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Published version

A SANDS, William, R MCNEAL, Jeni, BULLOCK, Joshua, SCHILLER, Tschana, DECK, Houston, PENITENTE, Gabriella, DONTI, Olyvia and C. BOGDANIS, Gregory (2021). Body Size and Composition of U.S. National Team Skiers and Snowboarders. Journal of Sports Research, 8 (1), 16-25.

Journal of Sports Research
2021 Vol. 8, No. 1, pp. 16-25.
ISSN(e): 2410-6534
ISSN(p): 2413-8436
DOI: 10.18488/journal.90.2021.81.16.25

BODY SIZE AND COMPOSITION OF U.S. NATIONAL TEAM SKIERS AND SNOWBOARDERS

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Article History
Received: 12 March 2021
Revised: 19 April 2021
Accepted: 21 May 2021
Published: 17 June 2021

Keywords
Anthropometry
Elite athletes
Winter sports.

ABSTRACT

Athlete profiles have been a reliable means of characterizing athlete groups and individuals. Anthropometric data have been collected uniformly from 2010 to 2015 by U.S. Ski and Snowboard personnel and archived for analyses. These data involved 834 anthropometric tests on 234 individual athletes. The purpose this study was to understand these elite competitors' size, shape, and body composition. Competitors are categorized by their events: Alpine Skiing, Free Ski, FreeStyle, and Snowboard, with each event having subdisciplines. Missing data and the relative recency of some events and subdisciplines led to four athlete groups' analyses: alpine skiing, aerial skiing, moguls skiing, and snowboard halfpipe. ISAK trained anthropometrists and methods assessed the athletes. Analyses used the Kruskal-Wallis procedure. Results showed that male and female athletes differed from each other, and the alpine ski athletes were different in size and composition from the other disciplines. The non-alpine disciplines did not differ.

Contribution/Originality: This study contributes unique data on elite National Team Skiers and Snowboarders regarding anthropometry.

1. INTRODUCTION

One of the first few questions about a world-level sport is the athletes' typical sizes and shapes. Some sports nearly demand specific body sizes and shapes, while others are less restrictive. For example, gymnasts tend to be small and light (Sands, Murray, McNeal, Slater, & Stone, 2018), basketball players tend to be tall (Ziv & Lidor, 2009), and heavyweight class athletes tend to be large (Marković & Sekulić, 2006). Moreover, the distinctive characteristics of body size and shape among Olympic athletes have remained mostly stable with a few exceptions revealed by longitudinal analysis (Malina, Figueiredo, Coelho, & Silva, 2017; Rüst, Knechtle, Knechtle, Wirth, & Rosemann, 2012; Sands et al., 2018). Winter Olympic sports, alpine skiing, and snowboarding have received less scientific attention and research focus when compared to summer Olympic sports. The vast majority of research in these winter sports has involved metabolic factors such as dominate in cross-country skiing (Hébert-Losier, Zinner, Platt, Stöggl, & Holmberg, 2017) and injury in the high-speed sliding and acrobatic sports (Major, Steenstrup, Bere, Bahr, & Nordsletten, 2014; Spörri, Kröll, Gilgien, & Müller, 2017; Tarka et al., 2019). World-level alpine skiing and snowboard are governed by the International Ski Federation (F.I.S.) and nationally by the U.S Ski and Snowboard. There are eleven events, five for men and five for women, plus a Mixed Team Parallel event added to the sport in 2018. The primary performance categories are Alpine Skiing, Free Ski, FreeStyle, and Snowboard. These sports involve a myriad of subdisciplines. Alpine skiing consists of the Downhill, Super-G, Slalom, Giant Slalom, and Alpine Combined. Alpine skiing has been contested at the Olympic level since 1936, with a pause in 1940 due to World War II. Snowboard is a relatively recent addition to the world-level competition in the Winter Olympics only since 1998 as Giant Slalom and Snowboard Halfpipe. Parallel Giant Slalom followed these subdisciplines in 2002. Snowboard Cross entered in 2006, followed by Slope Style in 2010 and Big Air in 2018. Freestyle skiing, including Moguls and Aerials, was added to the Olympic events in 1992 and 1994. Although acrobatics were involved in skiing since the 1930s (Lund & Miller, 1998), the more recent trends are to add more air time, somersaults, twists, equipment grabs, and unusual "off-axis" rotations. International skiing and snowboard directions have shifted toward acrobatic and Parkour-like events while maintaining the traditional racing events (Lund & Miller, 1998). Thus, training now includes trampolines, water landings, giant airbags, overhead spotting rigs, and most commonly seen activities in gymnastics. The U.S. Ski and Snowboard provides national governance for Snowboard and Freestyle Skiing. Snowboard includes 11 events, five for men and five for women, plus Mixed Team Snowboard Cross. The Freestyle discipline consists of 13 events for men and women, including mixed team aerials, men's and women's moguls, men's and women's halfpipe, slopestyle, and big air. Big Air was included as an Olympic event for the first time in 2018 in South Korea. The term "Big Air" refers to the incredible airborne trajectories that are achieved, permitting even quadruple somersaults. While body size and composition are associated with performance in sports requiring acrobatics (Jemni, Friemel, Sands, & Mikesky, 2001), information on the anthropometric characteristics and body composition of ski and snowboard athletes is lacking. Examination of these parameters may help select key anthropometric variables to be used by coaches in the design and implementation of training programs to improve performance. The purpose of this exploratory study was to assess the characteristics of body composition and anthropometry among selected sports or disciplines within the U.S. Ski and Snowboard's purview. We hypothesized that there would be differences in body composition and anthropometry among the disciplines and subdisciplines.

