The effect of grit on adherence to a weight control programme in adults

Efecto del grit sobre la adherencia a un programa de control de peso en adultos

Authors

Alex Andrés Zárate-López [1]
José Raúl Hoyos-Flores [1, 2, 3]
Manuel Francisco De La Cruz Ortega [4]
Silvia Carolina Medrano-Mena [1]
Kathryn Valenzuela Mendoza [4]
Jorge Zamarripa [1]

[1] Universidad Autónoma de Nuevo León (Mexico)
[2] Comisión Nacional de Cultura Física y Deporte (Mexico)
[3] Instituto Estatal de Cultura Física y Deporte de Nuevo León (Mexico)
[4] Universidad Estatal de Sonora (Mexico)

Corresponding author:
Jorge Zamarripa
jorge.zamarriparv@uanl.edu.mx

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Abstract

Objective: The present study aimed to evaluate the effect of grit on adherence to a six-month weight-management intervention programme in adults.
Methods: A six-month experimental time-series study was conducted (seven measurement occasions). The sample comprised an experimental group (EG; n = 9; age: 36.89 ± 7.59 years; BMI: 34.71 ± 5.77 Kg/m²) and a control group (CG; n = 10; age: 33.40 ± 10.84 years; BMI: 33.60 ± 5.40 Kg/m²). Both groups received a training programme and a dietary programme; only the EG received the grit programme. The following instruments and measures were administered: the TMGS, the Exercise Self-Efficacy Questionnaire, the BREQ-3, the short-form Stages of Change scale, the dietary habits questionnaire, the OEE, exercise and dietary adherence indicators, and anthropometric assessments.
Results: Reliability and internal consistency analyses yielded Cronbach's alpha values ranging from 0.70 to 0.96. Although significant effects were observed over time (p < .05) for dietary habits, waist, WHR, FMA and FMB, no significant effects were found in the group or interaction between group and time, which can be attributed to variations throughout the seven measurements with similar changes between groups.
Conclusion: Grit levels remained stable and did not translate into greater adherence to exercise or dietary prescriptions. These findings suggest that internal grit development alone is insufficient to modify health behaviours in weight-management programmes and highlight the need to integrate external support strategies to strengthen adherence and promote sustained changes in habits.

Keywords

Perseverance of effort; consistency of interest; adaptability to situations; exercise adherence; lifestyle intervention; psychological traits.

Resumen

Objetivo: El presente estudio, tuvo como finalidad evaluar el efecto del grit sobre la adherencia de un programa de intervención de seis meses para el control de peso en adultos.
Metodología: Se realizó un estudio experimental de series cronológicas con duración de seis meses (siete mediciones). La muestra estuvo conformada por un grupo experimental (n=9; edad:36.89±7.59años; IMC:34.71±5.77Kg/m²) y grupo control (n=10; edad:33.40±10.84años; IMC: 33.60±5.40Kg/m²). Ambos grupos recibieron programa de entrenamiento y dieta. Solo el GE recibió programa grit. Se aplicaron los instrumentos TMGS, el cuestionario de autoeficacia, el BREQ-3, la escala de etapas de cambio (versión corta), el cuestionario de hábitos alimentarios, el OEE, indicadores de adherencia hacia el ejercicio/dieta y antropometría.
Resultados: Los análisis de fiabilidad y consistencia interna de los instrumentos oscilaron de 0.70 hasta 0.96 en alfa de Cronbach. Si bien se presentaron efectos significativos en tiempo (p < .05) para hábitos alimentarios, cintura, relación cintura-cadera, masa grasa en antropometría y en bioimpedancia, no se encontraron efectos significativos en grupo ni interacción grupo por tiempo, pudiéndose atribuir a las variaciones a lo largo de las siete mediciones con cambios similares entre grupos.
Conclusión: Los niveles de grit permanecieron estables y no se tradujeron en mayor cumplimiento del ejercicio o alimentación, lo que sugiere que el desarrollo interno del grit por sí solo, no es suficiente para modificar conductas de salud en programas de control de peso y señalan la necesidad de integrar estrategias externas de apoyo para fortalecer adherencia y favorecer cambios sostenidos en hábitos.

Palabras clave

Perseverancia del esfuerzo; consistencia del interés; adaptabilidad a la situación; cumplimiento al ejercicio; intervención en el estilo de vida; rasgos psicológicos.

Introduction

Physical activity (PA) refers to any unplanned activity involving movement of the musculoskeletal system and an associated energy expenditure during activities of daily living. Exercise, in contrast, is a subcategory of PA, as it is planned and structured, with the aim of improving physical fitness. Sedentary behaviour (SB) encompasses activities typically performed while lying or sitting across a range of contexts, including at work, school, during travel, and in leisure time; it is therefore characterised by very low energy expenditure (World Health Organization [WHO], 2020).

In addition to SB, an unhealthy diet constitutes another health risk behaviour. The World Health Organization (2021) characterises it as both excessive and insufficient dietary intake, encompassing three categories: undernutrition (insufficient energy and protein intake), micronutrient malnutrition (deficiencies of vitamins and minerals), and overweight or obesity (excess energy intake). The latter is most strongly associated with the development of chronic non-communicable diseases. Globally, the most prevalent conditions include cardiovascular diseases, certain cancers, and diabetes (WHO, 2021).

According to data from the World Health Organization (2020), individuals who are physically inactive have a 20–30% higher risk of mortality compared to those who meet the recommended daily levels of PA. In addition, obesity is a multifactorial chronic non-communicable disease that has been characterised as a pandemic due to its pathophysiological progression, resulting from an excessive accumulation of dysfunctional adipose tissue. This condition is associated with multiple comorbidities and increased mortality; it is also socially stigmatising, yet to some extent has become normalised within society. Obesity results from excessive fat mass accumulation arising from an interaction between genotype and environment that produces a positive energy balance, alongside interactions among social, behavioural, cultural, physiological, metabolic, and genetic factors (Riaz et al., 2018).

Among the various factors that contribute to the maintenance of unhealthy habits, lack of motivation can hinder adherence to exercise and a healthy diet; importantly, motivation is highly malleable depending on an individual's circumstances. Therefore, psychological indicators related to adherence to exercise and dietary behaviours are of particular interest for research. In this context, one psychological construct associated with long-term achievement is characterised by passion and perseverance to work hard towards goals that may take months or even years to attain: the personality trait known as grit (Duckworth et al., 2007). Higher levels of grit have been shown to be associated with more advanced (active) stages of change for engaging in moderate- and vigorous-intensity physical activity or exercise (Reed et al., 2013).

