Do young adult males aiming to improve strength or develop muscle hypertrophy train according to the current strength and conditioning recommendations?

¿Entrenan los hombres adultos jóvenes que buscan mejorar su fuerza o desarrollar hipertrofia muscular de acuerdo con las actuales recomendaciones para el entrenamiento de fuerza?

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Abstract. Objective: The present study aimed to verify if young adult males who aimed to improve their strength or attain muscle hypertrophy trained in agreement with the current strength and conditioning guidelines. Methods: Four hundred and fourteen subjects aged 18-25 with less than one year of strength training experience and whose training goal was to increase their strength or develop muscle hypertrophy were finally included in this research. They were surveyed through an 18-item self-administered questionnaire to verify whether their strength training practices met the current strength training guidelines. Results: Overall, more than 50% of the respondents did not follow the current strength and conditioning recommendations related to muscle action, number of sets, training structure, type of resistance, training to failure, and training supervision. Only slightly more than 50% of them did not train in agreement with the recommendations regarding exercise selection, number of repetitions, and weekly training frequency. The level of compliance with the training objectives of the respondents who followed the current strength and conditioning guidelines related to exercise selection, rest, speed, type of resistance, and training supervision was higher than specific cohorts who did not. Conclusion: Training in agreement with the current strength and conditioning guidelines would ensure that young adult males with less than one year of strength training experience attain their training objectives to a greater extend. Subjects who practice strength training should follow those strength and conditioning guidelines to avoid limiting future adaptations and increase the variability of their training programs, thus preventing workout plateau and fostering motivation.

Key words: Resistance training variables, strength and conditioning guidelines, training objectives.

Resumen. Objetivo:El propósito del estudio fue verificar si adultos jóvenes de sexo masculino cuyo objetivo era mejorar su fuerza o la hipertrofia muscular entrenaban de acuerdo con las actuales recomendaciones para el entrenamiento de fuerza. Métodos: Un total de 414 hombres con edades comprendidas entre los 18 y 25 años con menos de un año de experiencia en entrenamientos de fuerza fueron finalmente incluidos en el estudio. Fueron encuestados a través de un cuestionario autoadministrado de 18 ítems para verificar si sus entrenamientos de fuerza cumplían con las recomendaciones actuales en el desarrollo de esta capacidad. Resultados: Más del 50% de los encuestados no entrenaba de acuerdo con las recomendaciones actuales de fuerza relativas al tipo de acción muscular, número de series, estructura del entrenamiento, tipo de resistencia, carácter del esfuerzo y supervisión del entrenamiento. Apenas la mitad de los sujetos respetaron las recomendaciones relativas a la selección de ejercicios, número de repeticiones y frecuencia semanal de entrenamiento. El nivel de cumplimiento con los objetivos de entrenamiento fue más elevado entre los encuestados que siguieron las recomendaciones actuales de fuerza relativas a selección de ejercicios, descanso, velocidad de ejecución, tipo de resistencia y supervisión del entrenamiento. Conclusión: Entrenar de acuerdo a las actuales recomendaciones de entrenamiento de fuerza permitiría un mayor cumplimiento de los objetivos de los encuestados. Los trabajos de fuerza deberían realizarse de acuerdo con las actuales recomendaciones para evitar así el agotamiento prematuro de la reserva de adaptación, aumentar la variabilidad del entrenamiento, evitar estancamientos y fomentar la motivación.

Palabras clave: Variables del entrenamiento de fuerza, directrices para el entrenamiento de fuerza, objetivos del entrenamiento.

Introduction

The popularity of resistance training has increased in recent years (de la Cámara et al., 2020; de Salles et al., 2019; Gómez Chávez et al., 2022; Veiga Núñez et al., 2019; Campos et al., 2021). Resistance training is defined as the type of exercise that requires the body's musculature to move (or attempt to move) against an opposite force usually presented by some kind of equipment (Fleck, 2014, p. 1). The regular practice of resistance training has been shown to improve motor and sports performance, self-image, health conditions, quality of life, and prevent diseases and pathologies (Copeland et al., 2019; Larsen et al., 2021). The entire population can benefit from those improvements. From youth to elders, male and female, from professional athletes to people with disabilities, everyone should practice strength training (Fisher et al, 2011). To attain the benefits derived from the practice of resistance training, recent studies have tried to synthesize the conditions under which the strength training activities

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must be performed to be effective and safe for different groups of population (i.e., young adults, elderly, children) (American College of Sports Medicine, 2009; Fisher et al., 2011; Fragala et al., 2019; Zwolski et al., 2017). That is to say, experts have tried to translate complex scientific information into practical guidelines adapted to the context in which the physical exercise is performed, to be used by the different professionals involved in strength training such as athletes, physical trainers, coaches, physical education teachers, physicians, or physiotherapists (Bartlett & Drust, 2021).

