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Original article

Understanding the Distinction Between Machine-Based vs Free Weight Training and Their Correlation to Mobility

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Authors' Contribution: A: Study design, B: Data collection, C: Data analysis, D: Manuscript preparation, E: Discussion and conclusion

ABSTRACT

Study aim(s): Determination of the differences between Machine-Based Resistance vs Free Weight Training, and correlations to mobility such as a skill with a high range of motion during movement execution.

Methods: The study included 12 female physical education and sports students aged 20-25 years old, with an average body height of 167.0, weight of 59.3, and body mass index of 20.9. The students included in the study were informed about the benefits and risks (even if there was no risk detected) of the study and participation was made voluntarily. Wight lifting tests included in the study were; bench press on the Smith machine, dumbbell bench press, smith machine squat, barbell squat, smith machine shoulder press, and barbell shoulders press. Measurement of the mobility tests was made by using the Kinovea-0.9.4-x64-exe program. For the data analysis, the SPSS 26 program was used. The normality of the variables was determined by using skewness and kurtosis calculations. To handle the results of the study independent samples T-test and percentile(s) statistics were used. Correlations between tests were made by using Pearson correlation analysis.

Results: Results of the study have shown that differences between machine-based weight lifting and free weight lifting were statistically significant ($p<0.05$). On the other hand, there was no statistically significant correlation ($p>0.05$) between resistance training and mobility which is characterized by a high range of motion during movement execution.

Conclusion: machine-based resistance training may affect better in the ability to target specific muscle groups, whereas free weight training results better in stabilizing the body and extremities during multiplanar movements which seem to be closer to skills such as mobility.

Keywords: Resistance Training, Weightlifting, Mobility, Motor Skills

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INTRODUCTION

Machine-based training methods are easier to use by beginners and injury risk is lower in comparison to free weight training. Otherwise, free weight training is preferred by bodybuilders and athletes whose target is motor skills development because is known that free weight training is more beneficial in this case [1]. Nowadays machine-based and free-weight resistance training is widely used to gain muscle mass, force, etc. In addition, resistance training is used in different seasons of many sports changes to increase general motor skills and branch-specific skills. To be more effective, according to the goals of the athletes, branch characteristics, athlete characteristics, and physical level resistance training are divided into different categories. Some of them are machine-based and free-weight resistance training. Many times athletes seem to have difficulties in deciding which type of exercise to use. Based on the literature, when free-weight training methods are compared to machine-based training methods, each has advantages and disadvantages [2]. Machine-based resistance training plays an important role for both recreational and competitive athletes in sports branches such as weight lifting, etc [3].

The stability provided by the machine in machine-based resistance training may result in a better ability to target specific muscle groups, which may be more beneficial in a gain of muscle mass. However, in the context of sports performance, muscle rarely if ever functions in such an isolated fashion [2, 4, 5]. So, to increase sportive performance free weight resistance training may be more effective. It also is related to the sports branches and athletes' goals targeted motor skills [6]. Because of the many variables included in sportive performance, resistance training gets more complex. Even if it knows which type of training is more or less beneficial, it's very difficult to determine the effect size of these training types on certain performances. To determine the effect size of the different training types on certain sportive performance, firstly it needs to determine the differences between training types such as machine-based and free weight training, and the problem of our study starts here. In addition, the literature includes studies that are made to contradict another study's results about differences between free weight and machine-based resistance training [7].

In light of the previous information, the study aims to determine the differences between Machine-Based Resistance Training and Free Weight Training. Besides this, the determination of the correlations between resistance training the motor skills such as flexibility and mobility is aimed.

METHODS

Research design

Based on the aims to determine differences between machine-based and free weight training, the study consists of a comparative method. The machine-based group consists of three and the free-weight group consists of three elements as well. Compared groups were made by selecting one movement from machine-based training, and another from free weight training, which includes similar muscle groups.

