Original Article

Comparisons of physical fitness and body composition among Sasang types with and without body mass index as a covariate

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ABSTRACT

Background: The purpose of this study was to examine the difference of physical fitness and body composition among Sasang types with BMI as covariate, which is reported to have influence on physical fitness and body composition.
Methods: We measured the physical fitness and body composition of 930 korean female college students, and compared the differences among Sasang type groups with or without considering Body Mass Index (BMI). We evaluated muscle strength, agility, muscle endurance, power and flexibility for the physical fitness, and total body water, protein, muscle mass, mineral, lean body mass and fat mass for the body composition.
Results: We got 352 So-Yang (SY), 385 So-Eum (SE), and 193 Tae-Eum (TE) Sasang types, and there were significant differences among Sasang types in height, weight and BMI. The significant differences among TE and SY types were disappeared in muscle strength, total body water, protein when BMI is used as a covariate. In ANOVA, there were significant differences that TE was higher on the mineral and fat mass compared to the SY type and SE type. However it disappeared when we introduced BMI as covariate.
Conclusion: The results demonstrated that the BMI should be considered as an important element for studying physical characteristics of Sasang typology.

1. Introduction

In Korea, the Sasang typology by Lee Je-Ma groups humans into Tae-Yang (TY), So-Yang (SY), Tae-Eum (TE), and So-Eum (SE) types on the basis of functional differences of internal organs. Each Sasang type has consistent characteristics of physical appearance, physiology, and temperament. Because of these different traits, the diagnosis and treatment of diseases and regimen differ for each Sasang type.[1] The usefulness of the Sasang typology has been recently demonstrated in clinical medicine and in various fields such as nursing,[2] food,[3] architecture,[4] education,[5] literature,[6] and physical education.[7–10] This illustrates the usefulness of the

characteristics of Sasang typology in multiple aspects of health improvement such as disease treatment and extensive understanding of human beings.

In particular, the application of Sasang types to physical education is very promising. It modifies the stereotyped practical skill teaching method by introducing personal abilities based on temperament and physical characteristics. This requires the development and application of an exercise program that would fit a patient's constitution, temperament, and physical characteristics, according to the Sasang type. Studies conducted to date have reported differences between the Sasang types in body composition and physical fitness;[7,9,11–13] however, they fail to consider differences between the Sasang types in body shape.

According to the record in the *Dong-yi-soo-se-bo-won* for the physical characteristics of each Sasang type, the TE type is normally tall and well built.[1] The physical frame of the TE type is strong and solid. The SE type has a small frame and is thin and weak. People of the SY type are small in stature and have a tidy appearance, resembling the SE type. The body of the TE type is the largest among the Sasang types and the bodies of SE and SY are small and similar to each other.

In the Questionnaire of Sasang Constitution Classification II (QSCCII) used in this study, sections 1–6 are composed of questions on body shape and physique. This questionnaire has demonstrated differences in body shape and physique among the Sasang types. The QSCCII contents are as follows: Question 1, "what is your physique?"; Question 2, "what is your body shape?"; Question 3, "what is the ratio between your upper and lower body in your body shape?"; Question 4, "which of the following types does your body shape belong to?"; Question 5, "which of the following types does your appearance and physique belong to?"; and Question 6, "which of the following types does your chest belong to?"

The differences in body shape among the Sasang types have been recently confirmed objectively by measurements using dual-energy X-ray absorptiometry. Body shape and body mass index (BMI) of the TE type are reportedly the highest among the Sasang types.[7,9,11–15]

Body shape is related to body composition and physical fitness.[16,17] In particular, the BMI (kg/m^2), which is used internationally as a measure of obesity, shows a correlation with physical fitness and body composition.[18,19] It has been reported that BMI affects physical fitness.[20–23]

Chae[15,24] reported large differences in BMI among the Sasang types, and subsequently published a series of studies regarding Sasang personality.[25–32] Ko and You[33] reported that the BMI affects physical fitness factors. These studies indicate that the differences in BMI among Sasang types may affect body composition and physical fitness, and that BMI is an important variable in the physical characteristics of the Sasang types. Therefore, it is necessary to confirm the differences in physical fitness among the Sasang types by controlling differences in BMI. The pure effect of an independent variable on a dependent variable can be confirmed by controlling a nuisance factor that could affect the dependent variable using analysis of covariance (ANCOVA).