2. METHODS

Physical abilities tests were undertaken for all volunteering U.S. National Team Ski and Snowboard athletes from 1/27/2010 to 10/7/2015. Basic anthropometry assessments were incorporated into the test battery. A total of 834 anthropometric tests were conducted over the six years, with the number of individual athlete (athletes N = 234) tests ranging from 1 to 10 per athlete over the period. In-depth analyses of the anthropometric data were delimited to male and female athletes in alpine skiing, aerial skiing, moguls skiing, and snowboard halfpipe based on adequate sample sizes. Table 1 provides descriptive data based on ski and competitive snowboard disciplines included in this study.

All data were collected by U.S. Ski and Snowboard personnel and stored in athlete information databases. This study was conducted on these archived data in which all names or other personal identification were removed, and only group data are reported. This study was approved by the Eastern Washington University Institutional Review Board on the Study of Human Subjects.

2.1. Equipment and Procedures

Athletes were weighed and measured for height using a calibrated floor scale (Tanita BWB-800, Tokyo, Japan) and a wall-mounted calibrated stadiometer (Holtain Ltd, Crosswell, Crymych, Pembrokeshire, United Kingdom). The skinfold calipers and tape measure were calibrated Harpenden types (Harpenden, Ann Arbor, MI, U.S.A.).

All skinfold and anthropometric variables were measured twice, and again a third time if the first two values were discrepant by five mm or more for skinfolds, skeletal breadths, height, and approximately three cm for anthropometric measures of girths (Kinanthropometry, 2001). All measurement personnel was ISAK Level I trained, and the format for skinfolds, circumferences, mass, and height measurements followed the ISAK Level I protocols (Kinanthropometry, 2001). All pairs of testing trials were averaged for further analyses (Henry, 1967). The sums of skinfolds were made available to the athletes while the percent fat values were not calculated nor communicated at the time of data collection or since (Norton et al., 2000; Sands, Irvin, & Major, 1992). For this paper, body density values were calculated from Durnin and Womersley's work (Durnin & Womersley, 1974), and percent fat values were calculated from body densities via the Siri equation (Siri, 1956). Somatotype scores were calculated based on the protocol described by Carter and colleagues (Carter, 1996; Martin, Carter, Hendy, & Malina, 1991; Norton et al., 1996; Norton et al., 2000).

