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Research article

Comparing the impact of personal trainer guidance to exercising with others: Determining the optimal approach

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ABSTRACT

This study aimed to examine the effects of supervised fitness training under the guidance of a personal trainer and those of competitive fitness training with others and reveal the effects of specific differences between them in a detailed manner. The study's participants consisted of 66 healthy male adults (age: 29.2 ± 5.4 years). The participants were divided into three groups: the individual training group (n = 21), which served as the control group; the exercising with a partner group (n = 22); and the group trained by a personal trainer (n = 23). Each participant was subsequently assessed using one repetition maximum bench press, squats, skeletal muscle mass, fat mass, and a questionnaire regarding nutritional plan and injury to compare the effects of training sessions over a period of 12 weeks. Among the three groups, only the group trained by a personal trainer showed an obvious enhancement in fat reduction compared to baseline (-1.61 kg, $p = 0.033$), which was suggestive of a salient trend that far surpassed those of the individual training group and the exercising with a partner group. Regarding squats, only the group trained by a personal trainer showed a significant change compared to the individual training group ($p = 0.003$). Regarding the participants' consistent use of a nutritional plan, only the group trained by a personal trainer exhibited a palpable tendency ($p < 0.001$); furthermore, the effect of preventing injury in the group trained by a personal trainer was more notable than that in the individual training group and the exercising with a partner group. Our results indicate that a fitness personal trainer service is effective in expediting the process of achieving fitness goals in a relatively safe manner, thereby substantiating the diversified values of the fitness personal trainer service.

1. Introduction

The fitness industry has experienced rapid growth and development over the past decade [1]. An increasing number of people join fitness centers that cater to their fitness needs by providing them with training venues, fitness equipment, various fitness classes, and

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personal trainer (PT) services. Consequently, training in fitness centers has gained popularity [2,3].

Muscle building and weight loss are central to training mechanisms and contribute to a better physique [4]. Most fitness center members control their weight using a regimen that combines both methods [5]. Individual and training with partners are the most common methods used in fitness centers. Moreover, training under PT supervision is favored. In the Worldwide Survey of Fitness Trends for 2022, the top 20 prevailing fitness trends spanning diverse regions revealed that PT-supervised training held an esteemed position, ranking third in Europe, seventh in Australia, first in Brazil, and eighth in the United States, and demonstrating consistent and notable prominence across the international fitness landscape [6].

A PT can provide one-to-one services to fitness club members, specify a set of training programs according to their individual needs, and simultaneously provide guidance and supervision. Ratamess et al. (2008) reported that women who trained individually or with a PT were carefully instructed to self-select an intensity that was a mean 51.4 % in the PT group versus 42.3 % in the individual group during bench press, seated row, leg extension, and leg press exercises. The study also reported that resistance training under PT supervision led to self-selection of higher workout intensity and athletic performance [7]. When trained by a PT, members tend to voluntarily choose heavier weights than when training alone. This tendency has been attributed to the empowering effect of supervision, which stimulates and motivates individuals to exert greater effort at higher training intensities. This was confirmed in a recent study by Dias et al. (2017). Storer et al. (2014) reported a similar finding among fitness club members who exercised with a PT, as they achieved greater improvements in leg press strength and lean body mass. Leg press strength increased by 13 % in PT-supervised training versus individual training. Lean body mass increased by 1.3 kg during PT-supervised training versus no difference during individual training [8]. Melton et al. (2008) also observed fewer injuries during PT-supervised training [9]. Several previous studies indicated that assistance provided by a PT is more likely to help an individual complete their training and achieve their goals [10–12]. However, Kraemer and Ratamess (2004) indicated that supervised training can improve training quality and that a more targeted plan should enhance its efficiency [13]; however, the source of supervision was not identified. The fitness-related improvement in the members under PT guidance can be attributed to said supervision. However, PT guidance is not the sole approach; rather, two phenomena are progressively becoming more prevalent: some members attend fitness centers with friends as their partners, while others become acquaintances of individuals at the fitness center, leading to the establishment of training partnerships. The ubiquity of exercising with a partner have been realized to a certain extent. According to the social comparison theory, training with a partner is perceived as competition accompanied by supervision [14], which directly and positively impacts the partner since it increases enthusiasm and improves athletic performance [15,16]. Plante et al. (2010) reported that individuals who exercised with a highly fit partner exercised harder than those who exercised alone [17]. Studies have also shown that competitiveness can increase training intensity and that training with peers under the influence of competitiveness can enhance athletic performance [18,19]. Carnes (2014) also noted that exercising with a partner could enhance sports performance and extend training duration [20]. Training with a partner can elicit a sensation of exhilaration, which provides an impetus for staying motivated during training and is conducive to significantly enhanced athletic performance [21]. These findings indicate that training in a competitive environment is more effective than training in isolation.

The PT service provided by fitness centers incur an additional cost because trainers provide members with one-on-one fitness guidance services and scientific training programs. Nonetheless, training with an appropriate partner can achieve the dual effectiveness of supervision and competitiveness without such additional costs. The proportion of people who register for private training in fitness clubs is currently low, accounting for approximately 10 % of the total number of members [8,22]. Although a PT provides members with advantageous supervisory implementation during training, whereas training with a partner can assume equal supervisory weight [8,23]. Two approaches to enhancing training effectiveness have been examined: one involves implementing a scientific training plan under PT supervision, whereas the other entails training with a partner in a competitive and supervisory environment (EP). Previous studies consistently demonstrated the superiority of PT and EP over individual training. Furthermore, it is worth noting that both PT and EP have greater benefits than individual training. However, it is important to acknowledge that there is a gap in existing research regarding PT versus EP. Thus, the relative advantages of PT versus EP remain uncertain [7,8,17]. The emphasis of previous studies on PT-guided training has led to discrepancies in training intensity and athletic performance. Although most studies demonstrated that members who train with a PT tend to experience greater improvement than those who self-direct their own training, this finding does not preclude the possibility that the discrepancies in the results emanate from the supervisory component [24–26]. This is because resistance training under supervision may enhance one's motivation and enthusiasm about fitness, which does not strongly substantiate the PT's effect. Training guided by a PT versus with a partner implemented an identical training plan; however, the differences between them could not be determined. Moreover, the differences between training guided by a PT versus with a partner have not been clearly elucidated in published studies.

This study also examined two indispensable factors apart from training tasks: nutrition and injury. Nutritional supplements and appropriate nutrient proportions are conducive to improving athletic performance and aiding physical recovery [27]. Protein supplements play a pivotal role in muscle building [28]. Some problems arise owing to maladaptation during training [29]; these factors were not considered in previous studies. Nevertheless, they have both direct and indirect effects on fitness results. Additionally, whether these two factors, the same training program and training under supervision, play pivotal roles in PT-supervised success remains unknown.

