The effects of exercise and intermittent fasting on health: a systematic review

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doi: 10.18176/archmeddeporte.00027

Received: 24/04/2020
Accepted: 15/10/2020

Summary

Objectives: This research aimed to systematically review the scientific evidence regarding the effects on health of combining exercise and fasting, as well as to determine if their impact is greater than when both activities are performed separately.
Material and method: A search of following databases was performed: MEDLINE through PubMed, Scopus, SportDiscus, Cochrane Library and CINAHL, by combining the keywords "Intermittent Fasting", "Ramadan", "Time Restricted Feeding" and "Physical Exercise". The methodological quality was determined using the Physiotherapy Evidence Database (PEDro) scale.
Results: Of the 711 results found in the first search, only four studies were definitely selected. The methodological quality of the analyzed trials turned out to be "fair" in three studies and "good" in one of them. The results obtained show that fasting combined with exercise turns out to be more effective in improving the body composition-related parameters, such as body weight, body mass index (BMI), waist circumference, fat mass and fat mass percentage. An improvement in glucose, insulin resistance, HDL and LDL cholesterol, systolic and diastolic blood pressure, triglycerides and maximal oxygen uptake were also observed.
Conclusions: The combination of intermittent fasting with physical exercise is an effective and interesting strategy to improve cardiovascular and metabolic health. This strategy appears to be an effective method to improve people's health through variables related to body composition, as well as the level of glucose, cholesterol and triglycerides.

Key words:
Fasting. Physical Exercise. Obesity. Overweight.

Efectos del ejercicio físico y el ayuno intermitente en la salud: una revisión sistemática

Resumen

Objetivos: Esta investigación tuvo como objetivo revisar sistemáticamente la evidencia científica al respecto de los efectos que tiene en la salud el hecho de combinar ejercicio físico y ayuno intermitente, así como determinar si su impacto es mayor que cuando ambas actividades se realizan de forma separada.
Material y método: Se llevó a cabo una búsqueda en MEDLINE a través de PubMed, Scopus, SportDiscus, Cochrane Library y CINAHL, mediante la combinación de las siguientes palabras clave "Intermittent Fasting", "Ramadan", "Time Restricted Feeding" y "Physical Exercise". La calidad metodológica fue determinada mediante la escala Physiotherapy Evidence Database (PEDro).
Resultados: De los 711 resultados obtenidos tras la primera búsqueda, cuatro ensayos clínicos aleatorizados (ECAs) fueron definitivamente incluidos en el estudio. La calidad metodológica de los ensayos analizados resultó ser "regular" en tres estudios y "buena" en uno de ellos. Los resultados obtenidos muestran que el ayuno combinado con ejercicio resulta ser más eficaz en la mejora de parámetros relacionados con la composición corporal, tales como el peso corporal, el índice de masa corporal (IMC), la circunferencia de cintura, la masa grasa y el porcentaje de masa grasa. También se observó una mejora en la glucosa, la resistencia a la insulina, el colesterol HDL y LDL, la presión arterial sistólica y diastólica, los triglicéridos y el consumo máximo de oxígeno.
Conclusiones: La combinación de ayuno intermitente con ejercicio físico tiene efectos beneficiosos en la salud cardiovascular y metabólica. Dicha estrategia parece ser un método efectivo para mejorar la salud de las personas a través de variables relacionadas con la composición corporal, así como con el nivel de glucosa, colesterol y triglicéridos.

Palabras clave:
Ayuno. Ejercicio físico. Obesidad. Sobrepeso.

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Introduction

Sedentary behaviour is a factor related to overall mortality and associated with an increased risk of coronary heart disease, diabetes and colon or breast cancer[1]. Therefore, strategies to promote physical activity should be developed primarily in order to improve people's health.

One of the strategies to promote physical activity is to increase exercise, since it has been shown that this modifies associations between sedentary behaviours and mortality from cancer and cardiovascular disease[2]. Performing regular exercise has also been associated with a lower risk of both morbidity and mortality[3], benefits for mental health and a delayed onset of dementia[1].