Study sample

In the study, 12 female physical education and sports students whose mean body height was 60.3 kg and body height was 169.1 centimeters were included. The students included in the study and their parents were informed about the benefits and risks (even if there was no risk detected) of the study. The study was made according to the Helsinki Declaration which protects the privacy of the volunteers.

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Data collection tools

Resistance training tests included in the study

Resistance training tests included in the study were divided into two categories; machine-based resistance tests and free-weight resistance tests.

Machine-Based resistance tests:

- BPSM: Bench press on Smith machine
- SMS: Smith Machine Squat
- SMSHP: Smith machine shoulder press

Free weight resistance tests:

- DBP: Dumbbell bench press
- BS: Barbell Squat
- BSHP: barbell shoulders press

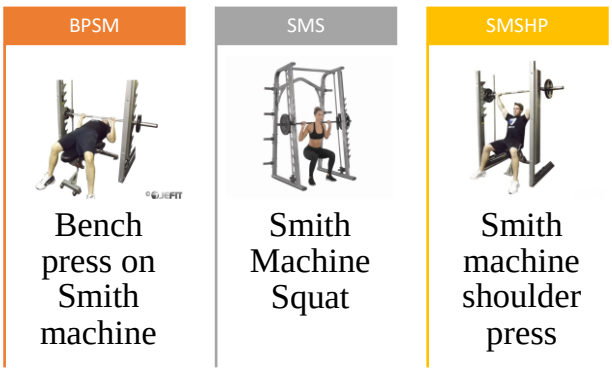

Chart 1. Machine-based resistance tests

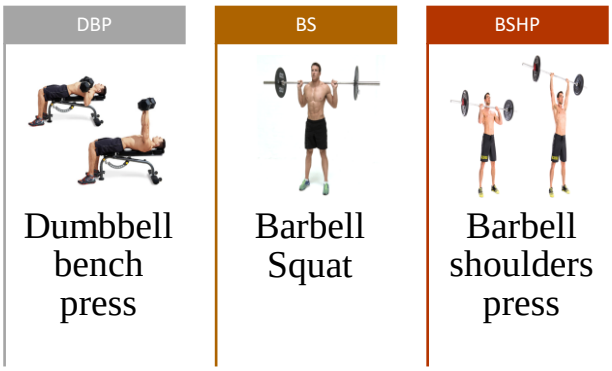

Chart 2. Free weight resistance tests

Test application protocols and maximal power calculation

All test protocols were made based on the literature such as ‘’Serious Strength Training’’ [8] and NSCA [6]. The maximal power of the students was determined by using the ‘’1RM’’ program, which calculates the maximal power based on the maximal repetition of the exercise. For the maximum number of repetitions at 70, 80, and 90% of 1RM, each lifter was instructed to perform as many repetitions as possible, to fail, at the percentage selected for a particular lift. Application of the repetitions was made continuously, with no more than a 2-second pause between repetitions [9]. Once again, for correctness, the maximum number of repetition attempts was evaluated by the 1RM app. This method was selected to avoid the injury risk that may occur during the ‘’1RM’’ classic method in people whose physical level is not sufficient.

Flexibility and mobility tests included in the study

LRF-RL: Leg Raise Forward (Right Leg), LRF-LL: Leg Raise Forward (Left Leg), LRS-RL: Leg Raise Sideward (Right Leg), LRS-LL: Leg Raise Sideward (Left Leg), ATA0SHF: Arm-Trunk Angle (shoulder flexion), SRT: Seat and Reach Tests were included in the study. Calculation of the angle degrees was made by using the Kinovea-0.9.4-x64.exe program. Determination of the reference points for each test were anatomical points of the body [10, 11].

Data analysis

Data analysis in the study was made by using the IBM SPSS statistics 26 programs. The normality of the data was tested by the skewness and kurtosis analysis. Based on the normality of the data, differences between two independent variables were calculated by using the Independent-samples T-test analysis. Correlation between continued types of

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variables was made by using the Pearson correlation method.