Several studies reported that PT-guided training versus that with a partner are superior to individual training [8,30]. Nevertheless, to date, no study has compared and analyzed these two circumstances. Based on the prevalent trend and the ubiquity of fitness-related knowledge, it remains unclear whether PT-related training obtains the best fitness results. Therefore, further elucidation of the specific differences between PT-supervised training and the competitive supervision of partner training is required. Additionally, a questionnaire was distributed to all participants to learn about their injuries and dietary changes. The current study aimed to ascertain different health- and performance-related outcomes between PT-guided exercise and that with a partner and identify the effects of specific differences between them. Furthermore, we hypothesized that individuals exercising under PT guidance would perform better in terms of fat mass reduction than those exercising with partners.

2. Methods

2.1. Participants

This study was a randomized controlled trial. The study's participants consisted of 76 eligible male volunteers (aged 21–40 years) recruited from local fitness centers in Qingdao, China. Owing to differences in body composition and training patterns between men and women, only men were recruited in this experiment. Recruitment and testing were conducted with the assistance of club employees and PTs. The inclusion criteria were as follows: The inclusion criteria were as follows: (1) members who had consistently engaged in resistance training for at least 2 months without regular training partners or purchasing personal training courses; (2) individuals in good health without pulmonary, metabolic, or unstable cardiovascular disorders; and (3) participants who refrained from using drugs or supplements to enhance anabolic responses during training. Exclusion criteria included individuals with a body fat percentage exceeding 30 %, often indicative of obesity [11,25], on the grounds that an excessive amount of adipose tissue may engender imprecise estimations whilst endeavoring to gauge the decrement of body fat. The indicators used were one-repetition maximum, variations in muscle and fat mass, injuries, and diet. The participants were randomly divided into three groups: the individual training group (IT group), which included 25 participants; the exercise with a partner group (EP group), which included 26 participants; and the personal trainer group (PT group), which comprised 25 participants. In the EP group comprising 26 participants, based on baseline data and further interviews, every two individuals who were estimated to have approximately the same level of physical efficiency were matched; consequently, the group was divided into 13 pairs. Ten participants discontinued the study (four from the IT group, four from the EP group, and two from the PT group). Eventually, 66 healthy male adults (age: 29.2 ± 5.4 years) completed all training sessions prescribed in this study (Fig. 1). All study protocols were approved by the Liaoning Normal University Research Ethics Committee (IRB: LL2022020), and the study was conducted in accordance with the principles of the Declaration of Helsinki. Written informed consent was obtained from all participants apprised of the option to terminate their participation at any moment throughout the experiment.

2.2. Experimental design and approach to the problem

This study adopted an intervention mechanism in which the IT and EP groups employed the same training plan, whereas the PT group trained under PT guidance. To ensure the objectiveness of the training effect, all training groups were provided with the same training program (three training sessions per week for 12 weeks, twice a week for the upper limbs, once a week for the lower limbs, and 30 min of aerobic exercise after each resistance training session). To preclude differences in training programs, all training programs were considered, and the repetition, set, and sequence of movements were performed in accordance with the plan. The participants were requested to spare no effort in completing all training programs. Subsequent to the termination of each training session, the IT and EP groups reported to the PT the basic information about their daily training to ensure its effectiveness, while the PT directly recorded the training details of the PT group. Dietary recommendations and training injury prevention precautions were delineated for all participants before initiating the experiment. Before beginning the intervention, each participant was asked to record data from one

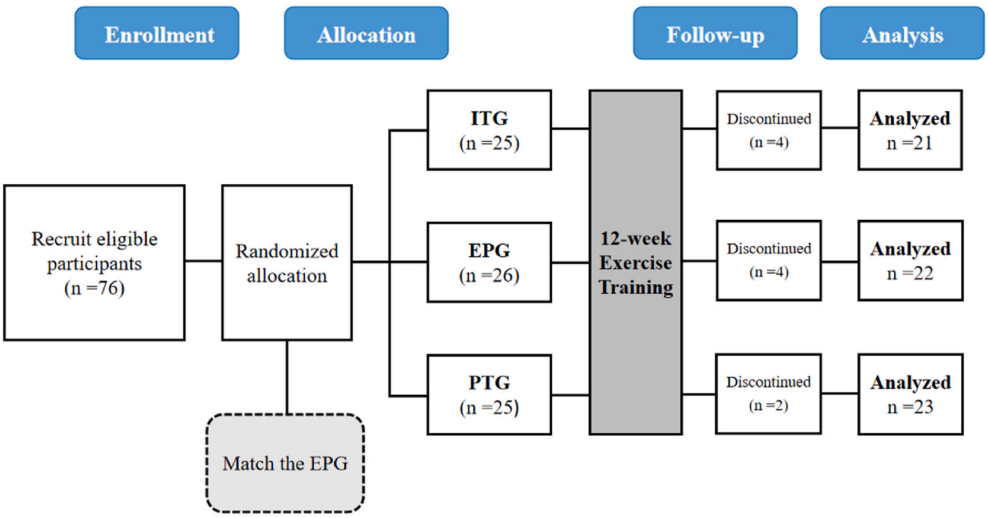


Fig. 1. Experimental flow diagram of study participants.

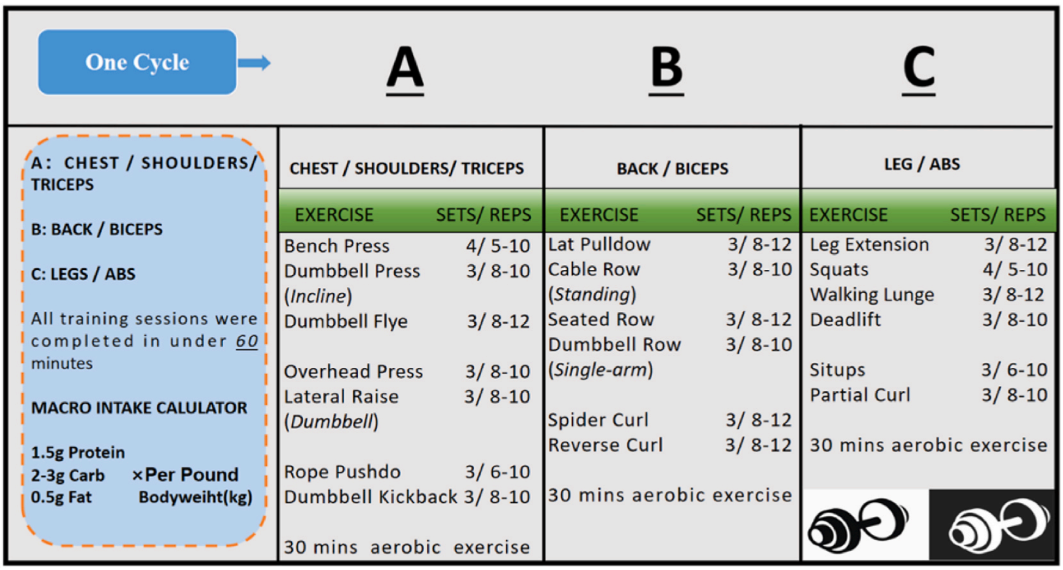
repetition maximum (1RM) bench press (BP) and squats. Body composition analyzers were also used to record information on body composition (muscle and fat mass). After the end of the intervention, all the aforementioned indicators were measured again. Each participant was subsequently assessed for 1RM (BP and squats), skeletal muscle mass, and fat mass to compare the effects of training; furthermore, a questionnaire was provided to the participants to examine their nutritional plans and injuries during training. The participants were asked about the occurrence of injuries and discomfort (deemed as inflammation and pain in muscles and joints due to training) and diet (their adherence to the nutritional plan) during the 12 weeks of training. The participants were trained in accordance with the recruitment sequence and PT schedule. The duration of this experiment was 3 months; hence, the participants were recruited and trained within 3 months (each participant was trained for 36 sessions over a period of 12 weeks).

