



Analyzing the effects of exercise prescribed based on health-related fitness assessment among different somatotypes

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ABSTRACT

Introduction: Human body types (somatotypes) are classified into ectomorph, mesomorph, and endomorph. The ectomorphs are physically weak and usually tall. Mesomorphs were characterized as muscular, thick skinned with good upright posture. Endomorphs characterized as fat, heavy, and usually short.

Methods: This study is an interventional study, in which a total number of 45 healthy male volunteers between the age group of 22 and 28 years were observed. Written consent was obtained from the patients after a detailed explanation of the study. Exercises were prescribed and executed based on the American College of Sports Medicine (ACSM) guidelines for exercise testing and prescription. Body composition, cardiorespiratory endurance, muscular strength, muscular endurance, and flexibility were assessed.

Results: The statistical analyses were done using the SPSS software version 16 executed at a 95% confidence interval. Mean and standard deviations were calculated by descriptive statistics. A paired t-test was done to find the effectiveness of the intervention. The level of significance in all tests was set to $p < 0.05$. Positive changes were observed in health-related fitness among the three groups.

Conclusion: This study reports about finding the somatotypes, and exercising based on that will provide the best results in health-related fitness components designed by the ACSM.

Keywords: Somatotypes; American College of Sports Medicine; ectomorphs; endomorphs; mesomorphs; exercise prescription

INTRODUCTION

Humans are born with a specific genetic body type, distinctive skeletal framework, and varying body composition (1). Human body types (somatotypes)

are classified into ectomorph, mesomorph, and endomorph (2,3). Somatotypes provide complete information about the morphology and features of the human body (4). Lewandowska J et al (5) studied the muscle power and torque among 14 volley ball players based on the somatotypes and reported that mesomorphs had the more ability to elicit a greater amount of muscle torque. The performances such as countermovement jump, spike jump among 14 volleyball players based on somatotypes. Mesomorphs have large and well-developed muscles and they are

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capable of producing powerful movements (6,7). William Herbert Sheldon an American Psychologist studied the behavioral analysis based on body types, by taking and using the naked photographs of more than a thousand undergraduate students in the 1940s and he termed it as somatotypology (8). Elazizi classified the female body types for standardization of textiles, based on shapes, such as rectangle, triangle, oval, diamond, and hourglass shape (9). Ectomorphs were characterized as skinny, thin, slender, flat-chested lightly lean muscled. Heath-Carter introduced anthropometric, photoscopic, and combination of both anthropometric and photoscopic methods of evaluating the different types of somatotypes (10). The ectomorphs are physically weak and usually tall, described as intelligent, they may feel inferior but perfectionist and very sensitive to pain (11). Mesomorphs were characterized as muscular, thick skinned with good upright posture; they are energetic, determine, and mostly aggressive (12). Endomorphs characterized as fat, heavy, and usually short, they are lazy, selfish, and slow to react (13). Sanchez-Munoz et al. identified the formula classify the somatotypes based on the skinfold thickness measurements (14). Somatotype formulations have been used in both the academics and fitness industries and to categorize an individual's body types (15). Nutrition and fitness professionals utilize the classifications for designing the exercise and diet plans, but how accurate are they? There is no substantial research to show the effects of exercises based on somatotypes. Therefore, to address these issues, the present study attempts to evaluate the effects of exercise intervention based on health-related fitness assessment, which was prescribed based on somatotypes according to the American College of Sports Medicine (ACSM).

METHODS

This study is an interventional study, in which a total number of 45 healthy male volunteers between the age group of 22 and 28 years were included, and the study was conducted in a fitness center in Chennai, the duration of the study was 3 months. Individuals with recent fractures, open wounds, ulcers, uncontrolled hypertension (systolic blood pressure >180 mmHg or diastolic blood pressure

>100 mmHg) or other cardiovascular diseases, any major active rheumatologic, pulmonary, hepatic, renal, dermatologic disease, or inflammatory conditions were excluded from the study. Ethical approval was obtained from the Institutional Ethics Committee of Sri Ramachandra Medical College and Research Institute, Tamil Nadu, Chennai. Written consent was obtained from the patients after a detailed explanation of the study, their role, risks, and benefits involved, and their rights. For this survey, we used fitness equipment's in the fitness center, standard height and weight measuring scale and tape, sit and reach the box, pulse oximeter, sphygmomanometer, and stationary materials.