The difference percentage between machine-based and free weight training was calculated by using the formula "%Δ = (x machine-based – x free weight) / free weight *100".

Calculation of the angle degrees in the flexibility and mobility tests was made by using the Kinovea-0.9.4-x64.exe program

FINDINGS

Table 1. Differences between Machine-Based Resistance Training and Free Weight Training

Pairs	Groups	Variables	X̄±SD	Skew.	Kur.	p	%Δ
Pair A	1	BPSM	33.429±7.5467	.372	-1.608	.010*	46.252
	2	DBP	22.857±4.1404	.457	.510		
Pair B	1	SMS	62.143±9.8561	-.252	.494	.050*	24.642
	2	BS	49.857±11.2758	1.016	1.597		
Pair C	1	SMSHP	29.857±3.0237	.190	-2.647	.005*	23.667
	2	BSHP	24.143±3.1320	1.456	.954		

P<0.05, 1=Machine-Based Resistance, 2=Free Weight Resistance, BPSM: Bench press on Smith machine, DBP: Dumbbell bench press, SMS: Smith Machine Squat, BS: Barbell Squat, SMSHP: Smith machine shoulder press, BSHP: barbell shoulders press*

Table 1, shows the statistically significant differences between machine-based resistance and free-weight resistance in both three pairs included in the study ($p<0.05$). This analysis has shown that machine-based resistance results are higher in comparison to the free weight resistance training method. While the differences in the first pair were 46.252%, the second pair's differences were determined as 24.642%, and the third pair was 23.667%.

Table 2. Correlations between Machine-Based Resistance, flexibility, and mobility

Variables	Correlation	*LRF-RL*	*LRF-LL*	*LRS-RL*	*LRS-LL*	*ATA^{0}SHF*	*SRT*
BPSM	r	.109	.016	.063	.002	-.717	.016
	Sig (p)	.817	.973	.893	.996	.070	.973
SMS	r	-.542	-.419	-.231	-.210	.062	.338
	Sig (p)	.209	.350	.617	.652	.895	.458
SMSHP	r	-.655	-.824	-.711	-.762	-.444	.378
	Sig (p)	.110	.023	.073	.047	.319	.404

BPSM: Bench press on Smith machine, SMS: Smith Machine Squat, SMSHP: Smith machine shoulder press, LRF-RL: Leg Raise Forward (Right Leg), LRF-LL: Leg Raise Forward (Left Leg), LRS-RL: Leg Raise Sideward (Right Leg), LRS-LL: Leg Raise Sideward (Left Leg), ATA0SHF: Arm-Trunk Angle (shoulder flexion), SRT: Seat and Reach Test

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Table 2 has determined the correlations between Machine-Based Resistance and flexibility and mobility, which resulted to be not significant (p>0.05).

Table 3. Correlations between Free Weight Training, flexibility and mobility

Variables	correlation	*LRF-RL*	*LRF-LL*	*LRS-RL*	*LRS-LL*	*ATA^{0}SHF*	*SRT*
DBP	r	-.321	-.295	-.300	-.298	-.350	.083
	Sig (p)	.482	.521	.514	.516	.441	.860
BS	r	-.556	-.497	-.379	-.196	-.201	.533
	Sig (p)	.195	.256	.402	.673	.666	.218
BSHP	r	-.368	-.430	-.362	-.212	-.518	.461
	Sig (p)	.417	.335	.425	.649	.233	.298

DBP: Dumbbell bench press, BS: Barbell Squat, BSHP: barbell shoulder press
LRF-RL: Leg Raise Forward (Right Leg), LRF-LL: Leg Raise Forward (Left Leg), LRS-RL: Leg Raise Sideward (Right Leg), LRS-LL: Leg Raise Sideward (Left Leg), ATA^{0}SHF: Arm-Trunk Angle (shoulder flexion), SRT: Seat and Reach Test

Table 3 has determined the correlations between free weight resistance and flexibility and mobility, which resulted to be not significant (p>0.05)