However, this task is not easy since sport evolves rapidly, and it is a heterogeneous and complex phenomenon. Therefore, some obstacles hinder scientific dissemination (Bartlett & Drust, 2021). In addition, the practice of physical exercise in general and strength training in particular have traditionally stood away from scientific knowledge due to factors such as institutional marginality, empiricism prevalence, and lack of definition of the object of study (Oña, 2002). Often, strength training practices are based on false beliefs, fads, or passionate philosophies that endure over time, and are not consistent with the current scientific evidence. These false beliefs lead athletes to engage in physical exercise that is potentially risky for their health (Bollado-Esteban, 2014; López-Miñarro, 2002). At this point, it is important to note that strength training is only effective and safe and allows athletes to achieve their goals when the strength exercises′ technique is performed with the correct form, when the training loads are properly organized and adapted to athletes′ abilities and characteristics (Faigenbaum &Myer, 2012).

Currently, it is not clear that the subjects who practice strength training comply with the current strength and conditioning guidelines. Hence, it must be verified whether the training parameters used in strength training programs are consistent with the scientific evidence. However, no previous research has analyzed this matter. Therefore, studies investigating the compliance with the current strength and conditioning guidelines are warranted, and could be particularly useful in countries where the number of people practicing physical exercise has been growing in recent years. Such is the case in Saudi Arabia, where the public authorities —in accordance with its 2030 vision and mission— are promoting the practice of physical exercise to improve the health conditions of the population (Vision 2030. Kingdom of Saudi Arabia, 2030). This requires the athletic activities to be performed under conditions that guarantee the safety and efficacy of the training programs. In this context, the purpose of this study was to verify whether the strength and muscle hypertrophy training programs performed by young adult males with less than one year of strength training experience are in line with the American College of Sports Medicine guidelines to develop strength and muscle hypertrophy.

Methods and materials

A descriptive comparative cross-sectional study was conducted.

Subjects

A total of 630 subjects participated initially in the present study. Two hundred and sixteen were excluded based on their training objective. Thus, 414 subjects [age 20.81(1.66); height: 176.32(7.46) cm; body mass: 79.00 (17.32) kg; body mass index (BMI): 25.40 (5.55)] were finally included. All of them aimed to improve their strength levels or develop muscle hypertrophy. The inclusion criteria were the following: a) Male; b) Aged between 18-25; c) Do not suffer any injury or disease incompatible with the practice of strength training; d) Non-smoker; e) Perform strength training exercise in one fitness center; f) Have a strength training experience of more than two months but less than one year; g) Perform strength training exercise to improve strength or develop muscle hypertrophy. Only males participated in the current study since both men and women train in separate-gender gyms and fitness centers, and it was not possible to access women-only gyms and fitness centers. Similarly, subjects whose objective was to improve power, muscular endurance, or motor performance were not included because sports-specific training is required to develop these types of strength, and the adaptations attained have a low residual effect (Navarro et al, 2010). This circumstance makes it difficult to compare the training parameters required to develop these types of strength with the current scientific recommendations established by international strength and conditioning organizations of recognized prestige. Study participants received complete information about the objectives, benefits, and inconveniences of participating in this research. In addition, all of them signed an informed consent indicating their willingness to participate in it. The present study was conducted according to the principles set out in the Helsinki Declaration, and it was also approved by the Institutional Review Board of the Bioethics Committee at Prince Sultan University (Riyadh, Saudi Arabia) (approval no. PSU IRB-2021-03-0078).

Preparation of the questionnaire

A self-administered questionnaire composed of open and closed questions was used. It was made up of 18 items grouped into two categories. Four items were related to personal data and 14 to strength training (see table 1).

Table 1
Items included in the questionnaire used to collect the data

Category	Items included
Personal data	■Sex ■Age ■Height ■Weight
Strength training-related aspects	■Years of strength training experience ■Objective ■Muscle action ■Exercise selection ■Exercise order (sequencing) ■Number of sets ■Number of repetitions ■Rest between sets ■Repetitions leading to failure ■Weekly training frequency ■Workout structure ■Type of resistance ■Training supervision ■Level of compliance with participants' objectives

Questionnaire items were drafted clearly, simply, and precisely to guarantee ease of understanding. Since the item level of compliance with participants' objectives is a non-quantitative variable, an ordinal scale ranging from 1 to 5 was used to register this parameter, where 1 refers to non-compliance and 5 to full-compliance. The questionnaire was created after undergoing a validation process in which its validity and reliability were assessed. Once the study's objectives were defined, the five leading researchers (experts in strength and conditioning training) listed and rated the items to be included in the study from 0 to 10. Subsequently, the Item-Level Content Validity Index (I-CVI) was estimated using this formula (Yusoff, 2019):

$$(I\text{-}CVI) = (Ne) / (Nt)$$

being I-CVI: content validity index; Ne: number of experts who qualified as "very relevant"; Nt: the total number of experts. Only those items with a score higher than 0.8 were finally included. The reliability of the questionnaire was also assessed using Cronbach's alpha. For this purpose, a pre-trial was conducted. Fifty subjects were asked to fill out the questionnaire. Next, the Cronbach alpha was calculated for the quantitative variables considering each item's variances and the total variance (González-Alonso & Santacruz, 2015). The value obtained was = 0.82, which indicates that the internal consistency is good.