Nutritional strategies are also considered another factor to be taken into account in modifying healthy habits. Certain nutritional strategies have been seen to help improve people's health. One of these is intermittent fasting, which consists of a period with no or only low caloric intake. Different ways of approaching this exist: fasting for 16 hours every day, fasting for 24 hours every other day and fasting for two days every week on non-consecutive days, for instance[4]. During fasting, around 20% of energy requirements are usually ingested, while on normal diet days, intake is generally "ad libitum"[5]. Tinsley & La Bounty[6] conclude that consideration of this strategy can be recommended as a valid method for individuals interested in improving their body composition and overall health.

Both strategies show positive effects on health, and so combining the two has been considered key when it comes to improving quality of life. Typically, these strategies have been used together when treating, due to its prevalence, obesity. Obesity has become a major public health problem globally[7], so the interest in developing working methods that could help curb the epidemic is clear.

Vieira *et al*.[8] wrote a systematic review with meta-analysis which covered randomised clinical trials (RCTs) assessing the effect of aerobic exercise lasting less than 120 minutes in a state of fasting on adults aged between 19 and 59. These interventions were compared with the same exercise after previously consuming a meal containing at least 25 grams of carbohydrates. The authors concluded that performing low-to-moderate intensity exercise when fasting increased fat oxidation during the activity, although they also pointed out that no changes in free fatty acid concentrations were observed between when the activity was carried out in combination with fasting and when it was not. They also observed large variations in glucose and insulin concentrations when exercise was carried out when fasting. In another systematic review with meta-analysis, Keenan *et al*.[9] studied the effect of combining resistance training with intermittent fasting, chiefly to study the effect on lean body mass in recreationally active subjects, while also observing the effect on fat mass, weight and protocol adherence. They concluded that lean mass is maintained but that fat mass may be reduced.

Notably, although intermittent fasting has mainly been studied in order to improve people's health, research has also been conducted on its usefulness when it comes to enhancing sports performance. Aird *et al*.[10] conducted a systematic review with meta-analysis looking into the effects of fasting compared to normal food intake on adults aged over 18 in terms of metabolic adaptations and subsequent performance, taking into account continuous aerobic and anaerobic or intermittent exercise, and point out that eating before prolonged aerobic exercise (> 60 minutes) improves performance. However, fasting or feeding had no effect regarding performance in aerobic exercise of shorter duration. The authors conclude that both conditions (fasting and normal diet) can affect performance, highlighting potential beneficial metabolic adaptations that fasted exercise may induce in peripheral tissues. Levy *et al*.[11] published a systematic review looking into the effects of intermittent fasting on performance in high-intensity, endurance and muscle-strengthening exercise, and found that fasting did not bring any benefits to performance.

It should be noted that the systematic reviews consulted conclude that a lack of relevant scientific evidence makes it difficult to know to what extent this strategy offers beneficial effects. Bearing this in mind, this study is necessary chiefly in order to systematically review the scientific evidence of the effects of combining exercise and fasting on the health, and also to determine whether the impact is greater than when the two activities are performed separately.