DISCUSSION

The study determined the differences between machine-based weight lifting and free weight lifting, which proved to be statistically significant. Besides this, the study also has determined no statistically significant correlation between resistance training and mobility which is characterized by a high range of motion during movement execution. The study has shown that machine-based resistance resulted higher in comparison to the free weight resistance training method. However, not all-time machine-based training results are higher in comparison to free weight training. Based on some NSCA statements, the stability provided by the machine may result in a better ability to target specific muscle groups. However, in the context of sportive sports performance, where functional ability is needed, muscles rarely if ever function in such an isolated fashion [6]. On the other hand, it is generally acceptable that in comparison to machine-based training, free weight training provides more stabilizing the body and extremities during multiplanar movements by activating stabilizer muscles. Many studies clarified that when subjects became more unstable, the activity of their stabilizers and postural muscles were more activated, which may result in increases in the performance of these muscle groups [12]. Similarly, it is generally accepted that activation of these muscles is greater during free weight training when compared with machine-based training [7]. If these types of exercises are analyzed from an application priority perspective, it can be concluded that because less skill is needed for their use, machine-based training can be an effective alternative and an excellent preparation for teaching free-weight exercises [3]. Parallel to previous information, it appears that free-weight (ground-based) exercises offer the ideal combination of specificity and instability, especially when one is focusing on strength and power development [6].

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Differences between these training types vary on each exercise type, athlete group, athlete level, etc. However, differences in movements such as Bench press on the Smith machine, vs Dumbbell bench press (46.252%), Smith Machine Squat vs Barbell Squat (24.642%), and Smith machine shoulder press vs barbell shoulder press (23.667%). According to Anderson and Behm, the activity of the back stabilizers is 30% lower during a Smith machine squat when compared to a free weight squat [6, 12]. Similarly, a comparison of development between machine and free weight training resulted in favor of machine-based training (13.9%) versus free weight training (8.6%). [13]. Also, another study analysis between the Smith machine and free weight squat found 43% higher muscle activation during the free weight squat compared to the Smith machine squat [13, 14].

Based on the previous information, it can be thought that certain techniques executions that require active movement, high range of motion, etc, may be affected positively more by free weight training in comparison to machine-based training. However, correlations between resistance training and tests that measure flexibility and mobility are not significant. This can be the result of the flexibility and mobility test which are branch-specific (artistic gymnastic) [10, 11].

Analyses of the comparisons between machine-based and free-weight training from in athletes' requirements perspective, it can be concluded that for athletes whose motor skills need sharpening, performing free-weight exercises safely and with proper technique may be virtually impossible [3]. Also, based on the literature the free weight squat may be superior to the Smith machine squat for training the major muscle groups of the legs and possibly would result in greater strength development and hypertrophy of these muscle groups with long-term training [13].

The advantages of machine-based training include increased body stability from the adjustable seat and back support (making machines easy to use), fewer skill requirements, and no spotting requirement [3].

CONCLUSION

The study has shown that machine-based resistance resulted in higher in comparison to the free weight resistance training method.

The stability provided by the machine may result in a better ability to target specific muscle groups. Because less skill is needed for their use, machine-based training can be an effective alternative and an excellent preparation for teaching free-weight exercises. The advantages of machine-based training include increased body stability from the adjustable seat and back support (making machines easy to use), fewer skill requirements, and no spotting requirement.

Free weight training provides more stabilizing of the body and extremities during multiplanar movements by activating stabilizer muscles. Techniques executions that require active movement, high range of motion, etc, may be affected positively more by free weight training in comparison to machine-based training.

Study results have shown that differences between machine-based training and free weight training vary between 23 to 46 % in favor of machine-based training.

Machine-based resistance training may affect the ability to target specific muscle groups for better, whereas free weight training results better in stabilizing the body and extremities during multiplanar movements which seem to be closer to the skills such as mobility.

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CONFLICT OF INTERESTS

The authors reported no potential conflict of interest.

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