3. DATA ANALYSIS

Due to the relative scarcity of information on anthropometry and body composition of the ski and snowboard disciplines, we present the information as an exploratory study emphasizing hypothesis generation above hypothesis acceptance or rejection. Data were obtained from archived computer database files. Only complete test records for body composition and anthropometric variables were used for further analyses. The most recent data were used when athletes had been involved in multiple tests over six years. Descriptive data Table 1 and statistical sport discipline group differences were calculated using IBM SPSS Statistics™, Version 27. Graphics were created via Microsoft Excel® (Microsoft® Excel® 2019 M.S.O.). As shown in Table 1, the alpine disciplines, moguls, aerials, and snowboard halfpipe had the largest numbers of athlete records for both sexes. Statistical analyses, beyond descriptive statistics, were focused on these four groups. Analyses consisted of multiple variables across four athlete groups or disciplines. Variables included: age, height, mass, skinfold sum, percent body fat, endomorphy scores, mesomorphy scores, and ectomorphy scores. Assessment of data distribution normality (Shapiro-Wilks) showed that only the variable height was normally distributed across all team groups. Given the violation of ANOVA assumptions, the non-parametric Kruskal-Wallis test was used. Asymptotic statistics values determined statistical significance. Statistical significance was set at $\rho \leq 0.05$ in keeping with the study's exploratory nature (Biesecker, 2013; Hébert-Losier et al., 2017; Porter, 1993).

4. RESULTS

Table 1 provides descriptive data across all of the selected sports under the U.S. Ski and Snowboard umbrella. The number of groups with data in the physical abilities archive was eight. We chose to further analyze four of these groups based on their larger sample sizes and both genders' presence. We hypothesized that differences would be shown among the four disciplines, and this was confirmed by the Kruskal-Wallis tests of each gender and pairwise comparisons (Sokal & James, 1969). The overall analysis of males across the four sports and eight variables indicated statistical differences for all variables. Females showed fewer specific variable differences, with age, endomorphy scores, ectomorphy scores, body density, and percent body fat not reaching statistical significance (all $\rho > 0.05$). Tables 2 (Males) and 3 (Females) show the pairwise comparisons of the eight dependent variables across the six athlete groups, including the Kruskal-Wallis test statistics and the asymptotic statistical significance values for pairwise comparisons. Note that all of the pairwise statistical differences involved alpine versus the remaining sports disciplines.

Table-1. Descriptive Statistics of Male and Female U.S. Ski and Snowboard National Team Members, Demographics, Body Composition, and Somatotype Score.