Grit is a psychological construct comprising two dimensions: perseverance of effort and consistency of interests. Evidence of positive associations with long-term achievement has been observed primarily in educational and occupational settings, suggesting that overall grit scores can serve as a reliable predictor. However, perseverance of effort has been found to be a stronger predictor than consistency of interests, implying that only the former dimension may be critical for explaining long-term achievement, whereas the latter may represent a more suitable target for future research (Tyumeneva et al., 2021). Datu et al. (2017) note that, in some circumstances, grit may not yield the outcomes predicted by the theory, due to exogenous circumstances encountered by individuals. Consequently, a third dimension has been proposed within the structure of grit, "adaptability to situations", although this dimension remains understudied.

Regarding health behaviour change, grit may influence adherence through its interaction with self-regulatory processes. The perseverance and passion for long-term goals inherent to the construct reflect an individual's capacity to maintain behavioural commitment despite setbacks, fatigue, or lack of immediate reward, all of which are common elements in weight control programmes that extend over several months (Crede et al., 2017). Theoretically, individuals with higher grit are expected to transition more effectively through the stages of change proposed by the Transtheoretical Model, as this trait provides the volitional resources needed to overcome typical barriers to adherence, such as loss of initial motivation following the action phase or relapses in response to stressful situations (Rhodes & de Bruijn, 2013). By considering adherence as an ongoing process of maintaining complex behaviours (including dietary modification and the incorporation of physical exercise as a habit) grit would operate as a protective factor against dropout, facilitating persistence in the face of daily challenges. Nevertheless, studies examining grit in relation to adherence to new habits such as exercise and dietary behaviours remain scarce, with the literature largely concentrated in occupational (Caza & Posner, 2019), academic (Bessey, 2022), or adverse-contingency contexts (Totosy de Zepetnek et al., 2021).

A theoretical framework that has provided guidance for the development of intervention programmes by categorising individuals into stages of change is the Transtheoretical Model. These stages are precontemplation, contemplation, preparation, action, and maintenance. Across the process, individuals may also experience relapse and discontinue the behaviour they sought to adopt as a new healthy habit (Prochaska & DiClemente, 1982), thereby influencing whether adherence is ultimately achieved.

Adherence is defined as "the extent to which a person's behaviour (whether taking medication, following a diet, or implementing lifestyle changes) corresponds with recommendations agreed with a healthcare provider" (WHO, 2003, p. 3). The breadth of this definition presents challenges in weight-loss programmes, which typically employ multifactorial approaches with multiple components (diet, exercise, psychotherapy, pharmacotherapy, etc.), resulting in diverse methods for assessing adherence. Consequently, adherence in such programmes is not measured uniformly (e.g., dropout, attendance, dietary adherence, retention, self-monitoring, discontinuation, among others), which complicates understanding and comparison of the impact of different factors on adherence (Wang et al., 2024).

Carraça et al. (2021) report that exercise-inclusive programmes tend to produce positive changes in quality of life, while also showing consistent improvements in self-efficacy and autonomous motivation in adults with overweight and obesity. However, further studies are required to better systematise programme characteristics and to incorporate longer follow-up periods to draw firmer conclusions. In addition, the meta-analysis by Pirrotta et al. (2019) identified only a limited number of strategies that reduced attrition in adult weight-loss programmes, including the implementation of financial incentives, a multicomponent approach, and the use of self-monitoring technologies. It should be noted that most studies were of low-to-moderate methodological quality due to inadequate reporting.

Based on the reviewed evidence, the following research hypothesis is proposed: higher levels of grit are expected to be associated with greater adherence to a weight control programme in adults, as measured through psychological indicators (self-efficacy, autonomous motivation, dietary habits, and progression through the stages of change) and anthropometric indicators (body mass index, waist circumference, and body fat percentage). Accordingly, the present study aimed to evaluate the effect of grit on adherence to a six-month adult weight-management intervention programme.

Method

Study design

The present study adopted a quantitative approach and employed a true experimental time-series design. A non-probabilistic sample was estimated, and participants were randomly allocated using matched pairing based on sex and age (Hernández, 2014). The study variables included grit, self-efficacy, motivation, stages of change, dietary habits, outcome expectancies, and anthropometric measures (fat mass, waist-to-hip circumference, body mass, stature, and BMI).

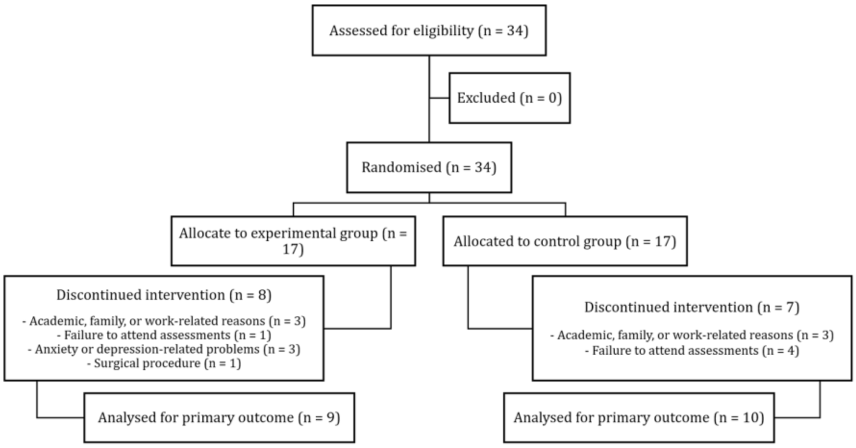
Participants

Individuals aged 18-59 years registered at the Energym gym in Hermosillo, Sonora, were considered. Inclusion criteria were having overweight or obesity and medical clearance to engage in exercise. The target sample size was set at a minimum of 15 participants per group, who were randomly assigned using online software (https://calcular.me/formar-equipos-al-azar) and matched by gender to the experimental group (EG; n = 17) and the control group (CG; n = 17) (Hernández, 2014). At the end of the study, the EG comprised 9 participants (age: 36.89 ± 7.59 years; mass: 96.17 ± 21.58 Kg; BMI: 34.71 ± 5.77 Kg/m2) and the CG 10 participants (age: 33.40 ± 10.84 years; mass: 95.23 ± 17.10 Kg; BMI: 33.60 ± 5.40 Kg/m2); only these participants were included in the data analysis, as shown in Figure 1.

