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ORIGINAL ARTICLE

Intelligent system of training data sets for current reported normality levels and physical fitness analysis

Système intelligent d'ensembles de données d'entraînement pour l'analyse de la normalité actuelle et du niveau de flexibilité comportementale rapportés

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KEYWORDS

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Summary The purpose of this study was to examine the relationship between current reported normality levels of human (mental stress level) and physical fitness variables using a nation-wide study conducted on adults and elderly persons. This study included 2830 adults (1683 men, 1147 women) aged 20–64 years, and 628 elderly subjects (263 men, 365 women) aged over 65 years who participated in the Survey of National Physical Fitness project conducted by the Korea Institute of Sport Science and the Korea Ministry of Culture, Sports and Tourism in 2015. The current reported normality levels of participants were recorded using self-report questionnaires. The physical fitness variables of the participants in the adult group were measured using exercises including grip strength, sit-ups, standing long jump, 50 m dash, sit-and-reach, and 20 m shuttle-run. The physical fitness variables of the participants in the elderly group were measured using exercises including grip strength, sit-up, sit-to-stand, sit-and-reach, back scratch, one leg standing with eyes open, and six-minute walk. There were no significant differences in any of the physical fitness variables of adult men under different normality levels of human ($P > 0.05$); however, adult women showed significant differences in grip strength ($P < 0.001$), standing long jump ($P = 0.048$), and sit-and-reach ($P = 0.013$) according to their normality levels of human. Both elderly men and women under different normality levels of human showed no significant differences in all physical fitness variables ($P > 0.05$). This study showed that there is little or

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no significant difference in the physical fitness variables of adult and elderly Koreans under different normality levels of human ($P > 0.05$). In this paper, we concluded that current reported normality levels of human are not associated with physical fitness level data set variables.
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Résumé Le but de cette étude était d'examiner la relation entre les niveaux de normalité actuellement rapportés des variables de la condition physique humaine et physique à l'aide d'une étude nationale menée sur des adultes et des personnes âgées. Cette étude a inclus 2830 adultes (1683 hommes, 1147 femmes) âgés de 20 à 64 ans et 628 sujets âgés (263 hommes, 365 femmes) âgés de plus de 65 ans qui ont participé au projet de l'enquête nationale sur la condition physique mené par l'Institut coréen des sciences du sport et le ministère coréen de la Culture, des Sports et du Tourisme en 2015. Les niveaux de normalité actuellement déclarés des participants ont été enregistrés à l'aide de questionnaires d'auto-évaluation. Les variables de la condition physique des participants du groupe d'adultes ont été mesurées à l'aide des tests, tels que la force de préhension, les redressements assis, le saut en longueur debout, le tirs de 50 m, assis et atteindre et la course navette de 20 m. Les variables de la condition physique des participants du groupe des personnes âgées ont été mesurées à l'aide d'exercices comprenant la force de préhension, la position assise, assis-debout, assis-debout, le dos égratigné, une jambe debout avec les yeux ouverts et une marche de six minutes. Il n'y avait pas de différences significatives dans toutes les variables de la condition physique des hommes adultes sous différents niveaux de normalité humaine ($p > 0.05$); cependant, les femmes adultes ont montré des différences significatives de force de préhension ($p < 0.001$), de saut en longueur debout ($p = 0.048$) et de position assis et atteindre ($p = 0.013$) en fonction de leurs niveaux de normalité humaine. Les hommes et les femmes âgés sous différents niveaux de normalité humaine n'ont montré aucune différence significative dans toutes les variables de la condition physique ($p > 0.05$). Cette étude a montré qu'il y a peu ou pas de différence significative dans les variables de la condition physique des Coréens adultes et âgés sous différents niveaux de normalité humaine ($p > 0.05$). Dans cet article, nous avons conclu que les niveaux de normalité actuels rapportés chez l'homme n'associent pas les variables des ensembles de données sur le niveau de condition physique.