	Alpine			Alpine			Moguls			Moguls			Aerials			Aerials			Snowboard Half Pipe						Snowboard Cross						Ski Slope Style			Snowboard Slalom			Ski Half Pipe		
	♂		♂	♀		♀	♂		♂	♀		♀	♂		♂	♀		♀	♂		♂	♀		♀	♂		♂	♀		♀	♀		♀	♂		♂	♂		♂
	Mean		SD	Mean		SD	Mean		SD	Mean		SD	Mean		SD	Mean		SD	Mean		SD	Mean		SD	Mean		SD	Mean		SD	Mean		SD	Mean		SD	Mean		SD
n =	34			32			11			14			13			10			15			12			11			5			9			8			6		
Demographics																																							
Age at Test (yr)	21.38	±	3.56	20.26	±	3.80	21.32	±	2.27	20.96	±	2.77	20.26	±	3.46	20.14	±	4.70	18.12	±	2.09	19.88	±	4.51	24.83	±	4.06	21.25	±	3.86	21.86	±	3.76	19.88	±	3.49	18.42	±	1.9
Height (cm)	181.92	±	5.30	167.61	±	5.74	175.73	±	5.93	164.56	±	4.36	174.76	±	6.12	162.70	±	6.74	174.20	±	8.11	161.93	±	5.76	180.96	±	6.80	164.60	±	3.60	168.00	±	12.15	175.39	±	2.18	175.65	±	3.8
Mass (kg)	85.77	±	7.27	67.43	±	6.36	70.13	±	6.03	59.09	±	4.63	69.92	±	7.54	58.00	±	6.39	68.53	±	10.35	58.62	±	4.59	80.26	±	7.90	62.31	±	3.86	62.44	±	10.22	70.15	±	5.51	71.87	±	9.2
Height /Weight Ratio	41.30	±	1.19	41.24	±	1.22	42.67	±	1.47	42.29	±	0.86	42.49	±	1.18	42.13	±	2.27	42.70	±	1.29	41.72	±	1.15	42.02	±	1.43	41.55	±	1.20	42.45	±	1.73	42.58	±	0.90	42.36	±	1.2
Skinfold Thickness																																							
Subscapular (mm)	10.41	±	2.63	15.65	±	4.16	7.15	±	1.21	9.45	±	2.31	8.84	±	2.45	10.46	±	4.00	7.77	±	2.01	9.53	±	3.84	8.62	±	2.21	11.50	±	3.22	10.09	±	3.09	7.84	±	1.18	7.43	±	1.1
Triceps (mm)	9.96	±	3.06	11.16	±	3.53	6.22	±	1.14	13.37	±	3.43	8.72	±	3.61	12.85	±	4.25	8.06	±	2.35	14.95	±	5.17	6.85	±	2.07	15.70	±	4.83	13.64	±	3.78	8.98	±	3.02	7.47	±	2.1
Biceps (mm)	4.46	±	1.60	7.26	±	4.26	3.29	±	0.64	5.60	±	2.10	4.15	±	1.82	7.38	±	3.58	3.91	±	1.16	6.44	±	2.07	3.00	±	0.66	7.02	±	1.82	6.80	±	2.63	4.21	±	1.44	3.38	±	0.8
Iliac Crest (mm)	14.94	±	4.82	16.79	±	5.19	8.71	±	2.22	13.92	±	5.10	10.62	±	5.32	16.39	±	7.82	9.38	±	3.50	15.24	±	4.85	11.53	±	4.97	16.94	±	4.71	19.27	±	2.72	10.45	±	3.76	10.03	±	2.3
Supraspinale (mm)	9.19	±	3.34	12.67	±	5.34	5.62	±	1.37	8.70	±	3.20	7.52	±	3.65	10.18	±	4.53	6.03	±	2.06	10.50	±	3.21	6.87	±	2.72	12.90	±	2.89	12.44	±	4.87	6.71	±	1.52	6.60	±	1.9
Abdominal (mm)	14.95	±	6.22	18.98	±	6.90	9.58	±	2.63	15.14	±	5.91	11.71	±	5.85	15.65	±	6.05	9.89	±	4.09	15.62	±	4.59	13.40	±	8.07	16.44	±	4.87	17.86	±	6.43	9.60	±	2.27	10.53	±	3.2
Thigh (mm)	11.15	±	3.53	13.82	±	4.80	8.25	±	2.15	11.56	±	2.35	9.66	±	3.49	9.87	±	3.64	9.74	±	4.59	11.78	±	3.86	8.38	±	3.47	11.80	±	1.94	12.11	±	2.84	11.43	±	3.76	10.67	±	2.0
Calf (mm)	8.42	±	2.63	23.42	±	6.19	5.99	±	2.18	20.09	±	5.80	7.25	±	3.23	18.00	±	5.36	7.01	±	2.63	18.79	±	5.83	5.21	±	1.65	17.24	±	3.24	18.31	±	3.30	7.58	±	2.74	7.13	±	1.9
Skinfold Sums																																							
Sum 7 Skinfolds (mm)	68.55	±	17.86	102.96	±	27.26	46.10	±	7.29	83.92	±	20.60	57.84	±	21.21	84.38	±	28.02	52.41	±	15.45	87.61	±	20.43	52.35	±	16.94	92.60	±	17.37	91.26	±	22.40	56.34	±	13.72	53.22	±	10.7