2.3. Procedures and measures

All personal trainers in this study volunteered and possessed recognized PT certifications from the China Bodybuilding Association. Furthermore, they had previously passed the aptitude test and oral interview, and completed approximately 250 h of personal training courses in the fitness industry. All participants were requested to undergo the same training program (Fig. 2) to increase muscular strength and hypertrophy. The core of the training program was based on scientific development methods [31]. The training program consisted of two training sessions for the upper limbs and one training session for the lower limbs in one week. The designations of movements, sets, and repetitions were delineated during the training program. Aerobic exercises were performed in accordance with the American College of Sports Medicine guidelines, namely, three continuous steady-state endurance exercises per week, which can effectively reduce fat mass and control body weight [32]. The program implemented a specific heart rate target range, which was set at 55–65 % of an individual's maximum heart rate (HRmax = 220 - age) by using a treadmill at a slow speed and at an appropriate incline after a 5-min interval after each of three resistance training sessions [10,32]. Each participant was required to perform aerobic exercise for at least 30 min. Before beginning the intervention, all participants communicated with the trainers for 1 h to ensure that the entire training program was comprehensible to all three groups. Trainers also demonstrated the movements involved in the training program. All the training programs were designed to achieve muscle and weight control. Participants in the three groups were incentivized with a 4-month membership extension. All members arranged time for self-training after the task assignment. The training durations of all the groups were registered and recorded by the trainers, and the two participants in the EP group confirmed a mutually available training duration through consultation. Participants in the PT group made a telephone appointment before each training session after docking with the PT and subsequently confirmed the specific training time.

2.3.1. Muscle strength

The 1RM strength testing was performed using the standardized methods described in a previous study [33]. The participants were positioned on a Smith machine (LMCC LK-8831A, Likang, China) in the correct posture after a light warm-up and stretching exercises to perform 1RM testing for BP and squats [34]. The participants engaged in a preliminary warm-up protocol that consisted of two sets of eight repetitions using a lightweight, estimated at 40 % of their one-repetition maximum (1RM). Following the warm-up, they were instructed to progressively adjust the intensity levels of their estimated one-repetition maximum (1RM) to 60 %, 70 %, 80 % (with the completion of three repetitions), 90 %, and 95 % (with the completion of one repetition). This gradual acclimatization was aimed at



Note: REPS indicates the maximum number of repetitions (at a certain intensity) that can be completed.

Fig. 2. Twelve weeks prescribed training programs and cautions.

minimizing the risk of injury and discomfort. Upon reaching the 95 % intensity level, personal trainers meticulously monitored the participants' performance, paying close attention to the speed and stability of their movements, as well as their facial expressions. This observation process facilitated informed discussions between trainers and participants regarding the possibility of incrementally increasing the weight load by 1–5 kg for subsequent attempts. This process was continued until each participant was unable to complete a set throughout the entire range of motion with proper form. Therefore, the heaviest load lifted by each participant in the proper form was defined as their 1RM [35,36]. To ensure adequate recovery and prevent undue fatigue, rest intervals of 2 and 3 min were incorporated between consecutive sets before and after the 80 % intensity level, respectively.

2.3.2. Body composition

Multifrequency bioelectrical impedance analysis was performed using InBody 720 (Biospace Co., Seoul, Korea). Bioelectrical impedance analysis is a feasible method for assessing body composition by measuring the electrical characteristics of body tissues at frequencies ranging from 1 to 1000 kHz [37]. The measurements were conducted twice, both in the morning of the non-training days. The first measurement was performed the day before the commencement of the intervention to obtain baseline data, while the second measurement was performed 2 or 3 days after the termination of the intervention. To minimize errors associated with hydration status and since the assessments were performed after a fast with an empty bladder, ingestion of alcohol or caffeinated beverages was prohibited for 12 h before measurement. Urination was requested immediately before measurement. During the measurements, socks and metallic objects were removed. The palms and soles of the participants in contact with the machine were sanitized and air-dried. Before the measurement, the participants' entire body surfaces, particularly their palms and soles, were dried. The participants were then positioned smoothly on the machine, with both hands grasping the handles. The participants' weights were first measured, and subsequently, their age and sex were manually recorded. An InBody 720 scan was performed for approximately 2 min per participant. Finally, data were collected, collated, and recorded on a registration form.

2.3.3. Aerobic measurement

After a 5-min interval subsequent to the termination of the resistance training session, each participant performed aerobic exercise on a treadmill, specifically an inclined walk, in accordance with the prescribed protocol. The velocity parameters have been delineated between 3.5 and 4.5 km/h, with the inclination configured to range from 10 to 15 %. The participants were requested to attain an aerobic heart rate, and the duration of maintaining the heart rate between 55 and 65 % was meticulously assessed. The heart rate and duration of aerobic exercise were continuously monitored and recorded using a wrist monitor recorder (Polar Electro, Finland), and signals were wirelessly transmitted through a chest strap to an Oxycon Mobile system for display and storage.

2.3.4. Nutritional, injuries, and discomfort Investigation and intervention

The participants were asked a series of questions to collect data regarding their injuries and diet. The injury survey questions mainly focused on the areas and number of times they felt sick or were injured during the training period. The injured areas included in the questionnaire were designed based on a previous research [38]. The diet survey predominantly focused on the adoption of a nutritional plan that encompassed all meals consumed (breakfast, midday meal, and dinner). Each participant completed the questionnaire 12 times (once per week, following the last training session of each week), and information regarding the participants' injuries and diet was obtained throughout the experiment.

Prior to the intervention, all participants received a 60-min course involving instructions on the training program, which only elucidated the proper forms of each motion in the absence of any initiative on interventions concerning injuries or discomfort. They were simultaneously provided with a brief description of the ingestion of carbohydrates, proteins, and fat [39]. Subsequent to the training course, the participants were advised to adopt the appropriate nutritional plan for their own physical condition combined with the training throughout the experiment to achieve the optimal fitness-related improvement. Furthermore, the target period for using the nutritional plan was 7 days (a week); however, the nutritional plan was considered to have been used if each meal was consumed for up to 6 out of 7 days.