Procedure

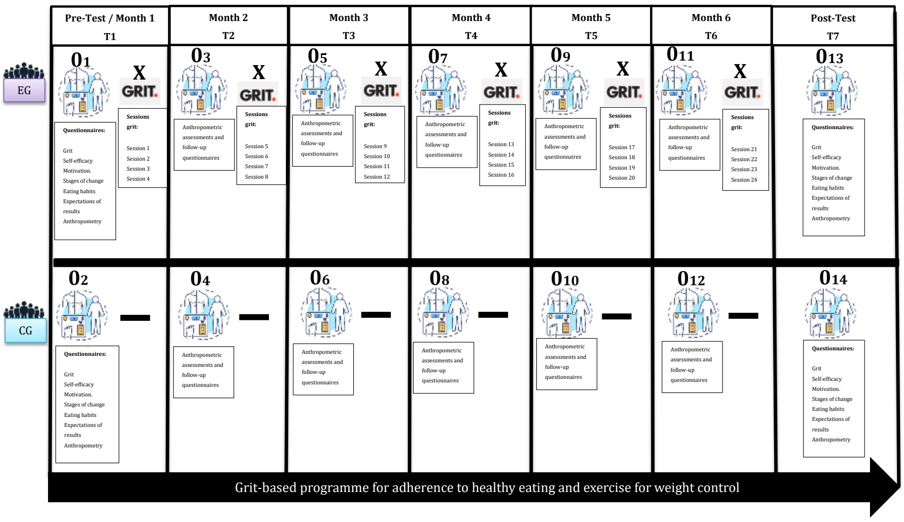
Data collection followed a series of steps beginning with institutional authorisation, programme promotion, and a meeting with participants. After obtaining permission from Energym to conduct an intervention study with gym members and to use the facilities, the intervention programme was promoted; interested individuals were registered and provided with individual, face-to-face explanation of the informed consent form. This included key information such as a description of the programme, the assessments, sessions related to the grit construct, training and dietary planning, confidentiality and/or privacy notice, and expected benefits. In addition, a medical screening was undertaken to confirm participants' eligibility for the study.

Figure 1. Study flow diagram



Subsequently, baseline assessments were conducted and the programme commenced, including provision of the training and dietary plans. To evaluate programme continuation and monitor assessments, gym attendance was recorded, with support from trainers to ensure participant safety. A total of six anthropometric monitoring sessions and questionnaire administrations were conducted at the time points specified in Figure 2. Both the EG and the CG received exactly the same procedures (training plan, dietary plan, and assessments); however, only the EG received the grit programme intervention. The study adhered to the ethical guidelines set out in the Mexican Official Standard (NOM-012-SSA3-2012) and followed the research ethics requirements of the School of Sports Organization at the Universidad Autonoma de Nuevo Leon. In addition, the study complied with the ethical principles for research involving human participants established in the Declaration of Helsinki (World Medical Association, 2025).

Figure 2. Study procedure



Note: EG = Experimental group of at least 15 adults aged 18–59 years with obesity, randomly assigned; CG = Control group of at least 15 adults aged 18–59 years with obesity, randomly assigned; X = grit sessions; O = anthropometric measurements and questionnaires administered to participants in each group; — = absence of grit sessions.

Training programme

For the prescription of resistance training, a total of 24 microcycles were established. The first month comprised an anatomical adaptation phase, followed by progressive overload applied on a monthly basis. Weekly distribution differed by sex: for men, three upper-body sessions and two lower-body sessions were scheduled, whereas for women three lower-body sessions and two upper-body sessions were scheduled. Exercise selection was modified each month. Training volume was set at approximately 10–20 sets per week per muscle group and 8–15 repetitions per exercise, performed five days per week, with sessions lasting ~60–90 minutes. Perceived exertion was monitored using the Borg Rating of Perceived Exertion scale, in its version adapted for the Mexican population (Borg, 1982; Castellanos & Pulido, 2009). Rest intervals were approximately 2 minutes between sets, and adequate hydration was maintained throughout training. Sessions concluded with 10–20 minutes of stretching for cool-down (Bompa & Buzzichelli, 2021; Borg, 1982; Israetel, 2017).

Dietary programme

A For dietary prescription, basal metabolic rate (BMR) was estimated using the Mifflin equation (1990), as follows:

- BMR (men) = 10 × body mass (kg) + 6.25 × height (cm) − 5 × age (years) + 5
- BMR (women) = 10 × body mass (kg) + 6.25 × height (cm) − 5 × age (years) − 161

Total energy expenditure incorporated a 10% thermic effect of food and a 10% physical activity level (sedentary). From the resulting total caloric value, 300–500 kcal was subtracted according to each participant's needs.

Subsequently, dietary plans were developed including seven different options for breakfast, lunch, dinner, and snacks, with comparable nutrient profiles to allow interchange over the month; each month, seven new options were added. Meal development used the Nutrimind database, which estimates energy and nutrient content based on Food and Drug Administration (FDA) data and the Mexican System of Equivalent Foods (SMAE, 5th ed.).

Grit programme

Regarding grit sessions, a total of 23 sessions were delivered during the intervention programme, covering four modules: (1) understanding grit (5 sessions), (2) developing a grit mindset (7 sessions), (3) developing grit-related behaviour (6 sessions), and (4) overcoming barriers to grit (5 sessions) (Baruch-Feldman, 2017). Sessions were delivered at the Energym gym on Saturdays using PowerPoint presentations. Attendance compliance with the GRIT programme was calculated as the sum of attended sessions and excused sessions (i.e. those participants who watched the recording of the GRIT session, confirmed they had watched the recording, and completed and submitted the activity corresponding to that session) divided by the total number of scheduled sessions. Among the participants in the experimental group included in the final analysis (n = 9), 202 out of 207 possible sessions were classified as attended or excused, corresponding to an attendance compliance rate of 97.6%. Specifically, 68 sessions were attended in person (32.9%), 134 were classified as excused absences (64.7%) and five as unexcused absences (2.4%).

Instruments

Sociodemographic information

At the first contact with each participant, the informed consent form for the research study was read aloud. Once signed, a medical assessment was conducted to compile the medical record and determine whether the individual was eligible to participate. Sociodemographic data were also collected, including nationality, sex, marital status, educational level, occupation, and socioeconomic status.

Triarchic Model of Grit Scale

To assess grit, the Triarchic Model of Grit Scale (TMGS) developed by Datu et al. (2017) was used. The scale comprises 11 items: three items assess perseverance of effort (e.g., "I am a hard worker"), three items assess consistency of interests (e.g., "New ideas and projects sometimes distract me from previous ones"), and four items assess adaptability to situations (e.g., "I am able to cope with the changing circumstances in life"). Responses were recorded on a five-point Likert scale ranging from 1 (Not at all like me) to 5 (Very much like me). The scale has demonstrated a Cronbach's alpha of 0.72.

Self-efficacy questionnaire

Perceived competence was measured using the Self-efficacy for Exercise Questionnaire by Marcus et al. (1992), in its Mexican version by Delgado et al. (2017). This instrument consists of five items assessing confidence in one's ability to continue exercising across different situations (e.g., "when I am tired"). Participants responded on a Likert scale from 1 (Not at all confident) to 5 (Extremely confident). The questionnaire has shown an internal consistency of 0.81.

