increase energy expenditure and improve health-related fitness. From the critical review process in 1 article, we found that in young adults with obesity, we can use a linear

periodization of strength training and aerobic exercise programs, which are combined simultaneously with an exercise menu consisting of 5 minutes of warm-up, 30 minutes of aerobic exercise (walking or running) followed by 20 minutes of resistance training which consist of 6 types of compound movements (barbell bench press, seated pec deck fly, low row, pull-down, guided squats, and 45° leg press), with a prescription for maximal repetition ranges (RM), will provide better results for the patient's health related fitness.

CONCLUSION

This study found that linear periodization with a combination of endurance and strength training was stated to be better in improving the fitness of obese patients. In addition, the determination of the periodization of the exercise program in obese patients must be communicated from the beginning of the exercise program. Another important thing is the effect of adherence and communication on the success of the target training program. Now, these findings are useful for incorporating the concept of periodization of exercise into exercise prescriptions for obese patients in clinical settings. Another thing that is also interesting for further research is how the frequency, intensity, time, type, and periodization of different exercises can affect health-related fitness components in obese people. The limitation of this EBCR is that only one study was included in the assessment process because the publication of experimental design, systematic reviews, and/or meta-analyses, which discuss periodization of physical exercise in obese patients and compared to no periodization is very limited. Furthermore, determining the appropriate periodization and exercise program in young obese adults still needs further research, but in the end, it is undeniable that exercise has a role in managing obesity and preventing complications.

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