This study was performed to investigate the effect of BMI on constitution, physical fitness, and body composition by statistically comparing analysis of variance (ANOVA) analysis and ANCOVA analysis for the same study participants.

2. Methods

2.1. Participants

The participants in the present study comprised 930 Korean female college students in their 20s who did not have a specific disease and did not exercise regularly.

We used the QSCCII for the Sasang type classification and measured body composition using a body composition analyzer. A total of 1673 women were initially enrolled; however, participants who insincerely responded to the QSCCII, body composition analysis, and physical fitness measures were excluded in the analysis. In addition, participants who were not classified into a Sasang constitution type were excluded. The estimate of the power according to the sample size was performed using the G*-power program.[34] Power (1-β err prob) was 0.999 in the ANOVA and ANCOVA analyses. All participants in this study submitted informed, written consent.

2.2. Method

2.2.1. Sasang type categorization
The Sasang types were classified, based on QSCCII. The QSCCII is a constitution classification questionnaire developed by Kim et al.[35] It is composed of 121 self-report items,

Table 1 – Methods for measuring physical fitness	
Factors	Method for the measurements
Grip strength	Grip strength was measured using a Smedley dynamometer (TKK 5401, Japan). The participants griped the dynamometer with four fingers, except the thumb, and controlled the width of the handle. The arms were naturally lowered. Maximum strength was applied to the dynamometer without touching the body.
Agility	Tapping was measured by pressing a number for 10 seconds using an automatic count, pen tapping-type equipment (Casio HS-3V, China).
Muscular endurance	The participants lay on a mattress with knees bent at a 90° angle. Fingers were interlinked behind the head. On the command "go", they began raising the upper body forward to touch the elbows, and then lowered back to the floor (Casio HS-3V, China).
Power	The participants stood on a long jump mat (NISPO NJM-425, Taiwan), with the legs spread 10–20 cm apart. The individual then jumped, using the rebound of the body, arms, and legs. The length was measured from the board to the closest body part.
Flexibility	The participants sat on a measuring apparatus with the legs straightened so that both soles touched the perpendicular plane (Spotop VIC-E-112, Korea). The individuals then slowly bent over and pushed the apparatus with the middle fingers.

Table 2 – General characteristics of the participants

	So-Yang (n = 352)	Tae-Eum (n = 193)	So-Eum (n = 385)	Total (n = 930)	F value	*Post hoc* test results
Age	21.12 (1.89)	20.95 (1.75)	21.25 (1.85)	21.13 (1.86)	1.74	
Height	162.24 (4.72)	162.69 (5.10)	160.97 (4.97)	161.81 (4.95)	10.126 [†]	TE > SE, SY > SE
Weight	52.82 (4.57)	61.12 (6.37)	51.32 (5.48)	54.06 (6.83)	226.447 [†]	TE > SY > SE
BMI	20.07 (1.58)	23.19 (2.18)	19.78 (1.79)	20.60 (2.24)	252.681 [†]	TE > SY, TE > SE

The data for each group are presented as the mean (standard deviation).

[†] $p < 0.01$.

BMI, body mass index; SE, So-Eum; SY, So-Yang; TE, Tae-Yang.

which include physical features, psychological characteristics, and pathophysiological symptoms. The Cronbach's alpha was 0.5708–0.6319, and the correctly predicted percentage was 70.08%.[35–37]

2.2.2. Body composition
Body composition was measured which factors are the most commonly applied. Total body water, protein, minerals, muscle mass, lean body mass and fat mass of body composition were measured using a body composition analyzer (Inbody 720; Biospace, Seoul, Korea). The height was measured separately (Anthropometer; Samhwa, Seoul, Korea). The women were measured in an upright stance with electrolytes placed at the hands and soles to measure the currents.

2.2.3. Physical fitness
For physical fitness, muscular strength was measured by grip strength (kg); agility, by tapping (number of taps/10 s); muscular endurance, by sit ups (number of times/min); power, by a standing long jump (cm); and flexibility, by trunk flexion (cm). All data were measured twice, except muscle endurance. The detailed methods for each measure are described in Table 1.