Sum 4 Skinfolds (mm)	51.01	±	13.49	60.23	±	17.44	32.75	±	5.96	58.61	±	16.28	40.82	±	15.60	60.49	±	21.18	37.07	±	12.25	59.18	±	14.18	40.17	±	15.62	62.12	±	12.00	65.52	±	12.66	40.45	±	10.73	38.70	±	8.7
%Fat Sum 4 Skinfolds	15.77	±	0.02	27.88	±	4.13	10.67	±	1.43	25.51	±	3.76	13.00	±	4.09	26.57	±	5.51	12.10	±	2.69	18.62	±	3.49	12.45	±	3.21	28.33	±	3.51	27.94	±	3.39	12.97	±	3.09	11.86	±	3.3
Girths																																							
Arm relaxed (mm)	33.24	±	1.91	28.96	±	1.79	29.94	±	2.41	27.17	±	1.35	29.57	±	1.86	27.01	±	2.40	29.59	±	2.50	28.01	±	1.56	32.69	±	1.49	29.50	±	2.29	27.53	±	1.92	30.49	±	1.97	30.62	±	2.6
Arm flexed (mm)	35.62	±	1.85	30.29	±	1.44	32.59	±	2.62	28.29	±	1.32	32.03	±	1.73	28.57	±	1.93	31.75	±	2.71	28.61	±	1.16	35.40	±	1.68	30.49	±	1.87	27.82	±	1.77	32.68	±	1.87	32.23	±	2.7
Waist (cm)	84.54	±	4.93	71.86	±	3.87	76.11	±	4.48	66.66	±	3.11	75.86	±	4.80	67.48	±	4.95	75.15	±	6.87	68.49	±	3.17	81.43	±	4.65	70.98	±	3.84	71.27	±	4.70	74.60	±	1.54	76.95	±	6.3
Hips (cm)	101.79	±	5.60	99.75	±	4.65	93.42	±	2.92	94.06	±	3.85	93.53	±	4.27	91.94	±	5.49	94.55	±	5.71	94.68	±	3.31	98.47	±	3.67	97.51	±	3.00	97.62	±	5.27	95.01	±	2.88	95.38	±	5.3
Mid-Thigh-R (cm)	57.40	±	3.29	53.55	±	4.50	50.56	±	6.13	50.66	±	2.49	52.05	±	2.95	49.78	±	3.74	50.06	±	5.83	50.63	±	2.86	54.42	±	2.93	51.82	±	3.88	49.86	±	2.54	51.18	±	3.48	52.65	±	3.7
Mid-Thigh-L (cm)	57.16	±	3.19	53.19	±	4.36	50.44	±	6.35	50.36	±	2.56	51.67	±	2.89	49.77	±	3.81	49.93	±	5.90	50.24	±	2.65	53.72	±	2.42	51.26	±	3.62	50.32	±	3.04	52.06	±	3.16	52.23	±	3.3
Calf (cm)	37.80	±	1.86	35.62	±	1.80	33.43	±	10.73	33.61	±	1.07	35.15	±	2.44	33.49	±	2.19	36.09	±	3.96	31.88	±	9.17	37.03	±	1.80	35.04	±	2.28	34.39	±	2.18	35.86	±	2.15	36.32	±	2.3
Skeletal Breadths																																							
Humerus (cm)	7.63	±	0.48	6.69	±	0.32	7.02	±	0.33	6.14	±	0.32	7.13	±	0.28	6.28	±	0.31	7.35	±	0.53	6.37	±	0.22	7.47	±	0.28	6.56	±	0.24	6.33	±	0.55	7.73	±	0.89	6.95	±	0.4
Femur (cm)	9.90	±	0.62	9.21	±	0.36	9.46	±	0.36	8.74	±	0.34	9.46	±	0.36	8.70	±	0.45	9.58	±	0.74	8.79	±	0.26	9.82	±	0.41	8.80	±	0.29	8.89	±	0.67	8.79	±	1.03	9.67	±	0.3
Somatotype Scores																																							
Endomorphy Score	2.92	±	0.80	3.99	±	1.10	1.78	±	0.28	3.22	±	0.81	2.45	±	0.96	3.42	±	1.23	2.11	±	0.59	3.60	±	0.95	2.13	±	0.73	4.11	±	0.90	3.67	±	1.07	2.30	±	0.58	2.07	±	0.4
Mesomorphy Score	5.24	±	0.89	4.64	±	0.94	4.00	±	1.77	3.56	±	0.60	4.40	±	0.99	3.84	±	1.35	4.89	±	1.04	4.01	±	1.70	5.02	±	1.05	4.63	±	1.09	3.56	±	0.96	4.68	±	1.04	4.63	±	0.8
Ectomorphy Score	1.72	±	0.77	1.68	±	0.79	2.66	±	1.07	2.38	±	0.63	2.53	±	0.84	2.37	±	1.51	2.68	±	0.94	2.00	±	0.79	2.21	±	1.00	1.89	±	0.81	2.52	±	1.22	2.59	±	0.66	2.43	±	0.9
Somatotype Categories	Endomorphic			Endomorphic			Ectomorphic			Endomorphic			Balanced			Endomorphic			Ectomorphic			Endomorphic			Balanced			Endomorphic			Mesomorphic			Balanced			Balanced		
	Mesomorph			Mesomorph			Mesomorph			Mesomorph			Mesomorph			Mesomorph			Mesomorph			Mesomorph			Mesomorph			Mesomorph			Endomorph			Mesomorph			Mesomorph		