Motivation for weight management

Motivation related to weight management was assessed using the Behavioural Regulation in Exercise Questionnaire (BREQ-3) by Wilson et al. (2007), drawing on the Spanish-language version validated for the Mexican population by Marentes-Castillo et al. (2022b). The questionnaire comprises 23 items, introduced by the stem "I manage my weight…", and is organised into six dimensions: intrinsic regulation (e.g., "because I think managing my weight is enjoyable"), integrated regulation (e.g., "because it fits with my lifestyle"), identified regulation (e.g., "because I value the benefits of managing my weight"), introjected regulation (e.g., "because I feel guilty when I do not do it"), external regulation (e.g., "because others tell me I should do it"), and amotivation (e.g., "but I do not know why I have to do it"). These regulations are commonly grouped as autonomous motivation (intrinsic, integrated, and identified regulation), controlled motivation (introjected and external regulation), and amotivation. Responses were recorded on a five-point Likert scale ranging from 0 (Not true at all) to 4 (Completely true). The questionnaire has demonstrated internal consistency with Cronbach's alpha values generally > .70 and ranging from 0.68 to 0.86 across studies (Cid et al., 2018).

Stages of change (short form)

The Stages of Change Scale (short version) was administered. Participants read a description of strategies commonly involved in weight loss or weight management, such as dietary modification, exercise, and regular medical monitoring. Based on this description, participants responded to a single item by selecting one response option; the chosen option reflected the participant's current behaviour and determines the stage of change. Response option 1 corresponds to the maintenance stage (e.g., "Yes, I have been for more than 6 months."), whereas response option 5 corresponds to the precontemplation stage (e.g., "No, and I do not intend to in the next 6 months"). The instrument has been previously implemented in Mexican samples with satisfactory empirical support (Zamarripa et al., 2019). In that study, its criterion validity was supported through significant associations with self-reported physical activity levels ($p < .001$), confirming its suitability for classifying individuals according to their stage of change.

Self-administered dietary habits questionnaire

Dietary habits were assessed using a self-administered questionnaire consisting of 18 items divided into three sections. The first section (consumption of recommended foods) includes six items; the second section (consumption of non-recommended foods) includes nine items; and the third section (eating behaviour) includes three items. Scoring criteria classify dietary habits as inadequate (<50% of the maximum possible score; <25.5 points), partially inadequate (>50% and <75% of the maximum possible score; >25.5 and <38.5 points), and adequate (>75% of the maximum possible score; >38.5 points. In its original validation in Mexican adolescents, internal consistency was reported within acceptable ranges for the evaluated sections and total score, supporting the reliability of the instrument (Florez-Vázquez & Macedo-Ojeda, 2016).

Outcome Expectations for Exercise Scale

Outcome expectations were assessed using the Outcome Expectations for Exercise Scale (OEE) developed by Marcus and Forsyth (2009). The scale comprises nine items (e.g., "Makes me feel better physically”), rated on a Likert scale from 1 (Strongly disagree) to 5 (Strongly agree). The purpose of the instrument is to evaluate perceived benefits and expected outcomes related to programme activities within the weight-control and weight-loss intervention. The scale has demonstrated internal consistency with a Cronbach’s alpha of 0.89.

Anthropometry

Anthropometric measurements were obtained in accordance with the ISAK manual (Stewart et al., 2011), using the restricted profile, by an ISAK-certified anthropometrist (Level 1). ISAK accreditation requires anthropometrists to demonstrate an acceptable technical error of measurement (%TEM), with commonly accepted accreditation thresholds of ≤5% for skinfolds and ≤1% for other anthropometric measurements. However, as no duplicate anthropometric measurements were recorded during data collection, it was not possible to calculate the technical measurement error, the standard measurement error, or the sample-specific intra-rater coefficient of variation.

Body mass and body fat percentage were assessed using a TANITA BC-533 InnerScan scale (capacity 150Kg; accuracy of 100g and/or 0.1%) using bioelectrical impedance analysis (BIA), whilst height was measured using a stadiometer integrated into a clinical scale (capacity 160Kg). Body circumferences were assessed using a Crescent Lufkin W606ME anthropometric tape measure (2m in length). The following circumferences were measured: neck, relaxed arm, flexed arm, waist, umbilical, hip and mid-thigh. In addition, skinfold thickness was assessed using a Slim Guide skinfold caliper at the triceps, biceps, subscapular and supraspinatus sites. These measurements were used to estimate body fat percentage using the Durnin and Womersley equation in combination with the Siri equation (Bauce, 2021). As noted above, the measurements were used to determine body fat percentage, as well as additional indices, including the waist-to-hip ratio or WHR (Hernández et al., 2018), calculated as waist circumference divided by hip circumference, and the body mass index or BMI (Mexican Official Standard NOM-043-SSA2-2012), calculated as body mass in kilograms divided by height in metres squared.

Adherence to Treatment

To calculate treatment adherence, the recommendations of Williams et al. (1998) were followed, applying at least three indicators for exercise and three for diet to assess adherence to the programme, as follows:

- Exercise adherence indicators: (1) days per week participants performed exercise (maximum of six days); (2) a 0–100 percentage scale indicating the level of adherence participants perceived they achieved for exercise; (3) number of exercises performed for the lower and upper body, with a maximum of seven exercises.
- Dietary adherence indicators: (1) days per week participants followed the diet (maximum of seven days); (2) a 0–100 percentage scale indicating the level of adherence participants perceived they achieved for the diet; (3) number of eating occasions per day, with a maximum of five.

Once the mean values for the three exercise indicators and the three dietary indicators were obtained, an “adherence index” was calculated for each factor by averaging the respective indicators, with 1.00 representing the ideal level of adherence (Williams et al., 1998). In addition, the programme “impact factor” was evaluated based on participants’ reported stages of change at each assessment. Impact (I) is a measure that incorporates both intervention efficacy and participation rate; in other words, impact is calculated as intervention efficacy (E) multiplied by participation (P), i.e., $I = E \times P$. This equation provides a metric to evaluate the impact of interventions targeting individuals and populations presenting multiple health risk behaviours (Riekert et al., 2014).

Data analysis

The continuous variables in the study were expressed as mean and standard deviation. The model assumptions were inspected using descriptive statistics (skewness and kurtosis) and Shapiro-Wilk normality tests in a complementary manner. The reliability of the scale instruments and internal consistency were also analysed using Cronbach's alpha. To analyse the difference between measurements, comparison between groups and group-by-time interaction, a mixed repeated measures ANOVA was performed (groups as an inter-subject factor and measurements as an intra-subject factor).