2.3. Data analysis

This study collected data from the QSCCII, body composition analysis, and measurements of physical fitness of the female students. The correlation between the BMI and physical fitness and body composition factors was assessed using Pearson's correlation. The difference between the Sasang types in body composition and physical fitness were analyzed using one-way ANOVA and ANCOVA with BMI as the covariate. *Post hoc* analysis of Scheffe or Dunnett's T3 was performed with the consideration of Leven's test. The data are expressed as the mean and the standard deviation, and the results of ANCOVA analysis are expressed as the estimated mean and standard

deviation. Statistical significance was accepted at $p < 0.05$ and $p < 0.01$. All analyses were conducted using IBM SPSS Statistics 20.0 (IBM, Armonk, NY, USA).

3. Results

The results are divided into four sections. The first section describes the general characteristics of the participants. The second section describes the correlation between the BMI and the measurement factors. The third section describes the difference in physical fitness and body composition between the Sasang types, based on ANOVA. The fourth section describes the difference in physical fitness and body composition between the Sasang types with BMI as the covariate, based on ANCOVA.

3.1. General characteristics of the participants

The mean age, height, weight, and BMI are described in Table 2. The mean age of the entire participants was 21 ± 1.89 years. There were no significant differences in age between the Sasang types ($F = 1.74$, $p = 0.176$). There were significant differences among the Sasang types in height ($F = 10.126$, $p < 0.001$), weight ($F = 226.447$, $p < 0.001$), and BMI ($F = 252.681$, $p < 0.001$). The *post hoc* test revealed that TE and SY types were taller than the SE type. Weight was highest in the TE type, followed by (in decreasing order) the SY type and SE type; this difference was significant. The BMI was higher in the TE type than in the SY and SE types.

3.2. Correlation between the BMI and the measured variables for each Sasang type

The correlation between BMI and measured variables analyzed using Pearson's correlation is presented in Table 3. For

Table 3 – Correlation between the body mass index (BMI) and measurement factor for each Sasang type

		Muscular strength	Agility	Muscular endurance	Power	flexibility	Total body water	Protein	Muscle mass	Mineral	Lean body mass	Fat mass
SY		0.133 [*]	0.090	0.053	0.065	0.111 [*]	0.443 [†]	0.251 [†]	0.434 [†]	0.251 [†]	0.446 [†]	0.750 [†]
TE	BMI	0.210 [†]	-0.037	0.028	00.021	0.150 [*]	0.416 [†]	0.328 [†]	0.509 [†]	0.169 [*]	0.517 [†]	0.818 [†]
SE		0.185 [†]	-0.066	0.068	0.060	0.053	0.409 [†]	0.286 [†]	0.477 [†]	0.189 [†]	0.471 [†]	0.793 [†]

[*] $p < 0.05$.

[†] $p < 0.01$.

SE, So-Eum; SY, So-Yang; TE, Tae-Yang.

Table 4 – Physical fitness and body composition for each Sasang type

	So-Yang (n = 352)	Tae-Eum (n = 193)	So-Eum (n = 385)	Total (n = 930)	F value	Post hoc test results
Muscular Strength	23.34 (4.14)	24.63 (4.96)	22.05 (4.28)	23.08 (4.48)	23.231 [†]	TE > SY > SE
Agility	70.02 (7.26)	70.12 (7.30)	69.96 (7.96)	70.02 (7.56)	0.027	
Muscular endurance	23.72 (10.30)	23.46 (9.75)	22.94 (10.74)	23.34 (10.37)	0.540	
Power	147.27 (26.83)	146.11 (25.66)	141.00 (21.34)	144.43 (24.59)	6.629 [*]	SY > SE
Flexibility	16.42 (8.78)	18.05 (8.20)	16.44 (8.43)	16.77 (8.53)	2.762	
Total body water	27.34 (2.11)	29.51 (3.69)	26.44 (2.68)	27.42 (3.04)	76.104 [†]	TE > SY > SE
Protein	9.01 (1.31)	9.83 (1.50)	8.47 (1.31)	8.95 (1.44)	65.495 [†]	TE > SY > SE
Muscle mass	36.48 (2.90)	39.83 (4.07)	35.21 (3.27)	36.65 (3.74)	124.980 [†]	TE > SY > SE
Mineral	2.44 (0.25)	2.67 (0.62)	2.45 (0.43)	2.49 (0.44)	21.382 [†]	TE > SY, SE
Lean body mass	38.83 (3.07)	42.36 (4.20)	37.51 (3.43)	39.01 (3.91)	125.426 [†]	TE > SY > SE
Fat mass	14.07 (2.75)	18.88 (3.98)	13.79 (3.19)	14.95 (3.79)	181.494 [†]	TE > SY, SE

The data for each group are presented as the mean (standard deviation).