Materials and methods

Search strategy

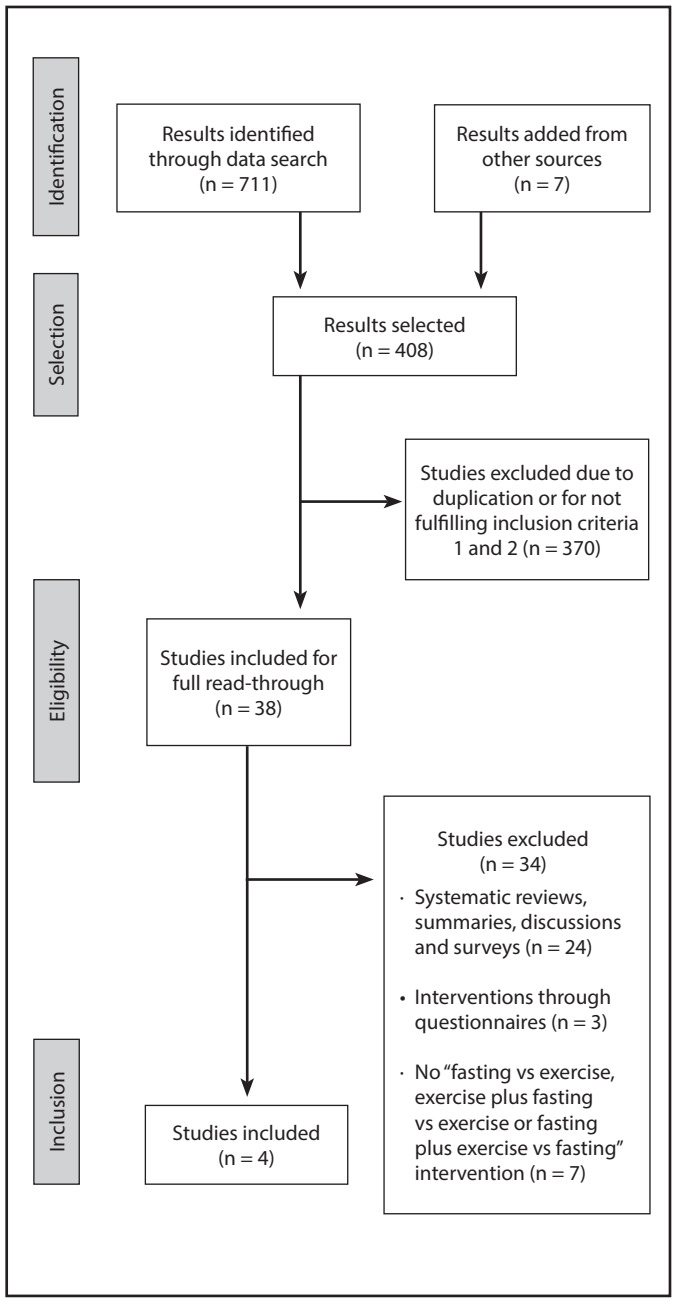
The search strategy used was designed to find RCTs examining the effect of physical activity and fasting or compared the impact of the two therapies on health-related variables. A search was carried out in the databases PubMed, Scopus, CINAHL, SportDiscus and the Cochrane Central Register of Controlled Trials, without any time restrictions. The following search formula was used: (*"Intermittent Fasting"* OR *Ramadan* OR *"time restricted feeding"*) AND (*"physical exercise"*).

The following studies were excluded: a) those which did not include physical exercise or intermittent fasting as part of the intervention, b) those that did not have a randomised controlled design, c) those that included traditional fasts (e.g. Ramadan), and d) those written in languages other than English, Spanish, French or Portuguese.

Selection procedure

When the duplicate studies had been eliminated, an initial selection was made in which the title and/or abstract of each paper was consulted and studies were classified as "included" for a reading of the full text or "excluded" according to the criteria specified above. Papers whose titles and abstracts failed to provide sufficient information were selected for full review. When these studies had been examined, those trials which did not meet the inclusion criteria were counted out. After performing this process, 34 studies were excluded for various reasons, and four studies were finally selected.

Figure 1. Flowchart of the systematic review process.



Data extraction

A table was created to identify the following aspects of the studies finally selected: the characteristics of the sample (number of participants, age, BMI and state of health), intervention type and characteristics, the study variables, the assessment tools and significant results. The data extraction procedure was not blind, the names of the authors and the titles of the papers being known.

Methodological quality

The methodological quality of the studies considered RCTs was assessed using the PEDro *(Physiotherapy Evidence Database)* scale. This scale scores 11 items: selection criteria, random allocation, concealed allocation, similarity at baseline, subject blinding, therapist blinding, assessor blinding, suitable follow up, intention-to-treat analysis, between-group comparison and point and variability measures. All the items except the one that assesses selection criteria were used to calculate the final score for each article, which ranged from 0 to 10 points. In line with Sánchez-Lastra *et al*[12], those studies which obtained scores of 6 or more on the PEDro scale were considered to be of "good" quality, and those which received scores of five points or less were considered to be of "fair" quality.

Results

The first search in the databases gave 711 results, to which seven from other sources were added. After removing duplicate studies, 408 papers remained, whose titles and abstracts were reviewed. Following this analysis, 370 articles were excluded and 38 were analysed in their entirety. This process led to the elimination of 34 studies which did not meet the specified criteria, leaving a total of four RCTs which were finally included.

Designs and samples

The characteristics of the intervention and the variables analysed are shown in Table 1. The four studies selected included comparisons of fasting and exercise with just fasting and just exercise in people with obesity or overweight[13-16].

The sample size of the studies included ranged from 45[16] to 112[15] participants, with a mean age of between 33[16] and 49[13,14]. The proposed interventions ranged from 8[15,16] to 12 weeks[13,14].