2.4. Statistical analyses

The initial baseline and 12-week training data were reported using descriptive statistics. The relevant data collected by the researchers were analyzed using analysis of variance (ANOVA) with Statistical Package for the Social Sciences (SPSS) 26.0. Before the analysis, normality and homogeneity tests were performed for all dependent variables. Data of eligible primary and secondary outcome variables were evaluated using the correlation *t*-test, the Mann-Whitney *U* test was used for ineligible variables. Between-group comparisons of the differences in the changes observed in the outcome variables were performed using one-way ANOVA. And used a two-tailed test for all statistical analyses, Cohen's *d* and partial eta-squared as a measure of effect size. When the ANOVA test revealed a significant interaction effect, the Scheffé's test was performed as a post-hoc analysis. Statistical significance was set at $p \leq 0.05$.

3. Results

3.1. Subject characteristics

No significant differences were found in the basic characteristics of the groups (Table 1).

3.2. Aerobic

When measuring outcomes related to aerobic exercise, times the average aerobic times were 27.4, 26.9, and 28.7 min in the IT, EP, PT groups, respectively. No significant differences were observed between the three groups.

3.3. Muscle, fat, and strength

Table 2 presents the skeletal muscle and fat mass data, as well as the 1RM data of BP and squats in each group before and after 12 weeks of training (Fig. 3). In the IT group, no differences were observed in changes of muscle mass (0.33 kg; $p = 0.571$, Cohen's $d = 0.11$) and fat mass (-0.39 kg; $p = 0.512$, Cohen's $d = 0.16$); however, there was a significant (15 %) increase in BP (10.28 kg; $p = 0.028$, Cohen's $d = 0.79$) and a 25 % increase in squats (20.05 kg; $p = 0.001$, Cohen's $d = 1.16$). In the EP group, significant increases in muscle mass (1.16 kg; $p < 0.001$, Cohen's $d = 0.61$), a 30 % increase in BP (18.55 kg, $p < 0.001$, Cohen's $d = 1.45$), and 35 % increase in squats (26.27 kg; $p < 0.001$, Cohen's $d = 1.61$) were observed; however, only fat mass (-0.51 kg; $p = 0.616$, Cohen's $d = 0.15$) remained statistically unchanged. In contrast, persons who trained with PTs exhibited significant differences in muscle mass (1.38 kg; $p = 0.002$, Cohen's $d = 0.61$), fat mass (-1.61 kg; $p = 0.033$, Cohen's $d = 0.65$), a 32 % increase in BP (19.70 kg; $p < 0.001$, Cohen's $d = 1.45$), and a 47 % increase in squats (36.21 kg; $p < 0.001$, Cohen's $d = 1.61$).

Regarding the changes in skeletal muscle mass (Fig. 4A), the IT (0.33 kg), EP (1.16 kg), and PT (1.38 kg) groups differed significantly; $F(2, 63) = 48.938$, $p < 0.001$, $\eta p^2 = 0.608$. Post-hoc tests revealed that the IT group was significantly different from the EP ($p < 0.001$) and PT groups ($p < 0.001$). However, there were no significant differences in the data changes between the EP and PT groups ($p = 0.145$). Regarding the fat mass change data (Fig. 4B), the IT (-0.39 kg), EP (-0.51 kg), and PT (-1.61 kg) groups differed significantly; $F(2, 63) = 28.202$, $p < 0.001$, $\eta p^2 = 0.472$. Post-hoc tests revealed that the PT group showed significant differences from the IT ($p < 0.001$) and EP ($p < 0.001$) groups. However, there were no significant differences in the changes between the IT and EP groups ($p = 0.811$).

Regarding the 1RM BP change data (Fig. 5A), significant differences were observed among the IT (10.28 kg), EP (18.55 kg), and PT (19.70 kg) groups; $F(2, 63) = 5.285$, $p = 0.008$, $\eta p^2 = 0.144$. Post-hoc tests revealed that the IT group showed significant differences compared to the EP ($p = 0.039$) and PT ($p = 0.015$) groups. However, there were no significant differences in the data changes between the EP and PT groups ($p = 0.933$). In the 1RM squats change data (Fig. 5B), significant differences were observed among IT (20.05 kg), EP (26.27 kg), and PT (36.21 kg) groups; $F(2, 63) = 6.424$, $p = 0.003$, $\eta p^2 = 0.169$. Post-hoc tests revealed that the IT group and EP group ($p = 0.408$) and the EP group and PT group ($p = 0.096$) were not significantly different. However, only the IT (20.0 kg) and PT (36.2 kg) groups showed significant differences in the changes in the data ($p = 0.003$).

3.4. Nutritional/injuries and discomfort

According to the survey, there were significant differences in the diet plans among the groups (Table 3, Fig. 6D). The average number of breakfast users in the PT group was 77.3 %, which was higher than that in the IT (38.8 %) and EP (39.3 %) groups. The average number of individuals in the PT group at lunch was 81 %, which was higher than those in the IT (43.5 %) and EP (47.3 %) groups. The average number of PT group members at dinner was 81.7 %, which was higher than that of the IT (48.3 %) and EP (51.7 %) groups. No significant differences were observed between the IT and EP groups. The average numbers of PT group users were significantly higher than those in the IT and EP groups, as evidenced by the following statistical results, in consuming breakfast, $F(2, 33) = 117.84$, $p < 0.001$, $\eta p^2 = 0.877$; lunch, $F(2, 33) = 80.963$, $p < 0.001$, $\eta p^2 = 0.831$; and dinner, $F(2, 33) = 43.249$, $p < 0.001$, $\eta p^2 = 0.724$ (The implementation of the 12-week nutritional plan are illustrated in Fig. 6A, B, C). The adoption of the nutritional plan indicated that the supervisory and supporting components of the PT group played a significant role not only in the training course but also in the diet.

In the survey of sports injuries and discomfort, 188, 167, and 60 occurrences were recorded in the IT, EP, and PT groups, respectively (Fig. 7). The shoulder (31/188 and 35/167), wrist (28/188 and 24/167), knee (24/188 and 30/167), and middle back (27/188 and 21/167) were the most injured areas in the IT and EP groups, respectively. These injury-prone areas were similar to those reported in previous studies [27,29]. In the PT group, the incidence in each of these four injury-prone areas did not exceed 12 times (half the least number of injuries in these areas in the other two groups). Overall, the PT group had the lowest number of injuries and discomfort during training, indicating that the trainer played a positive role in injury prevention.

Table 1
Subject characteristics.

	ITG (N = 21)			EPG (N = 22)			PTG (N = 23)		
	Mean	*SD*	Median	Mean	*SD*	Median	Mean	*SD*	Median
Age, years	30.0	8.1	28	28.4	6.1	28	29.1	6.4	30
Height, cm	174.2	7.0	172	174.8	5.3	175.3	175.1	6.7	176.2
Weight, kg	74.1	5.1	72.6	73.1	4.5	72.8	71.9	4.6	70.8
RTE, years	5.0	3.4	4	5.4	4.5	3.5	4.8	4.1	3

Note. RTE = resistance training experience. There were not significantly different between groups.