[*] $p < 0.05$.

[†] $p < 0.01$.

SE, So-Eum; SY, So-Yang; TE, Tae-Yang.

the SY type, the analysis showed that the BMI had a low positive correlation with muscular strength ($r = 0.133$, $p < 0.001$), flexibility ($r = 0.111$, $p < 0.05$), protein ($r = 0.251$, $p < 0.001$.), and minerals ($r = 0.251$, $p < 0.001$), whereas the BMI had a high positive correlation with total body water ($r = 0.443$, $p < 0.001$), muscle mass ($r = 0.434$, $p < 0.001$), lean body mass ($r = 0.446$, $p < 0.001$), and fat mass ($r = 0.750$, $p < 0.001$). For the TE type, the analysis showed that the BMI had a low positive correlation with muscular strength ($r = 0.210$, $p < 0.001$), flexibility ($r = 0.150$, $p < 0.05$), and minerals ($r = 0.169$, $p < 0.05$), whereas the BMI had a high positive correlation with total body water ($r = 0.416$, $p < 0.001$), protein ($r = 0.328$, $p < 0.001$), muscle mass ($r = 0.509$, $p < 0.001$), lean body mass ($r = 0.517$, $p < 0.001$), and fat mass ($r = 0.818$, $p < 0.001$). For the SE type, the results showed that the BMI had a low positive correlation with muscular strength ($r = 0.185$, $p < 0.001$), protein ($r = 0.286$, $p < 0.001$), and minerals ($r = 0.189$, $p < 0.001$), whereas the BMI had a high positive correlation with total body water ($r = 0.409$, $p < 0.001$), muscle mass ($r = 0.477$, $p < 0.001$), lean body mass ($r = 0.471$, $p < 0.001$), and fat mass ($r = 0.793$, $p < 0.001$). The correlation differed based on the Sasang types. For the TE type, the

correlation between BMI and other the variables were higher than for the other types.

3.3. Differences in physical fitness and body composition between the Sasang types

The results of one-way ANOVA analysis are presented in Table 4. Physical fitness among the Sasang types showed significant differences in muscular strength ($F = 23.231$, $p < 0.001$) and power ($F = 6.629$, $p < 0.001$). Post hoc tests revealed that muscular strength was highest in the TE type, followed by (in decreasing order) the SY type and SE type. The SY type was higher in power than the SE type. However, there were no significant differences between the Sasang types in agility ($F = 0.027$, $p = 0.973$), muscular endurance ($F = 0.540$, $p = 0.583$), and flexibility ($F = 2.762$, $p = 0.064$).

Body composition among the Sasang types showed significant differences in total body water ($F = 76.10$, $p < 0.001$), protein ($F = 65.49$, $p < 0.001$), muscle mass ($F = 124.98$, $p < 0.001$), minerals ($F = 21.38$, $p < 0.001$), lean body mass ($F = 125.42$, $p < 0.001$), and fat mass ($F = 181.49$, $p < 0.001$). The post hoc tests

Table 5 – The estimated mean (standard deviation) of each Sasang type when body mass index is incorporated as a covariate

	So-Yang (n = 352)	Tae-Eum (n = 193)	So-Eum (n = 385)	F value	Post hoc test
Muscular strength	23.57 (0.234)	23.53 (0.371))	22.40 (0.229)	7.306 [*]	TE > SE, SY > SE
Agility	70.00 (0.410)	70.21 (0.652)	69.93 (0.402)	0.059	
Muscular endurance	23.88 (0.561)	22.67 (0.892)	23.18 (0.551)	0.775	
Power	147.63 (1.327)	144.32 (2.10)	141.56 (1.297)	5.671 [*]	SY > SE
Flexibility	16.66 (0.459)	16.88 (0.730)	16.81 (0.450)	0.043	
Total body water	27.68 (0.139)	27.83 (0.221)	26.98 (0.136)	8.447 [†]	TE > SE, SY > SE
Protein	9.12 (0.070)	9.28 (0.112)	8.64 (0.069)	16.51 [†]	TE > SE, SY > SE
Muscle mass	36.93 (0.159)	37.57 (0.252)	35.93 (0.156)	17.93 [†]	TE > SY > SE
Mineral	2.46 (0.023)	2.55 (0.037)	2.49 (0.023)	2.138	
Lean body mass	39.31 (0.166)	39.97 (0.263)	38.26 (0.162)	17.68 [†]	TE > SY > SE
Fat mass	14.81 (0.107)	15.24 (0.171)	14.95 (0.105)	2.17	