Note: SD = Standard Deviation, ♂ = Male, ♀ = Female.

Table-2. Male pairwise comparisons for dependent variables and athlete groups.

Males		Age KW	Age $\rho_{adjusted}$	Height KW	Height $\rho_{adjusted}$	Mass KW	Mass $\rho_{adjusted}$	Endomorphy KW	Endomorphy $\rho_{adjusted}$	Mesomorphy KW	Mesomorphy $\rho_{adjusted}$	Ectomorphy KW	Ectomorphy ρ	Body Density KW	Body Density ρ	Percent Fat KW	Percent Fat ρ
Aerials - Alpine				-22.325	0.008	-31.456	0.000					18.324	0.049				
SB HP - Alpine		20.515	0.011	20.932	0.009	32.423	0.000	20.916	0.000			-20.524	0.011	-22.564	0.004	22.564	
Moguls - Alpine		24.136	0.025			31.138	0.000	31.019	0.009					-31.670	0.000	31.670	
Aerials - Moguls																	
SB HP - Moguls																	
SB HP - Aerials																	

Note: KW = Kruskal-Wallis Test Statistic.

Table-3. Female pairwise comparisons for dependent variables and athlete groups.

Females		Age KW	Age $\rho_{adjusted}$	Height KW	Height $\rho_{adjusted}$	Mass KW	Mass $\rho_{adjusted}$	Endomorphy KW	Endomorphy $\rho_{adjusted}$	Mesomorphy KW	Mesomorphy $\rho_{adjusted}$	Ectomorphy KW	Ectomorphy ρ	Body Density KW	Body Density ρ	Percent Fat KW	Percent Fat ρ
Aerials - Alpine						-27.184	0.001										
SB HP - Alpine				19.552	0.021	23.693	0.002										
Moguls - Alpine						23.342	0.001			22.379	0.002						
Aerials - Moguls																	
SB HP - Moguls																	
SB HP - Aerials																	

Note: KW = Kruskal-Wallis Test Statistic.

Somatographs were created to obtain visual information about the athletes' sizes and shapes, allowing visual comparisons across the disciplines. Figure 1 shows the somatographs of both genders and each discipline. Squares represent individual male athlete values and group means. Circles represent individual female athletes and group means. Figure 1-F shows the combined somatographs of ski slopestyle for women, snowboard slalom for men, and ski halfpipe for women.