After enrollment in the study, all participants were given a pre-assessment health questionnaire, consists of past and present medical history, lifestyle information, dietary patterns, and level of physical activity and exercise. Based on the questionnaire result, the participants were selected for the subjective assessment. Participants with risk factors for assessment and the exercises were excluded at this stage (ACSM Ehrman, 2010) (16). Basic subjective assessments such as height and weight were measured and body mass index (BMI) was calculated.

Health-related physical fitness assessment

Body composition

Skinfold measurements were done using a standard skinfold caliper, the skinfold measurements were made at chest, abdomen, and mid-thigh (17).

Cardiorespiratory endurance

One mile walk test was conducted using a treadmill to estimate the maximal oxygen consumption, after a few trials of walking to get familiarize with treadmill, the participants were instructed for a brisk walk at their comfortable speed to cover the distance of 1 mile, after completion of 1 mile, the heart rate (HR) was measured using pulse oximeter and time was noted (18).

Muscular strength

Leg press machine was used to assess muscular strength; the technique was demonstrated and performed by the investigator before assessing the participants. About 50–70% of the subject's perceived capacity was selected as initial weight.

With few trials and familiarization with the machine, resistance was progressively increased by 2.5–20.0 kg until the subject could not complete the selected repetition(s); all repetitions were performed at full range of motion (ROM) in the same speed of movement with normal inhalation and exhalation. The final weight lifted effectively is noted as the absolute 1- repetition maximum (RM) (19).

Muscular endurance

The push-up test was conducted to assess the muscular endurance, the participants were instructed to position the body with arms straight out, with contracted abdominal muscles tight and not to hold the breath and holding the body in a prone position. Then, lower the body until the chest is in one or two inches above the floor, with elbows pulling back at roughly a 45° angle, then push the torso away from the ground until the arms lock, then repeat. Instructions were given to maintain the normal breath during the procedure (20).

Flexibility

Assessment of low back and hamstring was done by a sit and reach test using sit and reach measuring box. The subject was made to sit on the floor with knees locked, legs stretched out, and the feet were kept flat against the box. With palms facing downward, the hands were kept on top of each other. The subject moved the hand forward along the measuring scale as far as possible without any jerky movements, when the maximum level has reached the subject remained for 1–2 seconds and the distance was noted (21,22).

Based on the assessment and observation, the participants were categorized as ectomorph (Group – A), mesomorph (Group – B), and endomorph (Group – C) which are shown in Figures 1A–C, respectively. The characteristics of the subjects was shown in Table 1. The exercise intervention was appropriately prescribed and executed based on the guidelines provided by the ACSM for the duration of 3 months, as shown in Table 2.

Intervention

Exercises were prescribed and executed based on the ACSM guidelines for exercise testing and prescription (23-30).

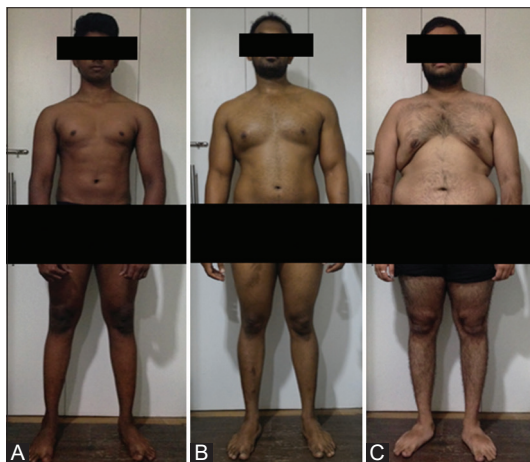


FIGURE 1. Different body types (somatotypes) (A) Ectomorph, (B) mesomorph, (C) endomorph.

TABLE 1. The characteristics of subjects mean (SD)

Age mean (SD)	Height mean (SD)	Weight mean (SD)
23.6 (5.2)	176 (3.4)	79.4 (11.5)

SD: Standard deviations

RESULTS

The statistical analyses were done using the SPSS software version 16 executed at 95% confidence interval (CI). Mean and standard deviations (SD) were calculated by descriptive statistics. The paired t-test was done to find the effectiveness of the intervention. The level of significance in all tests was set to $p < 0.05$.

The designed protocol for intervention based on somatotypes brought about significant improvement in health-related fitness parameters in ectomorphs, mesomorphs, and endomorphs. The pre- and post-exercise intervention for Groups A, B, and C are shown in Tables 3-5, respectively.