The data for each group are presented as the mean (standard deviation).

[*] $p < 0.05$.
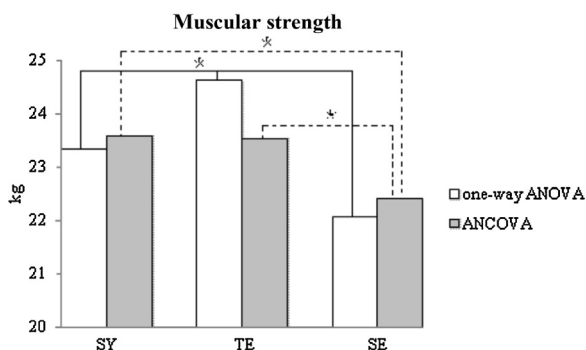
[†] $p < 0.01$.

SE, So-Eum; SY, So-Yang; TE, Tae-Yang.

Fig. 1 – The muscular strength of each Sasang type.
ANCOVA, analysis of covariance; ANOVA, analysis of
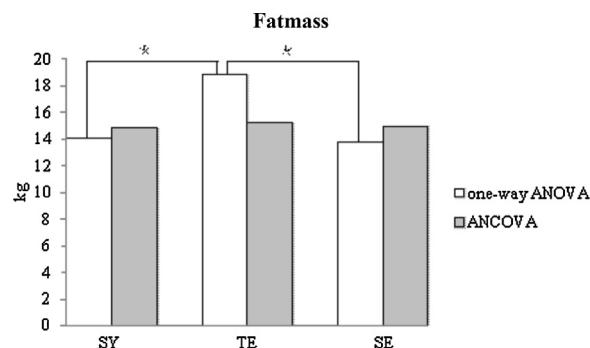**variance; SE, So-Eum; SY, So-Yang; TE, Tae-Eum.**

Fig. 2 – The fat mass of each Sasang type.
ANCOVA, analysis of covariance; ANOVA, analysis of
variance; SE, So-Eum; SY, So-Yang; TE, Tae-Eum.

revealed that the total body water, protein, muscle mass, and lean body mass were highest in the TE type, followed by (in decreasing order) the SY type and the SE type. The TE type was higher in minerals and fat mass than the SE type.

The ANCOVA analyses with BMI as the covariant are presented in Table 5. In physical fitness, the Sasang types showed significant differences in the muscular strength ($F = 7.306$, $p = 0.001$) and power ($F = 5.671$, $p = 0.004$). The *post hoc* tests revealed that the TE type and SY type were higher in muscular strength, compared to the SE type. The SY type was higher in power than the SE type. However, there were no significant differences among the Sasang types in agility ($F = 0.059$, $p = 0.943$), muscular endurance ($F = 0.775$, $p = 0.461$), and flexibility ($F = 0.043$, $p = 0.958$).

The body composition among the Sasang types showed significant differences in total body water ($F = 8.44$, $p = 0.000$), protein ($F = 16.51$, $p = 0.000$), muscle mass ($F = 17.93$, $p = 0.000$), minerals ($F = 2.13$, $p = .118$), lean body mass ($F = 17.68$, $p = 0.000$), and fat mass ($F = 2.17$, $p = .115$). The *post hoc* tests revealed that the TE type and SY type had a higher total body water and protein, compared to the SE type. The *post hoc* tests revealed that the muscle mass and the lean body mass were highest in the TE type, followed by (in decreasing order) the SY type and SE type. The TE type was higher in minerals and fat mass, compared to the SY type; however, there were no significant differences in the minerals and fat mass (Fig. 1).

Therefore, based on the comparison of the results of ANOVA and ANCOVA, the variables affected by BMI were: muscular strength; total body water; minerals; protein; fat mass; and constitution, which is apparently most affected in the TE type.