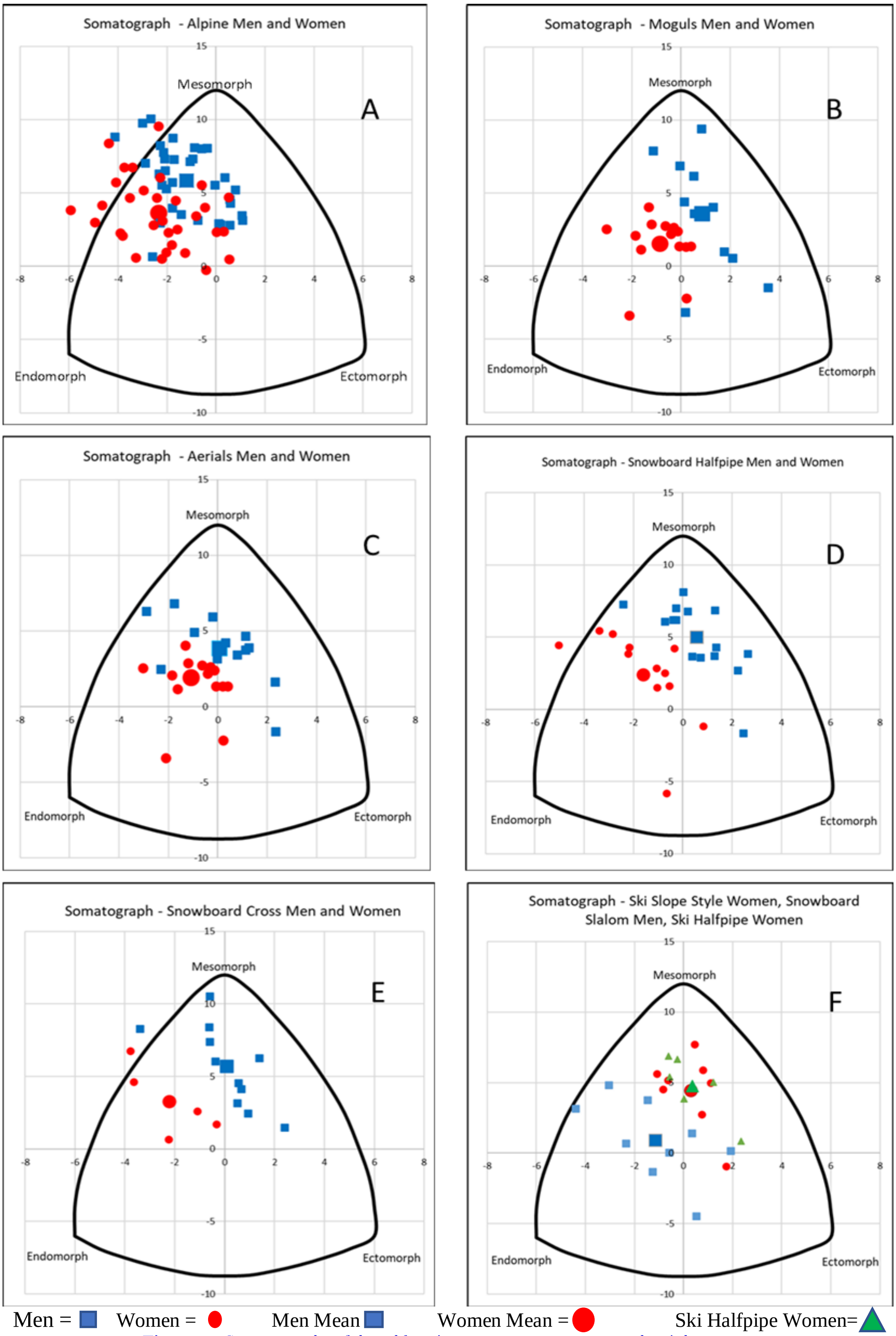

Figure-1. Somatographs of the athletes' somatotype scores across the eight sports.