They consisted of a combination of strength training and moderate-intensity aerobic endurance exercise[15,16], and just aerobic exercises[13,14]. As for fasting, the studies chose a diet restriction in which the participants only consumed 25% of their daily energy intake, eating between 12:00 and 14:00, and then having meals *"ad libitum"* on the other days1[3-16].

None of the studies reported adherence or possible undesirable effects. However, four studies did include the participant dropout rate, these being 81[15], 19[13,14] and 10 subjects[16].

Main results

Comparison of fasting and exercise with just fasting and just exercise

A total of four studies reported significant results in body weight, their all concluding that both the combined strategy and the intervention which consisted of just fasting led to a significant decrease in

Table 1. General characteristics of the studies included.

First author (year)	Sample	Intervention	Variables analysed (assessment tool)	Significant results
Bhutani *et al.*, (2013)	**Obese** **Sample size:** 83 **Distribution and age (years):** G1: 16 (45 ± 5) G2: 16 (42 ± 2) G3: 16 (42 ± 2) CG: 16 (49 ± 2) **BMI (kg/m²)** G1: 35 ± 1 G2: 35 ± 1 G3: 35 ± 1 CG: 35 ± 1	**Duration:** 12 weeks **G1:** Moderate-intensity programme using exercise bikes and elliptical trainers. The length of the training was progressively increased by 5 minutes and 5% HRmax in weeks four, seven and ten and was combined with a fasting regime with controlled intake lasting four weeks in which the participants consumed 25% of their basic energy needs on the fasting day (24 h) and ate "ad libitum" on the normal diet day (24 h). For the next eight weeks, the subjects continued not eating on the fasting days. **G2:** Fasting regime with controlled intake lasting four weeks in which the participants consumed 25% of their basic energy needs on the fasting day (24 h) and ate "ad libitum" on the normal diet day (24 h). For the next eight weeks, the subjects continued not eating on the fasting days. **G3:** Moderate intensity programme using exercise bikes and elliptical trainers. The length of the training was progressively increased by 5 minutes and 5% HRmax in weeks four, seven and ten. **CG:** Daily life activities.	- Body weight (balance beam scales) - BMI (kg/m²) - Fat mass (bioimpedance) - Lean mass (bioimpedance) - Waist circumference (flexible measuring tape) - Total cholesterol - HDL cholesterol - LDL cholesterol - Triglycerides - Fasting plasma glucose - IR (HOMA-IR = fasting plasma insulin x fasting plasma glucose) - Systolic blood pressure (heart rate monitor and automatic digital blood pressure device) - Diastolic blood pressure (heart rate monitor and automatic digital blood pressure device) - HRmax (heart rate monitor and automatic digital blood pressure device)	**Adherence:** NI **Dropped out:** 19 **Completed the programme:** 64 **Adverse effects:** NI **Intragroup (pre vs post)** - Decrease in body weight, BMI and waist circumference in G1, G2 and G3. - Decrease in fat mass in G1 and G2. - Decrease in lean mass in G2. - Increase in HDL cholesterol in G1. - Decrease in LDL cholesterol in G1. - Decrease in systolic and diastolic blood pressure in G2. **Intergroup (pre vs post)** - Body weight and BMI decreased more in G1 than in G2 and G3. - Fat mass and waist circumference decreased more in G1 than in G2, G3 and GC. - Fasting plasma glucose decreased more in G1 and G2 than in GC in week 12.
Bhutani *et al.*, (2013)	**Obese** **Sample size:** 83 **Distribution and age (years):** G1: 16 (45 ± 5) G2: 16 (42 ± 2) G3: 16 (42 ± 2) CG: 16 (49 ± 2) **BMI (kg/m²)** G1: 35 ± 1 G2: 35 ± 1 G3: 35 ± 1 CG: 35 ± 1	**Duration:** 12 weeks **G1:** Moderate intensity programme using exercise bikes and elliptical trainers. The length of the training was progressively increased by 5 minutes and 5% HRmax in weeks four, seven and ten and was combined with a fasting regime with controlled intake lasting four weeks in which the participants consumed 25% of their basic energy needs on the fasting day (24 h) and ate *"ad libitum"* on the normal diet day (24 h). For the next eight weeks, the subjects continued not eating on the fasting days. **G2:** Fasting regime with controlled intake lasting four weeks in which the participants consumed 25% of their basic energy needs on the fasting day (24 h) and ate *"ad libitum"* on the normal diet day (24 h). For the next eight weeks, the subjects continued not eating on the fasting days. **G3:** Moderate intensity programme using exercise bikes and elliptical trainers. The length of the training was progressively increased by 5 minutes and 5% HRmax in weeks four, seven and ten. **CG:** Daily life activities.	- Weight (balance beam scales) - Fat mass (bioimpedance) - Waist circumference (flexible measuring tape) - Systolic blood pressure (ultrasound imaging) - Diastolic blood pressure (ultrasound imaging)	**Adherence:** NI **Dropped out:** 19 **Completed the programme:** 64 **Adverse effects:** NI **Intragroup (pre vs post)** - Decrease in weight and waist circumference in G1, G2 and G3. - Decrease in fat mass in G1 and G2. **Intergroup (pre vs post)** - Body weight decreased more in G1 than in G2 and G3. - Fat mass and waist circumference decreased more in G1 than in G2, G3 and GC.