When Mauchly's sphericity assumption was not met, the Greenhouse-Geisser or Huynh-Feldt correction was applied. Multiple comparisons were performed using planned contrasts with Holm adjustment (group-by-time comparisons). Effect sizes are reported using partial omega squared (ω^2_p). Adherence to exercise was calculated as the average of IE1, IE2 and the composite indicator IE3 ((IE3.1 + IE3.2)/2), whilst adherence to the diet was calculated as the average of ID1, ID2 and ID3 and is reported as a percentage. Comparisons between groups were carried out using the Mann-Whitney U test. Rank-biserial correlation (r_{rb}) was used as the effect size.

Given that the stages of change variable is ordinal in nature and is derived from a single item, it was not included as a continuous variable in the mixed repeated measures ANOVA. Instead, it was analysed descriptively using frequencies and percentages by group and measurement time point. In addition, an exploratory cumulative link mixed model with a logit link was fitted, including participant as a random intercept to account for the dependence of repeated measurements. Two models were compared: one with main effects of group and time, and another that included the group-by-time interaction. Model fit was compared using the likelihood ratio test (LR) and Akaike's information criterion (AIC). Complementarily, a sensitivity analysis of power in G*Power v.3.1.9.7 (G*Power, Heinrich-Heine, Universität Düsseldorf, DE) to estimate the minimum detectable effect size for the group-by-time interaction in the mixed repeated measures ANOVA, considering α = .05, $1\text{-}\beta$ = .80, two groups, seven measurements, a total sample of 19 participants, a correlation among repeated measures of .50, and a non-sphericity correction ε = .75.

Statistical analyses were performed using JASP v.0.97.1 (The JASP Team, University of Amsterdam, NL). The cumulative link mixed model was conducted in RStudio v.2026.5.0.218 (Posit Software, PBC, Boston, MA, USA) with R v.4.6.0 (R Core Team, Vienna, AT) using the clmm function from the ordinal package. Statistical significance was set at p < .05.

Results

The results of the reliability and internal consistency of the pre-test and post-test instruments are shown below (Table 1). Descriptive data for the anthropometric and psychological variables throughout the seven measurement points are also presented in Table 2 and Table 3. Finally, Table 4 shows the main effects of group and time, as well as the group-by-time interaction for the psychological variables, while the anthropometric variables are presented in Figure 3.

Firstly, the reliability and internal consistency analyses of the instruments identified that Cronbach's α ranged from 0.70 to 0.89 in the pre-test, while in the post-test measurement, several of the values increased substantially, ranging from 0.74 to 0.96 (Table 1). For the variable stages of change, Cronbach's α is not presented as it is a single-item measure.

Table 1. Reliability and internal consistency analyses of the instruments

	Pre-Test					Post-Test				
	M	SD	Skewness	Kurtosis	α	M	SD	Skewness	Kurtosis	α
Grit personality	4.00	.48	.19	-.07	.73	3.93	.52	.24	-.56	.83
Grit perseverance of effort	4.07	.53	.05	-.36	.70	4.10	.67	-.25	-.53	.83
Grit consistency of interests	3.21	.92	.35	-.59	.73	3.29	.87	-.16	.05	.78
Grit adaptability to situations	4.43	.51	-1.49	1.94	.71	4.21	.59	-.26	-.61	.83
Stages of change	1.78	1.08	1.34	.66	-	1.21	.41	1.54	.41	-
Self-efficacy	3.35	.86	.13	.04	.73	3.22	.87	-.41	-.39	.90
Intrinsic regulation	3.46	.93	.41	-.89	.78	3.68	1.11	-.65	-.29	.87
Integrated regulation	3.46	.95	.29	-.92	.89	3.76	1.19	-.84	-.18	.96
Identified regulation	4.38	.65	-.82	-.51	.83	4.38	.78	-1.08	-.28	.82
Introjected regulation	2.89	1.05	-.01	-.15	.74	2.92	1.12	-.50	-.83	.77
External regulation	1.65	.72	.87	-.47	.75	1.47	.65	1.20	.04	.74
Amotivation	1.46	.85	2.82	9.25	.88	1.47	.57	1.14	.18	.80
Motivation	11.09	6.08	.58	-.18	.86	12.67	6.31	-.24	-.81	.91
Dietary habits	2.92	.33	-.44	.18	.71	3.01	.30	.10	-1.73	.86
OEE	4.52	.93	-3.34	12.03	.85	4.54	.98	-2.97	9.57	.98

Note: OEE = Outcome Expectations for Exercise Scale; M = mean; SD = standard deviation; α = Cronbach's alpha.

Table 2 shows the changes in the anthropometric variables at the seven time points, revealing relatively stable behaviour with minor variations, suggesting that there were no changes in any of the groups for all variables.

Table 2. Descriptive data for each group's measurements for anthropometric variables

	T1	T2	T3	T4	T5	T6	T7
	M ± SD	M ± SD	M ± SD	M ± SD	M ± SD	M ± SD	M ± SD
EG							
Mass	96.17 ± 21.58	95.78 ± 21.64	95.72 ± 21.72	95.32 ± 21.60	94.90 ± 22.49	95.57 ± 22.78	99.61 ± 25.04
BMI	34.71 ± 5.77	34.65 ±5.68	34.41 ± 5.80	34.46 ± 5.73	34.24 ± 6.24	34.48 ± 6.29	35.48 ± 6.57
Waist	97.05 ± 8.49	95.22 ± 7.30	96.51 ± 7.69	96.61 ± 8.10	95.68 ± 7.85	95.13 ± 8.66	96.23 ± 11.12
Hips	120.03 ± 18.25	118.60 ± 16.61	118.64 ± 17.04	118.80 ± 16.76	118.44 ± 16.73	118.44 ± 17.03	119.83 ± 18.11
WHR	0.83 ± 0.12	0.81 ± 0.10	0.83 ± 0.10	0.82 ± 0.10	0.81 ± 0.09	0.81 ± 0.10	0.80 ± 0.08
FMB	41.95 ± 6.99	40.66 ± 6.65	39.74 ± 7.33	40.48 ± 6.95	40.12 ± 7.38	41.53 ± 6.58	41.45 ± 6.19
FMA	36.85 ± 6.00	36.56 ± 6.25	36.95 ± 6.17	36.41 ± 6.40	36.13 ± 6.41	35.55 ± 6.72	35.59 ± 6.71
CG							
Mass	95.23 ± 17.10	94.10 ± 17.21	90.59 ± 21.14	93.26 ± 16.15	92.93 ± 16.53	93.46 ± 16.96	93.43 ± 16.01
BMI	33.60 ± 5.40	33.13 ± 5.19	32.93 ± 4.96	32.82 ± 4.76	32.70 ± 4.76	32.88 ± 4.89	32.66 ± 4.64
Waist	102.63 ± 12.08	102.35 ± 12.08	101.43 ± 11.16	100.22 ± 11.28	99.81 ± 11.67	98.43 ± 11.33	98.07 ± 10.17
Hips	113.62 ± 8.18	112.92 ± 7.42	113.12 ± 8.18	112.65 ± 8.24	112.62 ± 7.80	113.06 ± 7.76	112.58 ± 8.41
WHR	0.90 ± 0.07	0.90 ± 0.07	0.89 ± 0.07	0.89 ± 0.07	0.88 ± 0.09	0.87 ± 0.07	0.87 ± 0.08
FMB	40.43 ± 5.76	38.06 ± 6.83	37.40 ± 6.89	38.39 ± 7.39	37.77 ± 7.33	37.44 ± 6.93	37.70 ± 6.75
FMA	34.94 ± 6.13	35.17 ± 6.18	35.32 ± 6.59	35.02 ± 6.84	34.44 ± 6.98	33.59 ± 7.14	33.84 ± 7.29