5. DISCUSSION

The results of this exploratory study indicated that we should reject the null hypothesis of no differences among the selected disciplines with either males or females. Moreover, Tables 2 and 3 show that the alpine discipline was statistically different in several variables from the other disciplines, which were not statistically different from each other. The alpine athletes tended to be bigger and heavier than the other disciplines' athletes (Andersen & Montgomery, 1988). The idea of larger alpine athletes is supported by the patterns observed in the somatographs Figure 1. Although not presented here, strength is a significant factor in world-class alpine skiing in concert with the high ground reaction forces that reach five times body weight during turns (Supej & Holmberg, 2019). Male alpine athletes differed from snowboard halfpipe and moguls athletes in terms of endomorphy scores. Male alpine athletes also differed from aerials and snowboard halfpipe in ectomorphy. World-class ski athletes tend to be in their twenties, supported by this study Table 1 (Neumayr et al., 2003). The athletes in snowboard halfpipe, ski halfpipe, snowboard slalom had average ages less than 20 y.

Somatotype categories Table 1 showed that six of the thirteen groups or disciplines were categorized as endomorphic-mesomorphs. Two disciplines were categorized as ectomorphic-mesomorphs. Four disciplines were categorized as balanced mesomorphs. One discipline was categorized as a mesomorphic-endomorph (Carter & Heath, 1990; Carter, 1996; Carter, 2002). "Today, successful skiers are taller and heavier than their predecessors. Slalom skiers tend to be leaner than skiers in other events while the downhill racers are the heaviest." (Andersen & Montgomery, 1988), p 210. A previous investigation of the relative age-effect with youth skiers showed that those skiers with first-quarter birthdays obtained an advantage relative to later-born skiers in terms of increased height and body mass (Müller, Hildebrandt, & Raschner, 2015). Greater height and body mass (i.e., anthropometric variables) may be essential selection criteria for talent identification among youth alpine skiers (Müller et al., 2015).

One might consider the variables addressed in this paper as too permanent with little potential for modification and therefore offer a trivial influence on skiing and snowboarding success. However, even physical fitness testing and monitoring have shown minimal changes across an entire alpine skiing season (Andersen & Montgomery, 1991). Moreover, a field-test battery was able to differentiate among giant slalom skiers without including anthropometry (Andersen, Montgomery, & Turcotte, 1990). Interesting to note that a document from U.S. Ski and Snowboard presents five pages of developmental guidelines for alpine skiing, including the domains of Developmental Phase, Physical Fitness, Technical, Tactical, Equipment Selection, and Preparation, Mental Training, and Competition, but neglects any mention of anthropometric measurements except for using peak height velocity as an age-related maturation marker (U.S. Ski and Snowboard Association, 2017).

Body composition assessments remain useful despite no "gold standard" methodology (Ackland et al., 2012; Mazić et al., 2014). The physical structure of winter sports athletes has shown the ability to discriminate among various winter sports (Orvanova, 1987). Application of body composition methods and current understanding has led to performance-enhancing aspects of multiple substances and their influence on the athlete (Sonksen, 2018). Among female winter sports athletes, sports participation's osteogenic capabilities have been noted along with higher fat-free mass and lower fat mass (Meyer et al., 2004). Correlations between speed rankings and body weight were moderate among female alpine speed skiers; high-speed rankings were also associated with higher relative fat mass (Vermeulen et al., 2017). High male alpine speed rankings for males were associated with lower ectomorphy, further supporting the role of muscular strength among male alpine skiers (Vermeulen et al., 2017).

Athletes, coaches, and scientists make comparisons among performance groups of interest. We commonly observe junior and senior skiers and snowboarders regarding an athlete's status relative to their sport's highest levels. Anthropometric measurements provide one of the simplest and common datasets compared with other winter sports athletes, sports, and national teams.

6. CONCLUSION

Skiing and snowboarding success at the highest levels is undoubtedly based on many factors. Among these factors, such as terrain, lighting, snow conditions, temperature, and many others, the role of anthropometry and body composition should not be ignored. As of this writing, skiers and snowboarders face enormous threats to training and access to travel and competition based on the COVID-19 pandemic. Perhaps now more than ever, the records of skier and snowboarder size and shape may be pertinent to the understanding and development of training plans, talent identification, and influence of the pandemic on athlete performances.

Funding: This study received no specific financial support.
Competing Interests: The authors declare that they have no competing interests.
Acknowledgement: All authors contributed equally to the conception and design of the study.

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