Data collection

Data collection was carried out between April 1 and 15 December 2021 in Riyadh (Saudi Arabia) using stratified random sampling. Since the city of Riyadh is composed of 15 districts, the questionnaire was applied in one fitness center in each of the 15 districts. Therefore, the total number of centers participating in the study was 15. The inclusion of the main fitness chains present in the city was also guaranteed. The data collection was carried out personally by the five main researchers of the present study. Thus, the 18 items included in the questionnaire were explained in detail to the respondents, and all doubts were clarified while filling out the questionnaire. The digital support used for data collection was Google forms. Regarding the number of participants required, the sample size was estimated with the following formula (Naing et al., 2006):

$$n = Z2p \times qN / e2 (N - 1) + Z2p \times q$$

where n = sample size, N = population size, Z = confidence level, p = probability of success, q = probability of failure, e = confidence interval. The confidence level was set at 95%, the confidence interval at 5%, and the probability of success at 50%. Since Riyadh's population in 2021 was 7,338,000 (Macrotrends. Riyadh, Saudi Arabia Metro Area Population), it was determined that the minimum number of individuals required to have a representative sample of the studied population was 385. Once the data collection process was completed, the researchers met to verify if the information gathered was flagged or incomplete and subsequently, amend possible errors before sending the data for statistical analysis. In any case, the incomplete presentation of the questionnaire was largely prevented by the functionality of Google forms since it does not allow the presentation of partially answered or incomplete questions in closed questions. Thus, once it was verified that the number of subjects whose training objective was to improve their strength or achieve hypertrophy was higher than 400, the data collection process was concluded.

Statistical analysis

Results are presented as mean (SD). The normality of the data was assessed using the Kolmogorov–Smirnov test and the homoscedasticity with Levene's tests, respectively. Comparisons between two conditions or cohorts were made using the Student's t-test for independent samples. The one-way ANOVA with Tukey's post hoc test was conducted to compare more than two cohorts or conditions. The effect size (ES) was estimated using the eta square (η^2) parameter. The ES was interpreted as follows: 0.2 small effect, 0.5 moderate effect, and 0.8 large effect (Cohen, 1988). The significance level was set at $p < 0.05$. All statistical analysis was performed using SPSS, version 26 (Chicago, IL, USA).

Results

Of the 630 subjects initially surveyed, 35.07% (n=221) stated that their objective was to increase their strength levels, 30.63% (n=193) muscle hypertrophy, 21.90% (n=138) muscular endurance, 7.61% (n=48) motor performance, and 1.90% (n=12) power. In addition, 2.86% (n=18) declared that their objective differed from those five mentioned above (see table 2).

Subjects whose objective was strength training

The training parameters used by the cohort of subjects whose objective was to increase their strength are shown in table 2. The results are presented in parallel with the recommendations established by the American College of Sports Medicine (ACSM) in each of the parameters analyzed (American College of Sports Medicine, 2009). Amongst these results it is remarkable that none of the subjects declared to perform multi-joint exercises before single-joint exercises or higher-intensity before lower-intensity exercises. It is also noteworthy that 37.10% of these subjects perform more than 12 repetitions, and more than half of them perform repetitions to failure. Moreover, it is noticeable that only one third of this cohort use full-body routines, and also a third of them their training was never supervised.

The subjects whose objective was to improve their strength were divided into subgroups or cohorts according to their strategy to apply each training parameter (i.e., number of sets, number of repetitions). Then, comparisons between cohorts were established considering the level of compliance of participants′ objectives (LCO) indicated by the subjects assigned to each cohort (see table 3). Thus, the one-way ANOVA revealed the existence of a main effect of the following variables: Exercise selection ($p < 0.001$; ES=0.21), exercise order ($p = 0.005$; ES = 0.36), repetitions ($p < 0.001$; ES = 0.54), workout structure ($p < 0.001$; ES = 0.67), type of resistance ($p < 0.001$; ES = 0.41), and training supervision ($p < 0.001$; ES = 0.43). The subsequent Tukey analysis showed that the LCO was significantly higher in the subjects who used single- and multiple-joint exercises ($p = 0.003$) and multiple-joint exercises only ($p = 0.032$) than the LCO of those who used single-joint exercises only. The LCO was also higher in the individuals who stimulated large muscle groups before small muscle groups ($p <0.001$) and rotated upper and lower body exercises ($p <0.001$) than the LCO of those who used an opposing exercises sequence (agonist-antagonist). The LCO of the participants who performed more than 12 repetitions per exercise was significantly lower than the LCO of those who performed 8-12 repetitions ($p = 0.027$) and less than eight repetitions ($p <0.001$). Regarding the