Cardiovascular endurance and the resting HR showed a positive change in all three groups. No significant weight loss was observed in Groups A and B since Group C had shown a significant reduction of weight (mean difference of 9.18 [1.52] kg and its 95% CI: 8.35–11.16), as shown in Tables 3, 4 and 5. The BMI and percentage of fat in the skinfold also recorded a significant reduction in Group C of 5.11 (1.04) kg/m² and 2.61 (0.21), respectively. Groups A, B, and C had responded equally well to

TABLE 2. The exercise prescribed and executed based on the ACSM for different somatotypes

Exercise prescribed by the ACSM guidelines	Ectomorph	Mesomorph	Endomorph
Warm-up	Joint mobilization Low step kicks (10 min/session)	Joint mobilization Low-to-moderate aerobic exercises (10 min/session)	Joint mobilization Low-to-moderate aerobic exercises (10 min/session)
Flexibility	Active stretching of all major muscles and other tightened muscles based on assessment results. (10 min/session)	Active stretching of all major muscles and other tightened muscles based on assessment results (10 min/ session)	Active stretching of all major muscles and other tightened muscles based on assessment results (10 min/session)
Cardiovascular conditioning	Weekly 2–3 days 10–15 min/session METs – 1.1–2.9	Weekly 3–4 days 20–30 min/session METs – 3–4	Weekly 5 days 30–40 min/session METs – 4–5.9
Core strengthening	Quadruped position 3–4 days/week	Plank position 3–4 days/week	Pelvic bridging 3–4 days/week
Weight training	3–4 sessions/week 2–3 sets 6–8 reps/set 2–4 min rest between sets Tempo – 2:1:4	4–5 sessions/week 2–3 sets 8–12 reps/set 30–90 sec rest between sets Tempo – 2:1:4	4–5 sessions/week 3 sets 15 reps/set 10–30 sec rest between sets Tempo – 2:1:4

Reps: Repetitions, min: Minute, sec: Second, METs: Metabolic equivalents

the intervention in the terms of muscular strength, muscular endurance, and flexibility.

DISCUSSION

Chaouachi (31) studied the effect of aerobic capacity Vo_2 max variables among 41 dominant somatotype individuals using the bicycle ergometer method with $p < 0.001$ for signs of progress in Vo_2 max and revealed that training methods should be designed based on somatotype along with aerobic exercises. In the present study, Vo_2 max was observed by a 1 mile test and the exercises were prescribed along with the cardiovascular conditioning in Groups A, B, and C, and the results showed the improvement in cardiovascular endurance with significant value ($p < 0.001$). When compared to the present study with Chaouachi study, the present study also achieved the positive results in cardiovascular endurance. Ryan-Stewart et al. (32) studied the effects of anaerobic capacity on different somatotypes among 36 participants aged between 26.0 ± 9.8 using 3RM bench press and 3RM back squats and found that mesomorphs have more muscular power and endurance levels. In the present study, health-related fitness assessment was done which includes both

cardiovascular endurance, muscular strength, and endurance tests. The pre-assessment results showed that mesomorphs can perform 1RM leg press in 60–70% of the body weight, whereas ectomorphs showed around 4–50% of 1RM and endomorphs showed 50–60% of 1RM. Thus, the present study agrees with the findings of Ryan-Stewart et al. The contrast between the present study and Chaouachi study is that the author utilized the bicycle ergometer for improving the Vo_2 max, but we have used the treadmill test to find the Vo_2 max and the cardiovascular conditioning was given. The contrast between the present study and Ryan-Stewart et al. study is that the author investigates the anaerobic capacity alone by 1RM methods. Perhaps, the present focussed on overall fitness improvement by implementing a complete fitness regimen.

The exercise was planned based on the results obtained from the health-related fitness assessment. Since the fat% is 12.46 in Group A individuals, they were prescribed with 8–10 minutes of cardiovascular conditioning to improve cardiovascular endurance. Aerobic exercises primarily activate and work type I muscle fibers and also increase the capillary size and muscle endurance. Individuals with low-fat content

also required to do some aerobic activity for a minimum of 8–10 minutes/session for around 3 days/week to improve cardiovascular endurance (33).

Isolated muscular exercises were implemented to activate the muscle contraction, these powerful and strong isolated muscle contractions cause compression in small arteries and increase the peripheral vascular resistance. Regular long-lasting muscle contraction increases the number of mitochondria and increases the size and strength in the myofibrils (34). Endurance exercises activate and promote the slow-twitch muscle fibers, these muscle fibers are capable of producing several repetitions with little force but without fatigue (35-37). In the present study, isolated strengthening exercises and endurance exercises were given based on the session/week, repetitions, duration, tempo, and rest period, respectively.