Table 2
Changes in body composition and muscle strength after 12 weeks of exercise training.

	ITG (N = 21)				EPG (N = 22)				PTG (N = 23)				3 groups
	Baseline	12wk	Change	*P*-within	Baseline	12wk	Change	*P*-within	Baseline	12wk	Change	*P*-within	*P*-between
Bench press 1RM (kg) rowhead	60.10 (9.97)	70.38 (15.39)	10.28 (9.71)	0.028‡	59.41 (9.81)	78.18 (15.48)	18.55 (10.02)	<0.001‡	61.34 (12.44)	81.04 (18.26)	19.70 (11.23)	<0.001‡	0.003
Squats 1RM (kg) rowhead	78.76 (12.11)	98.81 (21.15)	20.05 (14.32)	0.001‡	73.27 (10.04)	99.09 (20.33)	26.27 (16.81)	<0.001‡	76.61 (12.06)	113.26 (17.75)	36.21 (14.1)	<0.001	0.008
Skeletal muscle mass (kg) rowhead	30.10 (2.34)	30.36 (2.54)	0.33 (0.37)	0.571‡	29.92 (1.85)	31.04 (1.81)	1.16 (0.29)	<0.001‡	29.54 (2.05)	30.92 (2.09)	1.38 (0.43)	0.002‡	<0.001
Fat mass (kg) rowhead	13.40 (2.73)	12.99 (2.57)	−0.39 (0.59)	0.512	13.80 (3.32)	13.30 (3.35)	−0.51 (0.56)	0.616	14.05 (2.50)	12.44 (2.48)	−1.61 (0.65)	0.033	<0.001

Note. 1RM = 1 repetition maximum. Data are presented as means (*SD*). ‡ Mann-Whitney *U* test.

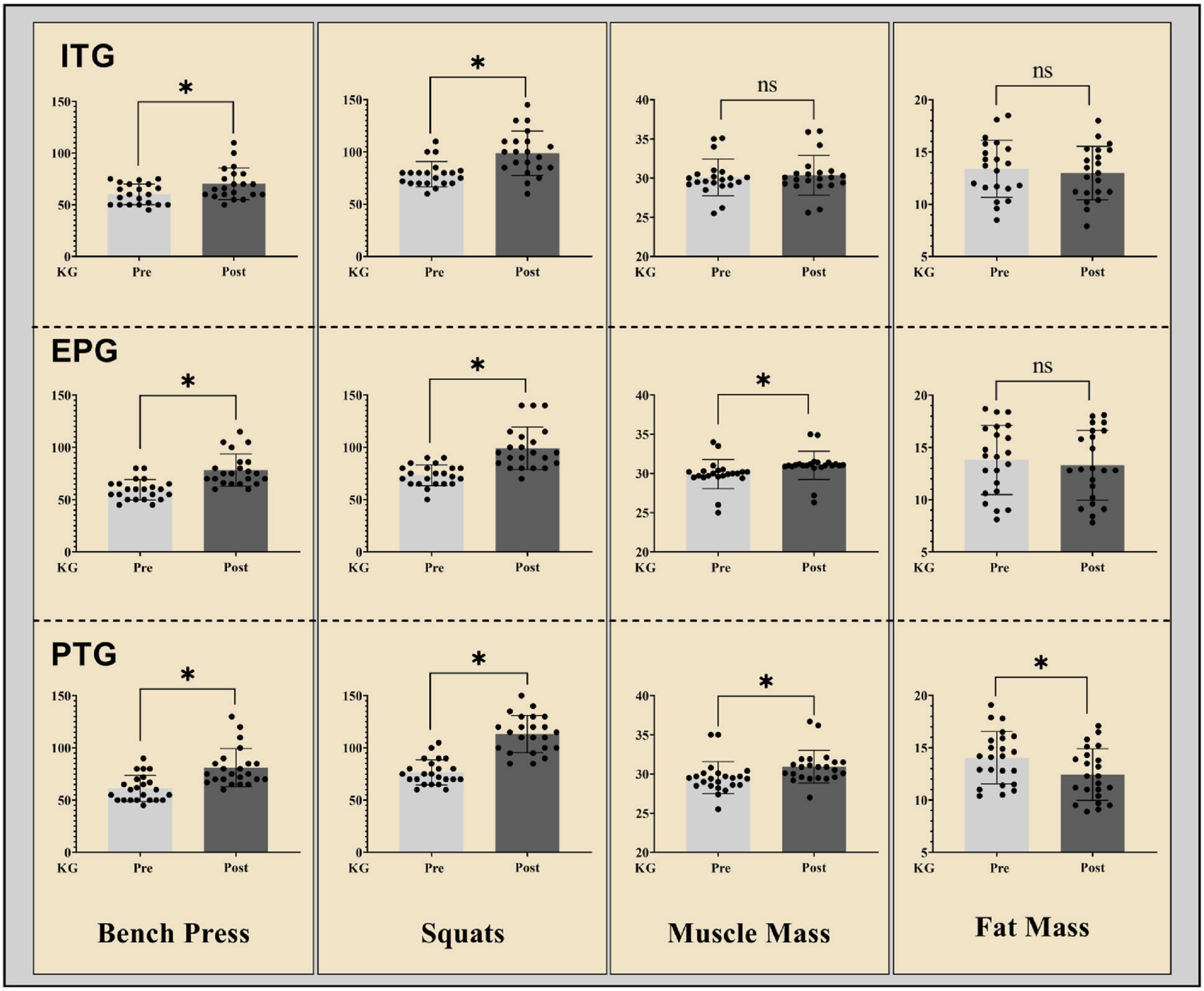


Fig. 3. The data concerning these four indicators bench press, squats, skeletal muscle mass, and fat mass were comparatively analyzed. *$p < 0.05$.

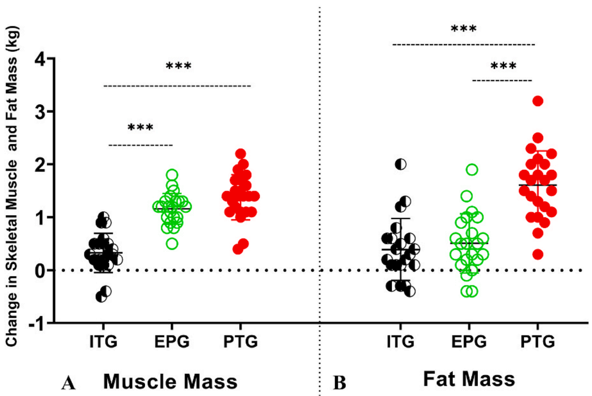


Fig. 4. Distribution of individual changes in skeletal muscle and fat mass for the three groups. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$. (A) The specific individual increment in skeletal muscle mass for each group, directly showing the difference of skeletal-muscle changes among them. (B) The precise reduction in fat mass for each group, providing a direct representation of the disparities in fat-mass decrement among them and underpinning the salient efficacy regarding fat-mass reduction in PTG.