Table 2
American College of Sports Medicine recommendations to enhance strength (American College of Sports Medicine, 2009) and training practices of the subjects whose objective was to improve their strength

	ACSM recommendations for strength training	Respondents′ practices
Muscle action	Concentric, eccentric and isometric	Concentric and eccentric only: 55.65%; n=123 Concentric, eccentric and isometric: 44.34%; n=98
Exercise selection	Single- and multiple-joint exercises with emphasis on multiple-joint	Single-joint exercises: 19.45%; n=43 Multiple-joint exercises: 28.85%; n=64 Single- and multiple-joint exercises: 51.58%; n=114
Exercise order (sequencing)	Large muscle group exercises before small muscle group exercises, multiple-joint exercises before single-joint exercises, higher-intensity exercises before lower-intensity exercises, or rotation of upper and lower body or opposing exercises	Large muscle group exercises before small muscle group exercises: 50.22%; n=111 Multiple-joint exercises before single-joint exercises: 0%; n=0 Higher-intensity exercises before lower-intensity exercises: 0%; n=0 Rotation of upper and lower body: 27.60%; n=61 Opposing exercises 22.17%; n=49
Sets	1-3	1-3 sets: 33.48%; n=74 More than 3 sets: 66.52%; n=147
Repetitions	8-12	Less than 8 repetitions: 11.31%; n=25 Between 8-12 repetitions: 51.58%; n=114 More than 12 repetitions: 37.10%; n=82
Rest	At least 2–3 minutes be used for core exercises using heavier loads. For assistance exercises, 1–2 minutes may suffice	Less than 1 minute: 19.45%; n=43 1-3 minute: 80.54%; n=178
Repetition to failure	Not specified for young adults	No: 47.06%; n=104 Yes: 52.94%, n=117
Frequency (weekly)	2–3 days	Once a week: 1.36%, n=3 2-3 times a week: 53.39 n=118 4-7 times a week: 46.15%, n=102
Workout structure	Full-body	Full-body routine: 33.48; n=74 Upper- lower-body routines: 27.60%; n=61 Split-body routine: 36.65%; n=86
Type of resistance	Free-weights and machine exercises	Bodyweight training: 15.38%; n=34 Free-weights and machine exercises: 8.14%; n=18 Free-weights: 48.41%; n=107 Machine exercises: 28.05%; n=62
Training supervised by one expert	Yes	Yes: 38.91%; n=86 No: 33.48%; n=74 Sometimes: 27.60%; n=61
Compliance of participants' objectives	N/A	Non-compliance: 2.71%; n=6 Partial compliance: 37.55%; n=83 Total compliance: 59.72%; n=132

Legend: N/A: not applicable.

workout structure, the LCO was significantly higher in the interviewees who used full-body routines compared to those who utilized upper-lower-body routines ($p < 0.006$) and also in those who used split-body routines ($p < 0.001$). As for the type of resistance, the LCO of subjects who used free weights and machines was significantly higher than the LCO of those who used bodyweight training ($p < 0.001$). Finally, the LCO of the respondents whose training practices were supervised by a qualified coach was significantly higher than the LCO of those whose training sessions were supervised only sometimes ($p < 0.001$).

Moreover, the Student's t-test revealed that the subjects who performed more than three sets presented a LCO significantly higher than those who performed between one and three sets ($p < 0.001$; ES = 0.972). The LCO of the respondents who rested between one and three minutes was significantly higher than the LCO of those who rested less than one minute ($p = 0.009$; ES=0.89). Finally, the interviewees who did not perform repetitions leading to failure reported a LCO significantly higher than those who performed repetitions to failure ($p = 0.032$; ES= 0.74). No significant differences in the LCO were observed between the subjects who included concentric and eccentric muscle actions in their training sessions only and those who performed concentric, eccentric, and isometric muscle actions. Nor were there significant differences in the LCO between the subjects who practiced strength training two or three times a week and those who trained between four and seven times a week. In this regard, it must be noted that no comparisons were made between these two subgroups and the subjects who trained only once a week. The reason is that only three respondents declared to exercise once a week.

Subjects whose objective was hypertrophy

The training parameters used by the cohort of subjects whose objective was to attain muscle hypertrophy are shown in table 4. The results are presented in parallel with the recommendations established by the ACSM in each of the variables analyzed. Amongst these results it is remarkable that none of the subjects declared to perform multi-joint exercises before single-joint exercises or higher-intensity before lower-intensity exercises. It is also noteworthy that 39.38% of these subjects perform more than 12 repetitions, only 21.24% use full-body routines, and 30.05% never train under supervision.