Increase in the muscle strength and endurance was observed in Groups A, B, and C, as shown in Tables 3-5. Static stretching is shown to be effective in increasing the ROM, if it occurs between 15 and 30 seconds. Cecilia F (38) et al studied the effects of static stretching among 45 subjects with hamstring tightness for a period of 6-8 weeks and observed that there is a significant change in the tightened structure. Revealed that a period of 6–8 weeks of static stretching is sufficient to increase the flexibility of hamstrings and back muscles. In the present study, flexibility of the hamstrings was assessed using the sit and reach the box, based on the results of fitness assessment, static stretching techniques were implemented for the individuals in Groups A, B, and C for 3 months and the results showed that there is an improvement in the flexibility.

TABLE 3. Evaluation of health-related fitness parameters in Group A before and after an intervention

S. No.	Parameters	Group – A (n=15)		t	p-value
		Mean (SD)			
		(Pre)	(Post)		
1.	Weight (kg)	58.66 (5.52)	58.2 (6.09)	1.46	0.401
2.	BMI (kg/m ²)	22.94 (1.46)	22.75 (1.69)	2.54	0.531
3.	Skinfold (Fat %)	12.46 (3.24)	13.17 (3.14)	1.14	0.381
4.	Heart rate (HR)	142/82 (10)	126/76 (8)	10.18	<0.001*
5.	Cardiovascular endurance	13.34 (1.44)	11.06 (2.13)	12.11	<0.001*
6.	Muscular endurance	23.53 (6.87)	30.13 (4.43)	11.56	<0.001*
7.	Muscular strength	53.33 (12.90)	61.33 (10.76)	11.67	<0.001*
8.	Flexibility	-1.8 (6.9)	2.2 (5.6)	9.22	<0.001*

*Statistically significant. SD: Standard deviation

TABLE 4. Evaluation of health-related fitness parameters in Group B before and after an intervention

S. No.	Parameters	Group – B (n=15)		t	p-value
		Mean (SD)			
		(Pre)	(Post)		
1.	Weight (kg)	71.62 (4.12)	72.12 (5.11)	3.16	0.831
2.	BMI (kg/m ²)	24.13 (1.13)	24.75 (1.19)	2.81	0.608
3.	Skinfold (Fat %)	23.14 (2.34)	23.71 (2.71)	2.12	0.422
4.	Heart rate (HR)	148/78 (12)	122/76 (10)	11.13	<0.001*
5.	Cardiovascular endurance	14.11 (1.22)	12.21 (2.12)	10.12	<0.001*
6.	Muscular endurance	29.13 (5.14)	32.18 (3.38)	11.85	<0.001*
7.	Muscular strength	63.15 (11.63)	72.13 (9.15)	10.54	<0.001*
8.	Flexibility	-2.3 (4.5)	3.4 (4.9)	10.15	<0.001*

*Statistically significant. SD: Standard deviation

TABLE 5. Evaluation of health-related fitness parameters in Group C before and after an intervention

S. No.	Parameters	Group – C (n=15)			
		Mean (SD)		t	p-value
		(Pre)	(Post)		
1	Weight (kg)	93.46 (3.68)	84.28 (2.16)	11.12	<0.001*
2	BMI (kg/m ²)	32.46 (3.23)	27.35 (2.19)	10.41	<0.001*
3	Skinfold (Fat %)	30.12 (2.64)	27.51 (2.43)	11.32	<0.001*
4	Heart rate (HR)	151/86 (14)	132/78 (8)	9.32	<0.001*
5	Cardiovascular endurance	16.19 (1.14)	13.17 (1.17)	11.18	<0.001*
6	Muscular endurance	10.12 (7.13)	17.14 (4.26)	10.16	<0.001*
7	Muscular strength	59.12 (13.47)	67.15 (8.22)	11.14	<0.001*
8	Flexibility	-4.2 (3.4)	1.3 (5.3)	9.24	<0.001*

*Statistically significant. SD: Standard deviation, BMI: Body mass index

CONCLUSION

This study reports about finding the somatotypes, and exercising based on that will provide the best results in health-related fitness components designed by the ACSM. According to the literature and our knowledge, this is the first study to design and implement the health-related fitness based on the somatotypes. To increase the health-related fitness components, a combination of warm-up exercises, flexibility training, cardiovascular conditioning, and weight training exercises must be prescribed and executed holistically based on the assessment results according to the body types. Physical activity or exercise not only maintains a healthy body but it also enhances the dynamic and creative intellectual activity. Fitness is not about building the muscle or endurance alone, neither having a six nor eight pack abdominals, a complete fitness is a combination of good muscular strength and endurance with adequate flexibility and a good proportion of body composition with satisfactory cardiovascular endurance level. The advantage of training based on the somatotypes yields the best results.

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