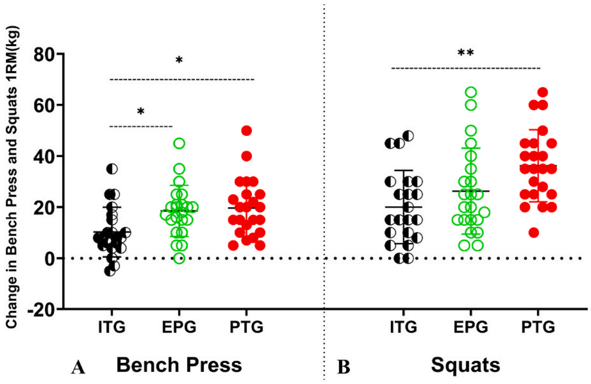


Fig. 5. Distribution of individual changes in bench press and squats for the three groups. *p < 0.05, **p < 0.01, ***p < 0.001. (A) The specific individual enhancement of bench-press weight for each group, reflecting the difference of the athletic-performance improvement in terms of upper limb among them. (B) The individual increase in squats weights within each group, serving as an indicator of the divergent enhancements in athletic performance, specifically pertaining to lower limb, across the three groups.

Table 3
Use of a three-meals plan during 12 weeks of exercise training.

	Breakfast		Midday meal		Dinner		3 groups
	Number	Percentage %	Number	Percentage %	Number	Percentage %	*P*-between
ITG (n = 21)	8.2 (2.0)	38.8 (9.3)	9.2 (2.1)	43.5 (9.8)	10.3 (2.3)	48.3 (10.7)	<0.001
EPG (n = 22)	8.7 (1.1)	39.3 (4.8)	10.4 (1.8)	47.3 (8.4)	11.3 (1.8)	51.7 (8.6)	<0.001
PTG (n = 23)	17.8 (1.5)	77.3 (6.4)	18.7 (1.2)	81.0 (5.3)	18.8 (2.2)	81.7 (9.6)	<0.001

Note. Data are presented as means (*SD*).

4. Discussion

This study aimed to investigate the differences in fitness- and performance-related outcomes between PT guidance during workouts and exercising with a partner. The results after 12 weeks of training revealed that the 1RM BP and squat values were significantly higher than the baseline values in all three groups. After 12 weeks of training, the IT group had no significant difference in skeletal muscle mass and fat mass compared to their baseline masses; however, the 1RM values for BP and squats significantly increased. The results of the EP group showed that skeletal muscle mass, BP, and squats significantly improved, while no significant change was observed in fat mass. On the other hand, all the values differed significantly in the PT group. The results of the current study showed that although participants who trained alone also used training plans, the effect on skeletal muscle mass was not obvious.

Increased skeletal muscle mass is associated with the intensity and effectiveness of resistance training [4,24,40,41]. According to the fluctuation of data concerning the resistance training, the EP group (BP = 18.55 kg, squats = 26.27 kg) and the PT group (BP = 19.70 kg, squats = 36.21 kg) improved faster than the IT group (BP = 10.28 kg, squats = 20.05 kg). Similarly, the changes in skeletal muscle mass and BP in the EP and PT groups were significantly greater than those in the IT group (Fig. 4A and 5A). A possible explanation for the notable and significant increases in skeletal muscle mass and BP in the EP and PT groups compared with those in the IT group is that two pivotal factors remained under supervision in the PT group and competitiveness in the EP group, of which the IT group was devoid, leading to the result that the participants of the IT group tended to adopt lower weights in training, thereby precipitating lower training intensities. Similar results have been reported by Ratamess et al. (2008). The weights selected for resistance among those who trained with PTs were 9 % heavier than the weights selected by those who trained individually [7]. Ives et al. (2020) found that training with others in a competitive environment exerted a significant promotional effect on athletic performance, irrespective of the level of competitive partners [42].

Notwithstanding enhancements in skeletal muscle mass and BP observed in both the EP and PT groups, surpassed those identified in the IT group. The results also revealed an intriguing anomaly in that the data related to squats were not pertinent to the comparative trends in skeletal muscle mass and BP among the three groups. Only the PT group showed significantly higher values than the IT group. The results regarding the improvements in squats revealed no statistically significant differences between the EP and IT groups and no marked dissimilarities between the EP and PT groups. This may be because participants in the PT group completed higher-quality training under the supervision of a PT. One possible explanation for the lack of significant differences between the EP and IT groups may be attributed to the fact that men often do not pay much attention to leg training. The primary objective of the majority of male fitness enthusiasts is to improve their physical attractiveness. Their inclination toward training upper body muscles can be attributed to the enduring appeal of upper body musculature in enhancing attractiveness to women and bolstering male confidence [43]. This means that the participants were inclined to neglect leg training without the trainer's guidance. A comprehensive study