Table 3
Level of compliance of participants' objectives (subjects whose objective was to improve their strength)

Parameter	Strategy implemented	Level of compliance
Muscle action	Concentric and eccentric only	3.10(1.10)
	Concentric, eccentric and isometric	3.19(1.12)
Exercise selection	Single-joint exercises	3.00(1.30)
	Multiple-joint exercises	3.14(1.19)
	Single- and multiple-joint exercises	3.19(0.99)
Exercise order (sequencing)	Large muscle group exercises before small muscle group exercises	3.22(0.98)
	Multiple-joint exercises before single-joint exercises	N/A
	Higher-intensity exercises before lower-intensity exercises	N/A
	Rotation of upper and lower body	3.20(1.19)
	Opposing exercises	2.88(1.26)
Sets	1-3 sets	2.83(0.96)
	More than 3 sets	3.33(0.60)
Repetitions	Less than 8 repetitions	3.50(0.92)
	Between 8-12 repetitions	3.31(0.96)
	More than 12 repetitions	2.82(1.24)
Rest	Less than 1 minute	2.86(0.68)
	1-3 minutes	3.20(0.56)
Repetition to failure	No: 47.06%; n=104	3.21(0.72)
	Yes: 52.94%, n=117	3.04(0.76)
Frequency (weekly)	Once a week	2.99(0.72)
	2-3 times a week	3.28(0.76)
	4-7 times a week	3.29(1.03)
Workout structure	Full-body routine	3.59(0.82)
	Upper- lower-body routines	3.01(1.18)
	Split-body routine	2.92(1.15)
Type of resistance	Bodyweight training	2.99 (1.12)
	Free-weights and machine exercises	3.54 (0.82)
	Free-weights	3.18 (0.99)
	Machine exercises	3.08 (1.36)
Training supervised by an expert	Yes: 38.91%; n=86	3.42 (1.07)
	No: 33.48%; n=74	2.82 (1.16)
	Sometimes: 27.60%; n=61	3.10 (1.02)

Legend: N/A: not applicable.

Table 4
American College of Sports Medicine recommendations to develop muscle hypertrophy (American College of Sports Medicine, 2009) and training practices of the subjects whose objective was to develop hypertrophy

	ACSM recommendations for hypertrophy	Respondents' practices
Muscle action	Concentric, eccentric and isometric	Concentric and isometric only: 54.40%; n=105 Concentric, eccentric and isometric: 45.59%; n=88
Exercise selection	Single- and multiple-joint exercises	Single 11.92%; n=23 Multiple 27.46%; n=53 Single and multiple 60.62%; n=117
Exercise order (sequencing)	Large muscle group exercises before small muscle group exercises, multiple-joint exercises before single-joint exercises, higher-intensity exercises before lower-intensity exercises, or rotation of upper and lower body or opposing exercises	Large muscle group exercises before small muscle group exercises: 57.51%; n=111 Multiple-joint exercises before single-joint exercises: 0%; n=0 Higher-intensity exercises before lower-intensity exercises: 0%; n=0 Rotation of upper and lower body: 27.46%; n=53 Opposing exercises 15.03%; n=29
Sets	1-3	1-3 sets: 33.16%; n=64 More than 3 sets: 66.83; n=129
Repetitions	8-12	Less than 8 repetitions: 6.21%; n=12 Between 8-12 repetitions: 54.40%; n=105 More than 12 repetitions: 39.38%; n=76
Rest	1-2 minutes	Less than 1 minute: 21.24%; n=41 1-2 minutes: 72.53%; n=140 More than 2 minutes: 6.22%; n=12
Repetition to failure	Not specified for young adults	No: 57.51%; n=111 Yes: 42.49%, n=82
Frequency (weekly)	2-3 days	Once a week: 0%, n=0 2-3 times a week: 27.46; n=53 4-7 times a week: 72.54%, n=140
Workout structure	Total-body	Full-body routine: 21.24%; n=41 Upper- lower-body routines: 30.05%; n=58 Split-body routine: 48.70%; n=94
Type of resistance	Free-weight and machine exercises	Bodyweight training: 6.22%; n=12 Free-weights and machine exercises: 5.70%; n=11 Free-weights: 34.71%; n=67 Machine exercises: 53.37%; n=103
Training supervised by an expert	Yes	Yes: 37.79%; n=71 No: 30.05%; n=58 Sometimes: 33.16%; n=64
Fulfillment of participants' goals	N/A	Non-compliance: 0%; n=0 Partial compliance: 45.07%; n=87 Total compliance: 54.92%; n=106

Legend: N/A: not applicable.