(keep going)

First author (year)	Sample	Intervention	Variables analysed (assessment tool)	Significant results
Cho *et al.*, (2019)	**Overweight and obese** **Sample size:** 112 **Distribution and age (years):** G1: 9 (34.5 ± 5.7) G2: 8 (33.5 ± 5.0) G3: 9 (38.6 ± 8.2) CG: 5 (42.6 ± 10.6) **BMI (kg/m²)** G1: 28.0 ± 2.6 G2: 27.8 ± 3.4 G3: 26.9 ± 3.9 CG: 25.8 ± 3.4	**Duration:** 8 weeks. **G1:** Muscle-strengthening exercise (40 min, 3 times/week) and aerobic exercise (20 min, 2-3 times per week) combined with fasting, consisting of consuming 25% of the participants' recommended daily energy intake on each day of fasting (24 h) and eating *"ad libitum"* on each normal diet day (24 h). On the days of fasting, they had a meal between 12 noon and 2 p.m. to maintain the same times of fasting. **G2:** Consumption of 25% of the participants' recommended daily energy intake on each day of fasting (24 h) and eating *"ad libitum"* on each normal diet day (24 h). On the days of fasting, they had a meal between 12 noon and 2 p.m. to maintain the same times of fasting. **G3:** Muscle-strengthening exercise (40 min, 3 times/week) and aerobic exercise (20 min, 2-3 times per week). **CG:** Daily life activities.	- Weight (balance beam scales) - BMI (kg/m²) - Fat mass (bioimpedance) - Fat percentage (bioimpedance) - Fasting plasma glucose - RI (homeostatic model assessment of insulin resistance – HOMA-IR) - Total cholesterol - HDL cholesterol - LDL cholesterol - Triglycerides - VO_{2max} (Modified Bruce protocol)	**Adherence:** NI **Dropped out:** 81 **Completed the programme:** 31 **Adverse effects:** NI **Intragroup (pre vs post)** - Decrease in weight, BMI and fat mass in G1, G2 and G3. - Decrease in glucose in G1 and G2. - Decrease in triglycerides in G1. - Increase in VO_{2max} in G1. **Intergroup (pre vs post)** - Weight, BMI and fat mass decreased more in G1 and G2 than in GC. - Triglyceride levels increased in G2 compared with G3.
Oh *et al.*, (2018)	**Overweight and obese** **Sample size:** 45 **Distribution and age (years):** G1: 12 (37.3 ± 7.3) G2: 13 (32.9 ± 7.3) G3: 10 (35.7 ± 7.9) CG: 10 (40.6 ± 10.0) **BMI (kg/m²)** G1: 27.5 ± 2.6 G2: 27.6 ± 2.8 G3: 28.3 ± 4.1 CG: 26.3 ± 3.0	**Duration:** 8 weeks **G1:** Strength training and aerobic exercise three days per week combined with a nutritional strategy, consisting of three days of fasting with 25% recommended daily intake (the participants ate between 12 noon and 2 p.m.) and four days eating *"ad libitum"*. **G2:** Nutritional strategy, consisting of three days of fasting with 25% recommended daily intake (the participants ate between 12 noon and 2 p.m.) and four days eating *"ad libitum"*. **G3:** Training programme, consisting of strength training and aerobic exercise three days per week. **CG:** Daily life activities.	- Weight (bioimpedance) - BMI (kg/m²) - Waist circumference (flexible measuring tape) - Fat mass, kg (bioimpedance) - Fat mass, % (bioimpedance) - Fasting plasma glucose - IR (HOMA-IR) - Triglycerides - Total cholesterol - HDL cholesterol - Systolic blood pressure (NI) - Diastolic blood pressure (NI)	**Adherence:** NI **Dropped out**: 10 Completed the programme: 35 Adverse effects: NI **Intragroup (pre vs post)** - Decrease in weight and fat percentage G1 and G2. - Decrease in BMI and waist circumference in G1, G2, G3 and GC. - Decrease in fat mass in G1. - Decrease in glucose, IR and triglycerides in G1. - Increase in HDL cholesterol levels in G1, G3 and GC. **Intergroup (pre vs post)** - BMI, fat mass and fat mass percentage decreased in G1 compared with GC. - Triglyceride levels decreased in G1 compared with G2 and GC.