4.   Discussion

To date, studies on the Sasang types have failed to notice that body shape can affect physical fitness and body composition. In this study, we compared the results of ANOVA analysis and ANCOVA analysis with BMI as the covariate to verify differences in body composition and physical fitness among the Sasang types.

In ANCOVA analysis, the covariate, which is the degree to which scattering is spread in the relation between two

variables, is divided by the number of cases after multiplying the deviation of X and Y from the mean value. The difference between the average value of ANOVA and the average adjusted for the covariate suggests that the group is affected by the controlled variable.

The results of the comparison between ANOVA and ANCOVA analysis of the Sasang types are as follows. First, when we introduced the BMI as a covariate, the average values in the TE type were greatly reduced for muscular strength, total body water, protein, minerals, and fat mass. This result indicates that all of these parameters are greatly affected by the BMI, and the degree of scattering in the TE type is larger than in the other types.

When the BMI was controlled, the adjusted average muscular strength did not appear to differ significantly between the SY type and TE type (Fig. 1). The adjusted average fat mass did not appear to significantly differ between the Sasang types (Fig. 2). These results indicate that muscular strength and fat mass are the factors most affected by BMI, and that the physical frame of the TE type is obese. In addition, the fat mass in the TE type varies greatly according to body shape and physique, and it was demonstrated that the TE type is most affected by BMI. The correlation between physical fitness and body composition of each Sasang type and among the Sasang types needs to be investigated in more detail.

Second, we found that the SY type has significantly greater power than the SE type, based on the result of ANOVA and ANCOVA analysis. "Power" was defined as the ability to transfer energy explosively into force, muscle strength, and speed.[38] The results of this study indicate that power in the SY type is excellent and that the SY type moves faster. This type has a constitution with developed fast muscles, which are related to high speed and excellent coordination of all muscles.

Third, among the Sasang types and regardless of BMI, the SE type has the lowest muscular strength of the upper body and power. This implies that the SE type has the worst physical fitness among Sasang types and needs exercise to strengthen muscles of the upper and lower body, and to improve speed. In further studies, the degree of the development of the upper and lower body in each Sasang type will need to be ascertained by measuring the muscle strength of the whole body and lower

body. In addition, body shape and the effect of physique are worth investigating.

This study compared the ANOVA analysis and ANCOVA analysis with BMI as the covariate to examine the differences between the Sasang types in physical fitness and body composition in a targeted population of female college students in their 20s. Our findings, that BMI affects muscular strength, total body water, protein, minerals, and fat mass of the TE type, suggests that BMI is an important factor for physical fitness and body composition in the Sasang types and can be a variable that allows distinguishing between the Sasang types. Therefore, the results of this study can be used to define physical characteristics by which the Sasang types can be distinguished.

Chae et al[25–32] have developed a Sasang type-distinguishing tool, the Sasang Personality Questionnaire (SPQ), which is composed of 14 questions organized by temperament and psychological factors. He is currently endeavoring to validate and standardize this questionnaire. Using correlation analysis between the SPQ and the BMI, he demonstrated that the SPQ and BMI are independent.[27,32] Further studies on the SPQ, physical fitness, and body composition are required. These studies will dissipate the part that constitution analyzing tool including body shape can affect physical fitness and body composition.

The present study did not take into consideration dietary habits and exercise. We analyzed the constitution using only the QSCCII. Continuous studies on physical fitness and body composition are required, based on a variety of study participants and the constitution diagnosed. In addition, longitudinal studies on exercise and sport activities based on Sasang types will be required.

5.　　Conclusion

This study compared the ANOVA analysis and ANCOVA analysis with BMI as the covariate to examine the differences in physical fitness and body composition between the Sasang types in a target population of female college students in their 20s. First, we found that the BMI affects muscular strength, total body water, protein, minerals, and fat mass, and that the results differed among the Sasang types, based on whether the BMI was controlled. Second, we confirmed that the TE type was the constitution most affected by the BMI, and the deviation of body shape and physique was substantial. We conclude that the BMI can be controlled in further studies on Sasang types and can be utilized as data on physical characteristics that distinguish between the Sasang types.

Conflicts of interest

All contributing authors declare no conflicts of interest.

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