The subjects whose objective was to attain hypertrophy were divided into subgroups or cohorts according to their strategy to apply each training parameter. Then, comparisons between cohorts were established considering the LCO indicated by the subjects assigned to each cohort (see table 5). Thus, the one-way ANOVA revealed the existence of a main effect of the following variables: Exercise selection ($p = 0.027$; ES=0.51), exercise order ($p < 0.001$; ES = 0.83), repetitions ($p < 0.032$; ES = 0.26), rest ($p < 0.038$; ES = 0.31), type of resistance ($p < 0.008$; ES = 0.21), and training supervised by an expert ($p < 0.031$; ES = 0.41). The post hoc Tukey's test showed that the LCO was significantly higher in the subjects who used single- and multiple-joint exercises ($p = 0.014$) and multiple-joint exercises only ($p = 0.029$) compared to the LCO of those who used single-joint exercises only. The LCO was also higher in the individuals who stimulated large muscle groups before small muscle groups ($p <0.001$) and rotated upper and lower body exercises ($p <0.001$) compared to the LCO of those who used an opposing exercises sequence (agonist/antagonist). The LCO of the participants who performed more than 12 repetitions per set was significantly lower than the LCO of those who performed 8-12 repetitions ($p = 0.036$) and less than eight repetitions ($p <0.001$). As for the rest between sets, the LCO was significantly higher in the interviewees who rested between one and two minutes ($p <0.001$) and more than two minutes ($p <0.004$) compared to the LCO of those who rested less than one minute. Regarding the type of resistance, the LCO of subjects who used free weights was significantly higher than the LCO of those who used bodyweight training ($p <0.003$). Finally, the LCO of respondents whose training was supervised by a qualified coach was significantly higher than the LCO of those whose training was not supervised ($p <0.001$) and also than the LCO of those who affirmed that their training was supervised only sometimes.

Furthermore, the Student's t-test revealed that the LCO of the subjects who included in their training sessions concentric, eccentric, and isometric muscle actions was significantly higher than the LCO of those who performed only concentric and eccentric muscle actions ($p = 0.04$; ES=0.79). The subjects who performed more than three sets presented a LCO significantly higher than those who

performed between one and three sets ($p < 0.004$; ES = 0.77). Finally, the interviewees who did not perform repetitions leading to failure reported a LCO significantly higher than those who performed repetitions to failure ($p = 0.025$; ES= 0.81). No significant differences in the LCO were observed between the subjects who practiced strength training two or three times a week and those who trained between four and seven days a week, and between the individuals who used full-body, split-body, or upper-lower-body routines.

Discussion

The purpose of the present study was to verify whether the strength and muscle hypertrophy training programs performed by young adult males with less than one year of strength training experience meet the ACSM guidelines to develop strength and muscle hypertrophy. Considering the study results, two-thirds of the study participants aimed to increase their strength levels or acquire muscular hypertrophy. One-fifth of the subjects trained to improve their muscular endurance, and less than 10% of the respondents declared to practice strength training to improve their motor performance or power. Therefore, fitness coaches must know precisely the recommendations set by strength and conditioning experts to improve strength and develop muscle hypertrophy. We understand that acquiring this knowledge is not particularly difficult since those recommendations are general and valid for all novice involved in strength training. However, strength training programs designed to improve muscular endurance, power, and motor performance require a greater and deeper knowledge of sports sciences since sports-specific training methods must be implemented.

As for the subjects who declared that their objective was to improve their strength, most used appropriate rest periods. However, more than 50% of them did not follow the strength and conditioning recommendations while implementing the following parameters: Muscle action, number of sets, training to failure, workout structure, type of resistance, and training supervision. Almost half of them did not follow the established recommendations regarding exercise selection, number of repetitions, and weekly training frequency. In addition, none of the respondents sequenced their training sessions performing multiple-joint exercises before single-joint exercises or higher-intensity exercises before lower-intensity exercises.

The degree of compliance with the strength and conditioning recommendations of the respondents whose objective was muscle hypertrophy was very similar.

Table 5
Level of compliance of participants' objectives (subjects whose objective was to achieve muscle hypertrophy)

Parameter	Strategy implemented	Level of compliance
Muscle action	Concentric and eccentric only: 54.40%	2.93(0.96)
	Concentric, eccentric and isometric: 45.59%	3.37(0.98)
Exercise selection	Single 11.92%; n=23	2.50(1.00)
	Multiple 27.46%; n=53	3.11(1.05)
	Single and multiple 60.62%; n=117	3.20(1.01)
Exercise order (sequencing)	Large muscle group exercises before small muscle group exercises: 57.51%; n=111	2.84(1.02)
	Multiple-joint exercises before single-joint exercises: 0%; n=0	N/A
	Higher-intensity exercises before lower-intensity exercises: 0%; n=0	N/A
	Rotation of upper and lower body: 27.46%; n=53	3.78(0.67)
	Opposing exercises 15.03%; n=29	2.80(1.09)
Sets	1-3 sets: 33.16%; n=64	2.91(0.64)
	More than 1-3 sets: 66.83; n=129	3.18(0.88)
Repetitions	Less than 8 repetitions: 6.21%; n=12	3.29(1.01)
	Between 8-12 repetitions: 54.40%; n=105	3.16(1.03)
	More than 12 repetitions: 39.38%; n=76	2.96(1.16)
Rest	Less than 1 minutes: 21.24%; n=41	2.57(0.98)
	1-2 minutes: 72.53%; n=140	3.28(0.98)
	More than 2 minutes: 6.22%; n=12	3.03(1.16)
Repetition to failure	No: 57.51%; n=111	3.22(1.08)
	Yes: 42.49%, n=82	2.91(0.96)
Frequency (weekly)	2-3 times a week: 27.46; n=53	3.11(0.70)
	4-7 times a week: 72.54%, n=140	3.08(0.84)
Workout structure	Full-body routine: 21.24%; n=41	3.14(0.80)
	Upper- lower-body routines: 30.05%; n=58	3.08(0.76)
	Split-body routine: 48.70%; n=94	3.07(0.92)
Type of resistance	Bodyweight training: 6.22%; n=12	2.97(1.16)
	Free-weights and machine exercises: 5.70%; n=11	3.03(1.14)
	Free-weights: 34.71%; n=67	3.17(1.03)
	Machine exercises: 53.37%; n=103	3.06(1.03)
Training supervised by an expert	Yes: 37.79%; n=71	3.67(0.78)
	No: 30.05%; n=58	2.60(0.97)
	Sometimes: 33.16%; n=64	2.91(1.04)