HR: heart rate; HRmax: maximum heart rate; CG: control group; G1: intervention group 1; G2: intervention group 2; G3: intervention group 3; HDL: high density lipoprotein; BMI: body mass index; LDL: low density lipoprotein; mg: milligrams; min: minutes; NI: not indicated; PM: post meridiem; IR: insulin resistance; IST: sprint interval training; VO_{2max}: maximum oxygen consumption.

this variable[13-16], while just exercise had the same effect in three of the studies[13-15]. The combined strategy was more effective compared to the other groups[13-15].

The body mass index (BMI) results were significant in three of the studies, their concluding that the variable decreased significantly after the three interventions[14-16]. The combined strategy seems more effective than taking no action[15,16] or only fasting or only doing exercise[14].

Significant reductions in waist circumference were also observed in three studies after the three interventions[13,14,16], the combined strategy proving more effective than the others[13,14].

Table 2. Results of the methodological quality assessment using the "*Physiotherapy Evidence Database* (PEDro)" scale.

First author, year	PEDro items										Score	Quality
	1	2	3	4	5	6	7	8	9	10		
Bhutani, 2013	+	-	+	-	-	-	-	+	+	+	5/10	Fair
Bhutani, 2013	+	+	+	-	-	-	-	+	+	+	6/10	Good
Cho, 2019	+	-	+	-	-	-	-	+	+	+	5/10	Fair
Oh, 2018	+	-	+	-	-	-	-	+	+	+	5/10	Fair

1: subjects randomly allocated; 2: allocation concealed; 3: groups similar at baseline; 4: blinding of subjects; 5: blinding of therapists; 6: blinding of all assessors; 7: suitable follow-up; 8: analysis by intention to treat; 9: between-group statistical comparisons; 10: point measures and measures of variability.

As for fat mass, the four studies yielded significant results, all reporting data favouring the combined strategy[13-16]. Just fasting proved significant in three studies[13-15], while only doing exercise led to a significant reduction in fat mass in just one study[15]. The combined group seemed to achieve better results compared with the other interventions[13,14] and with just the control group[16]. The percentage of fat mass was only statistically significant in one study, in which reductions were noted after a combination of fasting and exercise and just fasting. The combined strategy also showed a greater significant reduction compared with the control group[16]. Lean mass showed significant results in one study, which concluded that the only fasting strategy was more effective[14].

A significant reduction in glucose was observed in two studies, suggesting that the combined strategy is the most effective way to reduce glucose levels[15,16]. Indeed, it would seem that intermittent fasting carried out alone may affect glucose levels[15]. One study obtained significant results for the variable, showing a reduction after both the combined strategy and fasting compared with not taking any kind of action[14]. A significant decrease in insulin resistance (IR) was also observed in one study following the same intervention[16].

Two studies reported an increase in HDL cholesterol following the combined strategy[14,16]. One of these showed that just exercise or even taking no action at all led to an increase in this variable[16]. LDL cholesterol decreased after applying the strategy consisting of fasting and exercise[14].

Significant decreases were observed in both systolic and diastolic blood pressure in one study[14].