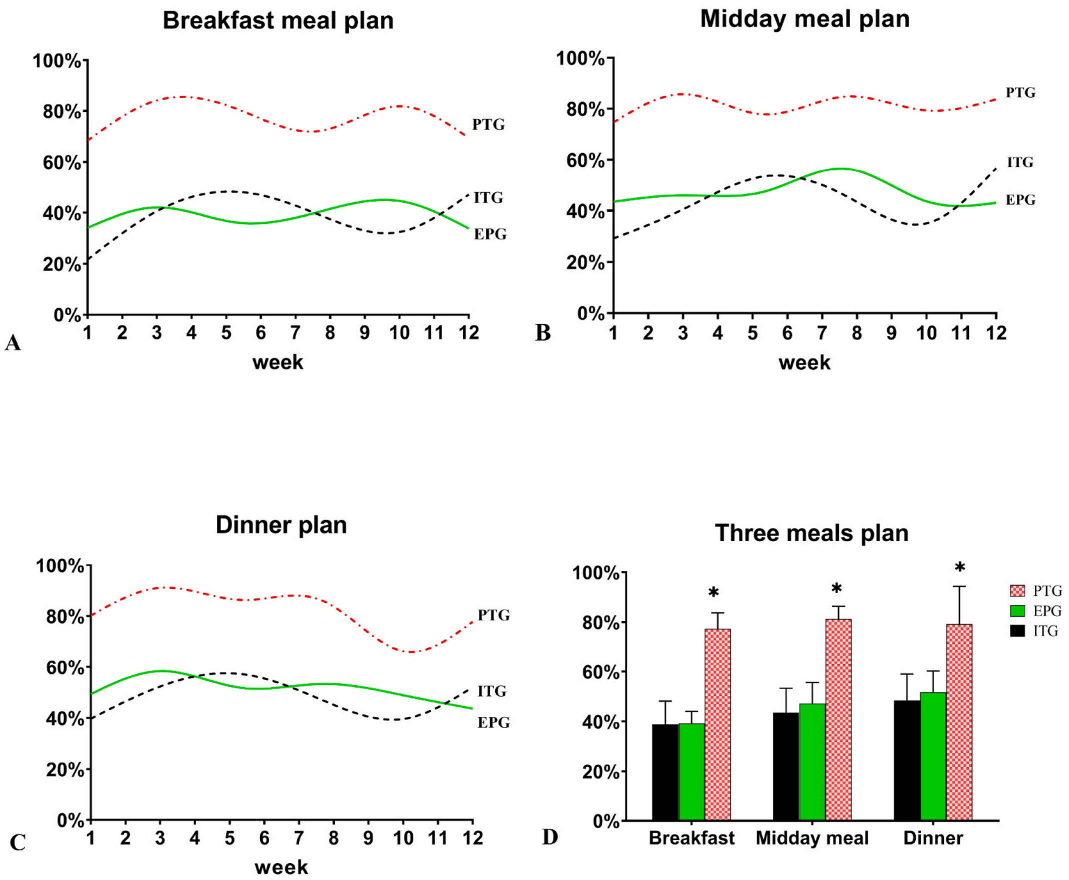


Fig. 6. Comparison of the use of three meals during the 12 weeks for each group, *Indicates a significant difference ($p < 0.001$). (A) The respective adoption of breakfast meal plan in the three groups throughout the entire experimental session, demonstrating the difference of the extent to which each group has implemented the nutritional plan among regarding breakfast meal them. (B) The implementation of the midday meal plan in each of the three groups over the entire experimental session that illustrates the distinctions in varying degree to which each group has incorporated the nutritional plan for midday meal. (C) The circumstance of the extent to which each group has implemented prescribed dinner plan throughout the experimental session over 12 weeks. (D) The holistic difference of the average-use of three meals among the three groups, respectively presented in each meal.

conducted by Sell, Lukazsweski, and Townsley (2017) highlighted that male attractiveness predominantly emanates from strength and physical fortitude, with well-built upper limbs contributing to their charisma and confidence [44]. Marković and Bulut (2023) recently further expanded on this perspective by establishing that women more naturally gravitate toward men with a T-shape silhouette characterized by robust chest and shoulder muscles [45]. These studies support this explanation and indicate that the services of PTs have an impact on the choice of training and guides members to exercise the muscles of the entire body properly.

Considering that aerobic exercise and a nutritional plan are germane to fat mass reduction and that no significant difference was observed in the amount of aerobic exercise among the three groups, one possible explanation for the effect on fat loss may be an appropriate nutritional plan. Moreover, regarding fat mass reduction, the PT group showed significant improvement compared to the IT and EP groups. This finding also supported our hypotheses. A reasonable nutritional plan plays a pivotal role in weight and fat loss [46]. The results showed that 79 % of the participants in the PT group consumed three meals, which was much higher than the 43 % in the IT group and 47 % in the EP group, possibly rationalizing the finding that a significant decrease in fat mass arose only in the PT group. The scientific nutritional plan involves controlled carbohydrate, high protein, and low fat intake. Moderate consumption of carbohydrates results in a considerable reduction in fat mass. According to the weight and height indices of the individual, a daily intake of constant carbohydrates was prescribed and a daily balanced intake of calories was maintained to achieve a better weight loss effect, including controlled carbohydrate intake, high protein intake, and low fat intake. Samaha et al. (2003) suggested that low-carbohydrate intake has an obvious effect on fat loss [47]. Similar results have been reported by Brehm [48].

The difference in the implementation of a nutritional plan may be attributed to the fact that the participants of the IT and EP groups, who were devoid of knowledge about nutrition, were inclined to neglect the nutritional plan, while it was less difficult for participants of the PT group to adopt and adhere to a nutritional plan formulated by PTs along with prompts from them. Despite the pivotal role that a healthy nutritional plan plays in fitness-related improvement, the constant preoccupation of fitness enthusiasts exists with the assimilation of knowledge concerning training programs as opposed to nutritional plans, on the grounds that nutrition involves a

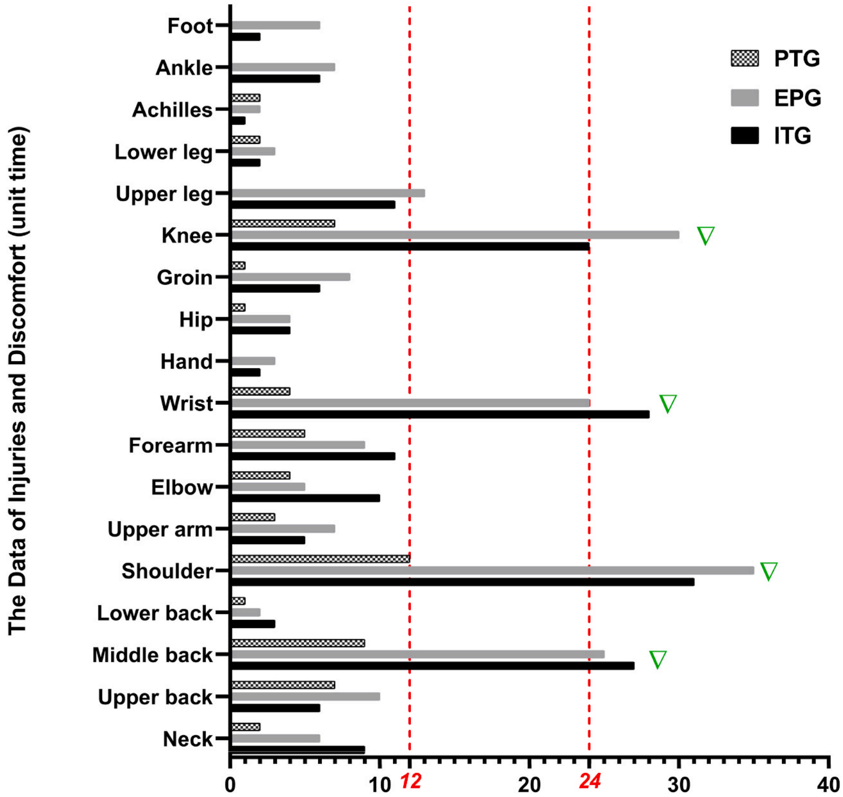


Fig. 7. Number of injuries and discomfort to various parts of the body. Inverted triangle symbol represents the most injury-prone areas.

spectrum of knowledge completely different from fitness. To develop an appropriate nutritional plan, the daily intake of each nutrient must be calculated and allocated to each meal. For beginners or intermediate fitness enthusiasts, this is not a small task as it requires professional knowledge and a theory of nutrition, accurate calculation, and different combinations of food ingredients, leading to the ubiquity of the phenomenon that most fitness enthusiasts cannot ensure the proper use of the training program and nutritional plan at the same time. Lokuge and Ganegoda (2021) found that without professional assistance, fitness enthusiasts were incapable of effectively implementing an appropriate nutritional plan to achieve their objectives [49], and this aligns with the rationale and findings of the current study.