Note: EG = Experimental Group; CG = Control Group; T1 = Time 1; T2 = Time 2; T3 = Time 3; T4 = Time 4; T5 = Time 5; T6 = Time 6; T7 = Time 7; BMI = body mass index; WHR = waist-to-hip ratio; FMB = fat mass (bioelectrical impedance analysis); FMA = fat mass (anthropometry).

With regard to the descriptive data for the psychological variables, Table 3 shows the behaviour of the variables by group and at the seven measurement points, revealing small fluctuations but no consistent pattern in either group. In addition, the stages of change variable (described using frequencies and percentages due to its ordinal nature) showed marked variability at certain points in time (Table 4).

Table 3. Descriptive data for each group's scores for psychological variables

	T1	T2	T3	T4	T5	T6	T7
	M ± SD	M ± SD	M ± SD	M ± SD	M ± SD	M ± SD	M ± SD
EG							
Grit	4.10 ± 0.29	3.77 ± 0.26	3.92 ± 0.33	3.85 ± 0.54	4.06 ± 0.42	3.92 ± 0.60	3.81 ± 0.51
Self-efficacy	3.02 ± 0.75	3.00 ± 0.58	2.80 ± 0.70	2.95 ± 0.83	3.02 ± 0.75	3.28 ± 0.57	2.91 ± 1.00
Motivation	9.01 ± 4.03	9.15 ± 4.92	9.76 ± 5.92	9.15 ± 6.54	9.62 ± 6.45	10.12 ± 7.62	10.51 ± 7.00
Dietary habits	3.02 ± 0.16	3.16 ± 0.27	3.10 ± 0.35	3.21 ± 0.27	3.00 ± 0.36	3.13 ± 0.38	3.04 ± 0.31
Outcome expectations	4.30 ± 1.26	4.66 ± 0.42	4.64 ± 0.38	4.11 ± 3.13	4.64 ± 0.41	4.11 ± 1.25	4.25 ± 1.29
CG							
Grit	3.90 ± 0.60	3.98 ± 0.66	3.93 ± 0.70	3.88 ± 0.57	3.76 ± 0.61	3.94 ± 0.56	4.03 ± 0.53
Self-efficacy	3.80 ± 0.80	3.48 ± 0.77	3.13 ± 0.63	3.75 ± 0.71	3.22 ± 0.77	3.44 ± 0.85	3.48 ± 0.72
Motivation	12.66 ± 7.53	14.71 ± 6.56	14.76 ± 7.08	16.37 ± 3.25	15.21 ± 5.18	13.95 ± 5.79	15.43 ± 4.80
Dietary habits	2.87 ± 0.43	3.13 ± 0.27	3.16 ± 0.31	3.01 ± 0.37	3.01 ± 0.38	3.03 ± 0.30	3.03 ± 0.29
Outcome expectations	4.71 ± 0.53	4.65 ± 0.65	4.64 ± 0.67	4.50 ± 0.56	4.61 ± 0.53	4.53 ± 0.68	4.77 ± 0.58

Note: EG = Experimental Group; CG = Control Group; T1 = Time 1; T2 = Time 2; T3 = Time 3; T4 = Time 4; T5 = Time 5; T6 = Time 6; T7 = Time 7.

Table 4. Descriptive data for each group's scores for psychological variables

		T1	T2	T3	T4	T5	T6	T7
		n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Maintenance	EG	6 (66.7)	6 (66.7)	5 (55.6)	6 (66.7)	5 (55.6)	6 (66.7)	7 (77.8)
	CG	4 (40.0)	3 (30.0)	4 (40.0)	6 (60.0)	6 (60.0)	7 (70.0)	8 (80.0)
Action	EG	2 (22.2)	2 (22.2)	4 (44.4)	3 (33.3)	3 (33.3)	3 (33.3)	2 (22.2)
	CG	4 (40.0)	7 (70.0)	5 (50.0)	4 (40.0)	4 (40.0)	3 (30.0)	2 (20.0)
Preparation	EG	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
	CG	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Contemplation	EG	1 (11.1)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
	CG	2 (20.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Precontemplation	EG	0 (0.0)	1 (11.1)	0 (0.0)	0 (0.0)	1 (11.1)	0 (0.0)	0 (0.0)
	CG	0 (0.0)	0 (0.0)	1 (10.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)

Note: EG = Experimental Group; CG = Control Group; T1 = Time 1; T2 = Time 2; T3 = Time 3; T4 = Time 4; T5 = Time 5; T6 = Time 6; T7 = Time 7.

For psychological variables, no significant effects were observed in the group, nor were there any group-by-time interactions ($p > .05$). An effect of time was observed for dietary habits ($F_{(3.5,56.2)} = 2.69$; $p = .046$; $\omega^2_p = .028$), but no group-by-time interaction, suggesting small variations at different times and in a similar manner between groups (Table 5).