Triglyceride levels dropped significantly in two studies after a combination of fasting and exercise[15,16]. This strategy led to a greater reduction than just fasting or not adopting any change at all[16]. In this regard, Cho *et al.*[15] reported a significant increase in this variable in the group that only fasted compared with the one that only did exercise.

Maximal oxygen consumption increased significantly in one study after both strategies[15].

Methodological quality

Following a methodological assessment of the four studies reviewed, three studies[13,15,16] obtained a score of five on the PEDro scale, considered "fair". One study achieved a score of six, considered "good"[14] (Table 2).

Discussion

The aim of this systematic review was to examine the scientific evidence of the effects of combining exercise and fasting on the health, and also to determine whether the impact is greater than when the two activities are performed separately. Four RCTs were included. Their methodological quality ranged from "fair" to "good". Through RCTs, it is possible to analyse the effectiveness of interventions and examine the cause-effect relationships between interventions and outcomes[17]. The information presented here is of interest to professionals working in medicine and sports in order to make decisions.

A combination of intermittent fasting and exercise was compared with just fasting and just following an exercise programme in the four RCTs included. It should be noted that the training programmes focused mainly on muscle-strengthening exercises and submaximal or moderate-intensity aerobic activities, either jointly or, in the case of moderate-intensity aerobic activities, on their own. The fasting consisted of a diet restriction in which the participants only consumed 25% of their daily energy intake, eating between 12:00 and 14:00, and then having meals *"ad libitum"* on the other days.

In general, the combined strategy led to a significant decline in those variables related to body composition and was considered the best intervention compared with the others for that purpose. As for weight, the data support the conclusions of Redman *et al.*[18] which pointed to greater weight loss in the group that applied both methods. This could be because the training programme was supervised, which could increase its effectiveness and lead to more marked results. Meanwhile, Keenan *et al.*[9] reported a certain inconsistency in the effects of combining resistance training and intermittent fasting

on body composition, specifically fat mass and fat mass percentage. Just intermittent fasting also led to improvements in body composition in terms of the variables mentioned. These results are in line with the conclusions reached by Tinsley & La Bounty[6] outlined earlier in this review; intermittent fasting would seem to be a strategy worth considering before restricting daily calorie intake in individuals interested in improving their body composition and overall health. These findings, however, appear to contradict those reported in other studies which observed no improvements in body composition after intermittent fasting every other day or full-day fasting[19,20]. Exercise on its own also proved to be relevant in terms of improving body composition, mainly with reference to weight, BMI and waist circumference. Conversely, a significant decrease in lean mass was observed after intermittent fasting for 12 weeks, which contrasts with the results obtained by Keenan *et al*.[9], who observed no change in this variable following the combined strategy.

Abnormal cholesterol metabolism is considered predictive of the development of cardiovascular disease[21]. This study concluded that HDL cholesterol levels increased following interventions in which exercise played a leading role, either in combination with fasting or on its own. This is consistent with the observations made in some other studies[22-24], while the results do not seem consistent in others[25]. The data on LDL cholesterol disagree in the trials included in this review, only one reporting a significant decrease after the combined intervention.

The combined strategy led to a decrease in glucose, triglyceride and IR levels, suggesting that caloric restriction in combination with exercise is the best way to reduce the levels of these variables[16]. The systolic and diastolic blood pressure results in one trial differ from those obtained in the other studies included in this review, a decrease in values being noted in the group that only fasted.

Finally, it should be pointed out that this review involves a set of limitations which need to be borne in mind when interpreting the results obtained. The number of trials which met the inclusion criteria was low. Furthermore, the heterogeneity of the trials makes it difficult to draw any firm conclusions. It should also be stressed that the methodological quality of the studies stood between "fair" and "good". Subject allocation was concealed in three of the studies reviewed[14–16]. The same number of trials[13–16] were not followed up suitably. None of the trials involved blinding of assessors, therapists or subjects. The sample size was small in most of the studies included. Finally, the interventions were only considered in the short term, meaning that any long-term effects which the interventions analysed might produce would require further study.

Conclusion

The combined strategy of exercise and intermittent fasting would seem to be an effective way of improving the health of people through variables related to body composition and glucose, cholesterol and triglyceride levels. Further research with more robust designs is needed in order to analyse the long-term effects of intermittent fasting and exercise.

Conflict of interest

The authors declare that they are not subject to any type of conflict of interest.

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