Legend: N/A: not applicable.

Nevertheless, more than 50% of them did not follow the recent strength recommendations while selecting the following parameters: Muscle action, number of sets, weekly training frequency, workout structure, type of resistance, and training supervision. Likewise, almost half of them did not follow the current recommendations in applying the following parameters: Exercise selection, repetitions, and training to failure. Moreover, none of the respondents sequenced exercises using multiple-joint exercises before single-joint exercises or higher-intensity exercises before lower-intensity exercises.

Based on these results, we consider that if the individuals who practice strength training exercise follow the strength and conditioning recommendations, their LCO would be guaranteed to a greater extent, and their training practices would be more effective and safer. In this regard, it would be advisable to use isotonic actions and isometric contractions (Anwer & Alghadir, 2014; Millar et al., 2014). Apart from increasing the training variability, according to recent studies, isometric exercise could have a beneficial effect at circulatory, postural, and functional levels (Anwer & Alghadir, 2014; Millar et al., 2014). As for the sets and repetitions, exceeding the recommended number of sets per exercise or performing less than eight repetitions could not be effective in attaining additional improvements in novice aiming to improve their strength or obtain muscle hypertrophy. It could also cause overtraining, increase the risk of suffering sports injuries and prematurely reduce their adaptation reserve or room for improvement (Contreras et al., 2012; Egan & Zierath, 2013; González-Boto et al., 2006; Kreher & Schwartz, 2012; Navarro, 2004). Similarly, performing repetitions leading to failure (failure training) may induce comparable or even lower improvements in strength training (Vieira et al., 2021). On the contrary, performing more than 12 repetitions per set could impede the attainment of subjects' objectives because the training stimulus would be under the stimulation threshold (Schoenfeld, 2013).

Regarding the workout structure, most interviewees declared not to use full-body routines. However, novices should opt for full-body routines as they are more effective for hypertrophy and produce similar strength improvements to split-body and upper- lower-body routines (Schoenfeld, 2013; Prieto-González et al., 2020). Additionally, full-body routines have some advantages, including the possibility of exercising the same muscle groups with a higher weekly frequency and stimulating a greater number of muscle groups per session, which increases the release of anabolic hormones (Kraemer & Ratamess, 2005; Schoenfeld et al., 2015).

Moreover, free weights and machines generate similar strength and hypertrophy improvements for novice (Aerenhouts & D'Hondt, 2020). However, it is recommended that novice use both types of resistance to provide their training programs with greater variability. As for the supervision, it has been verified that supervised training is more effective, and what is more, the higher level of training of the coaches, the greater benefits are attained through the training process (Roos et al., 2015). Therefore, regardless of the training objective, subjects should perform strength training exercise under the supervision of one expert. Furthermore, when it comes to hiring fitness experts, education and training might prevail over other aspects such as work experience, personal skills, or personality. However, this is not happening in reality (Estrada-Marcén et al., 2019).

As for exercise selection, both multiple- and single-joint exercises improve strength and develop muscle hypertrophy (American College of Sports Medicine, 2009; Brigatto et al., 2020). However, multi-joint exercises produce greater muscle activation, metabolic stress, and better mimic daily tasks and sport-specific movement patterns (American College of Sports Medicine, 2009; Brigatto et al., 2020). Single-joint exercises are also useful because they reduce the technical and coordinative demands, target specific muscle groups, and are useful to correct muscle imbalances (American College of Sports Medicine, 2009; Brigatto et al., 2020). In addition, it should be taken into consideration that variations in body position or grip provide greater variability, and therefore, a higher number of motor patterns are developed. Consequently, novice should use both types of exercises (American College of Sports Medicine, 2009; Brigatto et al., 2020).

According to recent scientific evidence, the adequate weekly training frequency for novice is between two and three sessions per week to improve strength and develop hypertrophy. However, 72.54% of the respondents whose objective was hypertrophy claimed to train more than three times per week, which could not provide them with additional improvements (Brigatto et al., 2020; Schoenfeld at al., 2019; Schoenfeld et al., 2016). This could increase the risk of suffering injuries, cause excessive fatigue, trigger overtraining, stress, anxiety, and limit the possibilities of attaining future strength training adaptations (Contreras et al., 2012; Egan & Zierath, 2013; González-Boto et al., 2006; Kreher & Schwartz, 2012; Navarro, 2004).