Table 5. Between-group comparisons and group-by-time interaction for psychological variables

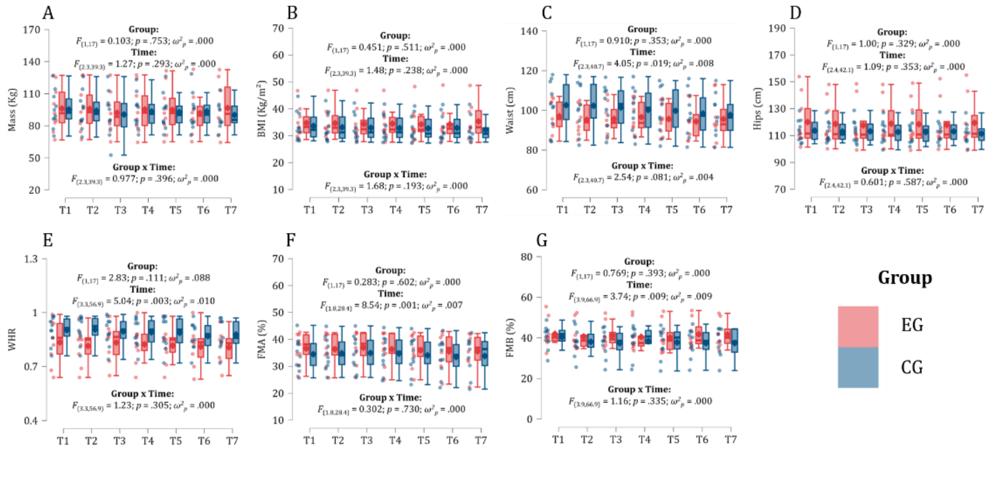
	Statistics
Grit	Group: $F_{(1,17)} = 0.000$; p = .989; $\omega^2_p = .000$ Time: $F_{(3.7,64.3)} = 0.350$; p = .833; $\omega^2_p = .000$ Group x Time: $F_{(3.7,64.3)} = 1.59$; p = .189; $\omega^2_p = .010$
Self-efficacy	Group: $F_{(1,17)} = 3.37$; p = .085; $\omega^2_p = .117$ Time: $F_{(3.3,54.3)} = 1.40$; p = .248; $\omega^2_p = .011$ Group x Time: $F_{(3.3,54.3)} = 0.959$; p = .427; $\omega^2_p = .000$
Motivation	Group: $F_{(1,17)} = 4.04$; p = .061; $\omega^2_p = .145$ Time: $F_{(3.2,51.4)} = 0.998$; p = .405; $\omega^2_p = .000$ Group x Time: $F_{(3.2,51.4)} = 0.744$; p = .539; $\omega^2_p = .000$
Dietary habits	Group: $F_{(1,17)} = 0.202$; p = .659; $\omega^2_p = .000$ Time: $F_{(3.5,56.2)} = 2.69$; p = .046; $\omega^2_p = .028$ Group x Time: $F_{(3.5,56.2)} = 0.979$; p = .419; $\omega^2_p = .000$
Outcome expectations	Group: $F_{(1,16)} = 0.992$; p = .334; $\omega^2_p = .000$ Time: $F_{(1.8,30.3)} = 0.812$; p = .448; $\omega^2_p = .000$ Group x Time: $F_{(1.8,30.3)} = 0.549$; p = .574; $\omega^2_p = .000$

Note: ω^2p = partial omega squared.

With regard to the stages of change, the cumulative link mixed model showed that the model with a group-by-time interaction did not improve the fit compared to the model with main effects, LR $\chi 2(6) = 3.96$, p = .682; AIC = 214.08 vs 206.05; therefore, it is considered that no evidence was found that the progression through the stages of change differed between the experimental group and the control group.

Finally, Figure 3 shows that no main group effects or group-by-time interactions were found (p > .05). However, a significant effect of time was found on waist circumference (F(2.3,40.7) = 4.05; p = .019; ω2p = .008), WHR (F(3.3,56.9) = 5.04; p = .003; ω2p = .010), FMA (F(1.8,28.4) = 8.54; p = .001; ω2p = .007) and FMB (F(3.9,66.9) = 3.74; p = .009; ω2p = .009), but with no evidence of group-by-time interaction (p > .05), which seems to be mainly due to behaviour at different measurement points, which was similar between groups.

Figure 3. Between-group comparison and group-by-time interaction for anthropometric variables



Note: EG = Experimental Group; CG = Control Group; T1 = Time 1; T2 = Time 2; T3 = Time 3; T4 = Time 4; T5 = Time 5; T6 = Time 6; T7 = Time 7; BMI = body mass index; WHR = waist-to-hip ratio; FMB = fat mass (bioelectrical impedance analysis); FMA = fat mass (anthropometry); ω^2p = partial omega squared.

No significant between-group differences were observed for final exercise adherence (EG = 86.0 ± 8.3%; CG = 78.2 ± 15.6%; U = 58.00, p = .307, r_{rb} = - .289) or final dietary adherence (EG = 64.8 ± 12.5%; CG = 66.1 ± 19.7%; U = 35.00, p = .436, r_{rb} = .222).

The sensitivity analysis indicated that, under the final study design, the minimum detectable effect size for the group-by-time interactions was Cohen's f = 0.258, equivalent to approximately $\eta^2_p \approx 0.062$. Therefore, the study was primarily capable of detecting effects of moderate magnitude or greater, whilst small effects may not have been detected.

Discussion

The primary aim of the study was to evaluate the effect of grit on adherence to a weight-management intervention programme based on resistance training and a hypocaloric diet. Overall, the results did not show significant between-group differences across the study variables (psychological, anthropometric, and adherence outcomes). This suggests that a grit-focused intervention, on its own, may not be sufficient to elicit health-related behaviour change.

With respect to grit and stages of change, no significant differences were observed, and both groups remained in active stages at the end of the intervention. This finding contrasts with previous research reporting an association between higher levels of grit and a greater likelihood of being in active stages of change (Reed et al., 2013; Marentes-Castillo et al., 2022a). Nevertheless, the minimal differences between active and inactive stages across groups suggest that the grit content delivered during the intervention was not sufficient to facilitate progression from one stage to another. This may be attributable to the fact that most participants began the intervention already in active stages of change, leaving limited scope for further detectable improvement. In addition, more intensive approaches combined with ongoing support typically yield greater impact on stage transitions, particularly those based on technology-assisted strategies or frequent supervision (Ainscough et al., 2020).

Focusing exclusively on grit as the psychological variable, levels of grit remained within optimal ranges throughout the programme, with no differences between groups. This aligns with Duckworth et al. (2007), who argue that grit is relatively stable in the short term and that meaningful changes in its level or traits typically require specific circumstances or prolonged interventions. Recent research has questioned the assumption that higher grit is associated with optimal outcomes for weight management. Call et al. (2022) reported that individuals with lower grit showed better acceptance of behavioural interventions, suggesting that grit may be limited or error-prone as a predictor of long-term success. Similarly, Kurita et al. (2024) showed that the relationship between grit, obesity, and eating behaviours may be mediated by factors such as emotional or uncontrolled eating, highlighting the importance of considering additional psychological mechanisms that were beyond the scope of the present intervention.