Injuries and discomfort were significantly lower in the PT group (60) than in the IT (188) and EP groups (167). The most injury-prone areas in the IT and EP groups were the shoulder, wrist, knee, and waist, with more than 24 injuries, whereas those in the PT group had fewer than 12 injuries, which indicates a reduction in the risk of injuries by as much as 50 %. This may be attributed to the fact that people who train individually or with a partner normally do not pay as much attention to the standardization of their movements during exercises, which leads to more injuries. However, a PT would constantly adjust exercise intensity and movement standards during training to ensure safety. In this study, the participants performed resistance training with standard movements, which may have reduced the occurrence of injury and discomfort. The professionalism of PTs reduced the number of injuries and discomfort experienced by the participants. Waryasz et al. (2016) reported that PTs play an important role in preventing injuries through professionalism [50]. Ahmed et al. (2022) found that the involvement of a PT with considerable expertise and experience is instrumental to preventing bone and joint injuries [51], Which is also supported by the findings of this study.

Our findings indicate that the effect of competitiveness only emerged in the EP group during resistance training. Furthermore, training with a partner was shown to enhance athletic performance compared with training with another individual, potentially due to the competitiveness that may have engendered more effort to enhance athletic performance. Therefore, being germane to the enhancement of athletic performance, the effect of competitiveness manifested itself as improvements in skeletal muscle mass and muscular strength in the EP group. However, it is worth noting that the positive impact of competitiveness did not seem to extend universally, as indicated by the results related to squats and injuries. In resistance training, the positive effect of competitiveness redounded on athletic performance, predominantly in programs for which the participants' ardor existed, as opposed to those that entailed caution and about which the participants felt apathetic. Regarding the PT group, instructive supervision from a personal trainer exhibited a relatively comprehensive positive effect, whereby members could easily complete training programs and obtain holistic fitness-related improvements under the guidance of a PT. In addition, supervision played an equivalent role to the positive effect of competitiveness on athletic performance, thereby motivating members during resistance training. Ubiquitous awareness exists regarding nutritional plans that appear to be instrumental to fitness-related outcomes, while a prescribed nutritional plan requires meticulous calculation and formulation, which precipitates difficulties and impedes its implementation among members in the absence of instructive supervision. Nonetheless, the prescribed nutritional plan indicated that instructive supervision also played a pivotal role in daily nutritional tracking, in addition to resistance training, leading to holistic fitness-related improvements in the PT group throughout the experiment. Therefore, apart from training courses that included the provision of supervision by a PT, many other aspects, such as nutritional planning and education, also entail instructive supervision for holistic fitness-related improvements to be achieved among members. Furthermore, in accordance with the status quo of the fitness industry, there is a transitional tendency for traditional PTs to gradually evolve into fitness consultants, from whom help can be solicited for anything related to fitness.

In summary, our results are consistent with those of previous studies that demonstrate the superiority of guidance services from a PT, confirming the diversified values of a PT [25]. Moreover, a paramount importance of a PT was expediting the process of achieving fitness goals in a relatively safe manner.

4.1. Practical applications

Training with a PT or a partner can enhance upper-body muscle strength and hypertrophy, while training with a PT can also ensure holistic coordination between the upper and lower extremities. Furthermore, a decrease in body fat was noted exclusively in the cohort receiving PT guidance. For individuals who aspire to achieve both weight control and muscle gains, training with a PT is far more effective than exercising with others [26]. With regard to corollary tracking and recording the implementation of nutritional plans and the occurrence of injuries and discomfort, technological assistance furnished by a PT facilitated the simplified and streamlined completion of prescribed nutritional plans while concurrently diminishing the risk of injury. Despite the finding that the EP group achieved greater fitness-related improvement than the IT group due to mutual supervision [17,52], such an approach still pales compared to PT guidance in terms of overall strength development and athletic performance. In terms of the implementation of nutritional plans and occurrence of injuries and discomfort, no statistically significant differences were observed between the EP and IT groups, indicating the ascendancy of PT-supervised training. Thus, it follows that, compared to exercising with a partner, PT guidance better helps participants achieve their fitness objectives [23].

4.2. Limitations of the study

This study utilized traditional testing mechanisms and approaches in its methodology, resulting in the relative generalizability of the research findings. The purpose of this scientifically rigorous experiment was to unveil issues that appeared to be contentious and had been insufficiently researched. Notably, the results yielded a directional perspective for selecting between training with a partner and training under the guidance of a PT, as holistic and insightful suggestions were provided by the current study. Nonetheless, this study has several limitations that must be considered. First, although identical training programs and protocols were adopted for three sessions per week among all participants who completed the experiment, unlike in previous studies, in this study, there was still variation among the participants in terms of the length of their training intervals, which may have affected the observed fitness-related improvements. In addition, although specific training programs were prescribed, most participants increased the volume of almost every training program by performing one or two additional sets of exercises. This may have been due to an attempt to obtain greater improvements from the training and is referred to as the "John Henry Effect" [24]. This was also observed in a previous study [7], in which participants in the PT group were instructed and inspired to increase their training intensity and volume to show the effectiveness of the method. The EP and IT groups attempted to demonstrate that they were able to obtain converging improvements as the PT group and consequently exercised several additional sets. Furthermore, despite statistical tracking investigations of the implementation of nutritional plans and the occurrence of injuries and discomfort conducted weekly, the participants' circumstances were approximated and their injuries were not categorized by severity. Future studies should emphasize the implementation of nutritional plans and the occurrence of injuries by utilizing more scientifically rigorous and comprehensive statistical and examination mechanisms to better control the data and determine the results.

5. Conclusions

In the present study, although the participants in the IT group experienced a certain training effect on 1RM BP and squats, there was no obvious effect on body weight. The effect of training alone was not commensurate with all fitness goals, and there were no obvious changes in body shape. The EP group achieved almost the same enhancement as the PT group in terms of skeletal muscle mass and BP; furthermore, leg training was higher than that in the IT group but had no obvious effect. The PT group showed significantly better leg-training improvements than the IT group. The key point was that only the PT group showed an improvement in fat mass; neither the EP nor IT groups showed a significant reduction in fat mass. During the 12-week training period, it was found that if participants wanted to achieve fitness goals in terms of body plasticity as soon as possible, PTs provided effective services, contributing to comprehensive fitness-related improvements. In this experiment, under the same training frequency, only PTs were effective for fat reduction. Additionally, PTs provided an important service to the participants in terms of formulating a nutritional plan. Apart from providing a nutritional plan, they also supervised the participants and ensured that they properly using it to achieve their goals. PTs also play a crucial role in helping fitness enthusiasts effectively prevent injuries.

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Data availability statement

The data used to support the findings of this study are available from the author upon request.

CRediT authorship contribution statement

Yunhang Lu: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Methodology, Investigation, Data curation, Conceptualization. **Xuan Leng:** Writing – original draft, Formal analysis. **Han Yuan:** Supervision, Methodology, Conceptualization. **Chengji Jin:** Resources, Formal analysis. **Qing Wang:** Writing – review & editing. **Zhengxue Song:** Writing – review & editing, Supervision, Data curation.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2024.e24625.

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