As far as the exercise order is concerned, subjects should use the following five sequences: Large muscle group before small muscle group exercises, multiple-joint before single-joint exercises, higher-intensity before lower-intensity exercises, rotation of upper and lower body, and opposing exercises. This will provide the

training with variability. It could be also useful to avoid workout plateau and foster motivation towards strength training (Baz-Valle et al., 2019; Kraemer & Ratamess, 2004). The rest periods between sets used by most respondents are in agreement with the current strength and conditioning recommendations. However, it would be preferable that all of them follow the guidelines. In this regard, the scientific evidence suggests that three-minute rests could generate greater improvements when the objective is strength because it allows athletes to use greater intensity and volume (de Salles et al., 2009). Conversely, rest periods between 30 seconds and one minute would be more effective when the objective is muscle hypertrophy due to the greater growth hormone release (de Salles et al., 2009).

Moreover, do not exercising according to the current strength and conditioning recommendations could explain why only 55% of the subjects whose goal was hypertrophy and 60% of the subjects aiming to increase strength indicated that they did not fully achieve their objectives. In fact, there is a certain agreement between the LCO of the respondents and their level of compliance with the strength and conditioning recommendations. Thus, within the subjects whose objective was to improve strength, those who followed the recommendations in exercise selection, rest, workout structure, type of resistance, and training supervision had a significantly higher LCO than specific cohorts who did not. Regarding the number of sets and repetitions performed, the respondents who did not follow the recommendations and performed more than three sets or less than eight repetitions, presented a higher LCO than the interviewees who trained according to the recommendations. However, this could lead —as mentioned previously — to long-term problems such as overtraining, increased risk of injury, premature reduction of the reserve of adaptation, depression, and anxiety (Contreras et al., 2012; Egan & Zierath, 2013; González-Boto et al., 2006; Kreher & Schwartz, 2012; Navarro, 2004).

Similarly, within the respondents whose objective was muscle hypertrophy, a higher LCO was observed in those who followed the recommendations related to muscle action, exercise selection, repetitions leading to failure, rest, type of resistance, and training supervision. As for the sets and repetitions, the interviewees who performed more than four sets or less than eight repetitions presented a higher LCO than the subjects who trained according to the recommendations. However, this may generate the long-term problems previously mentioned (Contreras et al., 2012; Egan & Zierath, 2013; González-Boto et al., 2006; Kreher & Schwartz, 2012; Navarro, 2004).

The present study has certain limitations. Firstly, it was only verified if young male adults with less than one year of strength training experience whose objective was strength or hypertrophy train in accordance with the current strength and conditioning recommendations. Secondly, it was not possible to compare the present study results with previous research since no similar studies have been published. Therefore, future research should verify whether groups of subjects different than those included in this study (i.e., women, adolescents, elderly, athletes with more than one year of strength training experience) or individuals with different objectives (i.e., muscular endurance, power, sports performance) are training according to the current strength and conditioning guidelines. Future research might also ascertain why several subjects practice strength training without supervision, and why a significant part of those who train with supervision do not attain their goals and use training parameters that do not meet the current strength training guidelines.

Conclusion

Most novices involve in strength training aim to improve their strength, muscular endurance or develop muscle hypertrophy. Among those whose objective is strength, more than 50% do not follow the strength and conditioning recommendations related to muscle action, number of sets, training to failure, workout structure, type of resistance, or training supervision. Almost half of them do not follow the mentioned recommendations regarding exercise selection, number of repetitions, and weekly training frequency. Amongst the respondents who aim to develop muscle hypertrophy, more than 50% do not follow the strength and conditioning guidelines regarding muscle action, number of sets, weekly training frequency, workout structure, type of resistance, and training supervision. Almost half of them do not follow the established guidelines regarding exercise selection, number of repetitions, or training to failure. Moreover, a greater LCO is obtained when parameters such as exercise selection, rest, type of resistance, and training supervision meet the strength and conditioning recommendations. Therefore, the non-compliance of the strength and conditioning recommendations by both groups of subjects (individuals aiming to improve strength and develop hypertrophy) could hinder the attainment of their objectives. It could also trigger overtraining, injuries, stress, anxiety, and limit their future strength training adaptations. It also limits their training variability, which could decrease their motivation towards strength training and increase the possibilities of reaching workout plateau.

Practical applications

It is essential to improve the dissemination of scientific knowledge in the strength and conditioning field among coaches, physical trainers, fitness instructors, and personal trainers. It is also crucial to develop awareness among the entire population of the need to perform strength training under one qualified professional's supervision. In this way, strength training programs will be safer and more effective, and all individuals will have greater possibilities to attain their training goals.

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