A further point relevant to interpreting these findings, consistent with the distinction proposed by Duckworth (2016), concerns the interplay between internal grit development (interest, deliberate practice, purpose, and hope) and external development (grit culture, social support, ongoing feedback, and mentors). Because the sessions primarily addressed components of internal development, while largely omitting external development, it is plausible that the absence of an external "grit culture", understood as the promotion of a growth mindset, autonomy, and mutual support to achieve shared goals, may have limited participants' capacity to translate grit-related content into sustained adherence.

Regarding anthropometric outcomes, although some variables changed over time, effect sizes were small and there were no group-by-time interactions. These findings are consistent with Weitzner et al. (2024), indicating that grit does not necessarily predict direct changes in body composition, particularly when determinants such as physiological, environmental, or behavioural factors play a dominant role. In a study by Gorin et al. (2024), grit was reported to be associated with habit automaticity; however, such effects appear to emerge when more structured support is provided over time. The absence of continuous supervision in the present study may have limited the consolidation of the habits required to produce meaningful changes in anthropometric outcomes.

With respect to exercise adherence, the experimental group showed slightly higher adherence; however, it also exhibited a somewhat higher dropout rate. This reinforces the notion that grit alone does not guarantee persistence in health programmes, and that factors such as autonomous motivation, baseline mood, social support, and incentives may exert a greater influence on adherence (Wang et al., 2024). In light of these findings, the external-development perspective on grit provides a useful interpretative framework: without a supportive environment, systematic supervision, or external behaviour-regulation strategies (e.g., technology, incentives, and feedback), grit may fail to translate into sustained behavioural perseverance and consistency. The interpretation that external adversities (e.g., academic, family, or work-related problems) contribute to dropout is also supported by this framework.

It is pertinent to examine the autonomous motivation data collected through the BREQ-3 in light of the findings on grit. Although no group-by-time interaction effects were detected for motivation, the descriptive statistics show that the control group displayed consistently higher autonomous motivation scores across the seven measurement points, whereas the experimental group remained at lower levels. This differential pattern, albeit non-significant, suggests that the grit-focused intervention did not succeed in enhancing participants' autonomous motivation above the levels achieved through standard treatment. Considering that autonomous motivation has been identified as a robust predictor of long-term adherence in exercise and weight control programmes (Teixeira et al., 2012), the absence of a favourable effect of grit on this variable may at least partially explain the lack of between-group differences in adherence indicators. This finding is consistent with Duckworth's (2016) proposal that grit development requires an environment that fosters both internal and external resilience: without a context that nurtures autonomous motivation through support for competence, autonomy, and social relatedness individual perseverance efforts may be insufficient to sustain adherence.

Regarding practical implications for exercise and health professionals, the results of this study invite the adoption of a broader, more integrative perspective in the design of weight control interventions. First, strengthening grit as an individual trait should not be assumed sufficient to improve adherence; it must be complemented with external strategies that structure the participant's environment. This includes providing frequent, personalised feedback from the trainer or nutritionist, setting progressive and attainable goals, and building a social support network within the programme or instance, through group sessions or peer mentoring systems. Second, professionals should pay deliberate attention to fostering autonomous motivation, using strategies such as motivational interviewing, validating patient preferences in activity choice, and promoting self-regulation. Third, incorporating technological tools (self-monitoring apps, reminders, supportive messaging) can offset the lack of continuous supervision and facilitate habit consolidation. Finally, assessing participants' baseline psychological profile (including grit, motivation, and self-efficacy) at the start of programmes is recommended in order to identify those at higher risk of dropout and offer them differentiated support. Taken together, these recommendations point toward moving from an exclusively individual-centred approach to a model that integrates internal grit development with an external environment that sustains it, thereby maximising the likelihood of long-term adherence.

The main limitations of this study include, first, the small sample size, which reduces statistical power and limits the detection of small-to-moderate intervention effects. In addition, the sample included a wide age range and heterogeneous baseline physical activity levels, which may have influenced participants' responses and attenuated grit-specific effects. For this reason, a power sensitivity analysis was carried out, which revealed that the study was primarily capable of detecting effects of moderate magnitude or greater, whilst small effects may not have been detected. Although general reasons for dropout were identified, the attrition rate was high, which may have affected the precision of the estimates and reduced the study’s ability to detect small or moderate effects. Another important limitation is that the intervention focused exclusively on internal grit development, without incorporating the external-development components described by Duckworth (2016), such as personalised support, ongoing feedback, mentors, or a structured environment that reinforces perseverance. Moreover, the use of multiple instruments and outcomes may have contributed to participant burden and fatigue, potentially compromising response quality, particularly across repeated assessments. Another point is that the lack of duplicate anthropometric measurements limited the ability to calculate the technical measurement error or the sample-specific intra-rater coefficient of variation. However, as mentioned above, an ISAK Level 1 anthropometrist was present for the assessments.

Building on these limitations, future research should consider interventions that integrate both internal and external grit development, including behavioural support strategies, frequent supervision, ongoing nutritional guidance, and the creation of a programme culture that reinforces perseverance. Longer, progressive, and more structured interventions are also recommended, supported by technological tools that facilitate adherence, such as mobile applications, self-monitoring systems, or digital feedback. It may also be advantageous to recruit participants in inactive or early stages of change in order to more clearly observe behavioural transitions attributable to the intervention. Finally, standardising adherence criteria and reducing the number of instruments could improve data quality and facilitate comparisons across future studies.

Conclusions

The present study found no significant effects of grit on adherence, or on psychological or anthropometric changes, within a six-month weight-management programme. Grit levels remained stable across the intervention and did not translate into improved adherence to exercise or dietary prescriptions, nor did they enhance autonomous motivation, suggesting that internal grit development alone may be insufficient to modify health behaviours. The lack of impact may be related to the absence of external development components (e.g., personalised support, ongoing feedback, or a structured environment), which, as proposed in the literature, are necessary to strengthen perseverance towards long-term goals. Taken together, these findings indicate that grit, when applied in isolation, may have limited effect on weight-management programmes and underscore the need to integrate external support strategies (including the active promotion of autonomous motivation) to enhance adherence and facilitate sustained changes in health-related habits.

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Authors' and translators' details:

Alex Andrés Zárate-López	alex.zaratel@uanl.edu.mx	Author
José Raúl Hoyos-Flores	jose.hoyosfl@uanl.edu.mx	Author
Manuel Francisco De La Cruz-Ortega	manueldelacruz@ues.mx	Author
Silvia Carolina Medrano-Mena	silvia.medranomn@uanl.edu.mx	Author
Kathryn Valenzuela-Mendoza	kathryn.valenzuela@ues.mx	Author
Jorge Zamarripa	jorge.zamarriparv@uanl.edu.mx	Author
Sofia Magdalena Santos Hernández	sofia.santoshr@uanl.edu.mx	Translator