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1. Introduction

Regular physical activity (PA) is reported to have a positive effect on mental disorders such as depression, mental fatigue, and anxiety [1–3]. It is also reported to improve cognitive function and reduce the risk of chronic diseases such as hypertension, cardiovascular disease, obesity, diabetes, and metabolic syndrome [1–3]. Physical Activity Guidelines for Americans have presented strong evidence on the importance of PA in health management, as well as ample scientific evidence on the effect of PA on general health [4]. Interestingly, recent studies have shown that psychological stress can inhibit participation in regular exercise [5,6]. In addition, psychological stress can lead to depression, a more sedentary lifestyle, and decreased PA [7].

Although the mechanism of the negative impact of psychological stress on participation in PA is not clear yet, the pathological mechanism of psychological stress suggests that it induces chronic disease by hypothalamus-pituitary gland-adrenal activation, long-term endotheliocyte malfunction, increased inflammation, and decreased autonomic neurological control. It also causes negative health-related behaviour including lack of sleep, drinking, and smoking, resulting in an increased risk of developing chronic diseases [8].

PA is known to be closely related to fitness levels. Many studies have already reported that participating in regular PA promotes physical health and affects various physical fitness variables in adults [1,4,9]. Although a number of studies have demonstrated that increased stress can reduce PA or physical fitness level, it is necessary to evaluate the association by investigating whether PA is reduced by stress levels, which then leads to a decrease in physical fitness level. Therefore, the purpose of this study was to examine the relationship between current reported normality levels of human (mental stress level) and measurable physical fitness variables using a nationwide study conducted on adults and elderly persons.

2. Methods

2.1. Participants

The Survey of National Physical Fitness project conducted in 2015 was a cross-sectional epidemiological study that used a sample allocation design within 14 stratifications and clusters. Samples were taken across all of the Republic of Korea. This study was conducted by the Korea Institute of Sport Science and the Korea Ministry of Culture, Sports, and Tourism.

Table 1 Anthropometric and physical characteristics of the participants.

Variables	Adults (n = 2830)		Elderly (n = 628)	
	Men (n = 1683)	Women (n = 1147)	Men (n = 263)	Women (n = 365)
Age (years)	38.17 ± 12.71	39.41 ± 13.10	72.19 ± 5.25	73.60 ± 5.87
Height (cm)	173.11 ± 6.11	160.04 ± 5.69	165.81 ± 5.52	153.85 ± 5.49
Weight (kg)	73.15 ± 9.71	56.99 ± 7.70	66.41 ± 7.97	56.67 ± 7.20
Body mass index (kg/m ²)	24.39 ± 2.85	22.27 ± 2.95	24.13 ± 2.43	23.94 ± 2.84
Physical fitness				
Grip strength (kg)	42.75 ± 9.09	25.01 ± 5.98		
Sit-ups (reps/60 sec)	34.75 ± 11.94	21.00 ± 12.37		
Standing long jump (cm)	197.71 ± 31.59	139.85 ± 26.26		
The 50-m dash (sec)	8.89 ± 1.69	11.33 ± 2.00		
Sit-and-reach (cm)	9.37 ± 8.42	14.72 ± 8.23		
The 20-m shuttle-run (sec)	32.87 ± 17.15	18.16 ± 8.26		
Grip strength (kg)			32.14 ± 7.71	20.48 ± 5.40
Sit-ups (reps/60 sec)			13.21 ± 9.90	5.32 ± 7.44
Sit-to-stand (reps/30 sec)			19.29 ± 7.76	16.22 ± 6.42
Sit-and-reach (cm)			4.21 ± 8.92	10.61 ± 8.58
Back scratch (cm)			−9.58 ± 12.28	−3.90 ± 10.13
One-leg standing test with eyes open (sec)			32.78 ± 34.51	22.35 ± 25.91
Six-minute walk (m)			552.86 ± 123.71	485.68 ± 135.59
Normality levels of human (mental stress level)				
Very low or low	304 (18.1)	209 (18.2)	94 (35.7)	107 (29.3)
Normal	950 (56.4)	674 (58.8)	139 (52.9)	209 (57.3)
High or very high	429 (25.5)	264 (23.0)	30 (11.4)	49 (13.4)

Results are expressed as mean ± standard deviation or n (%).

The study included 2830 adults (1683 men, 1147 women) aged 20–64 years, and 628 elderly subjects (263 men, 365 women) aged over 65 years old. There were no specific inclusion criteria; however, the exclusion criteria included physical disability and pregnancy. Anthropometric and physical characteristics of the participants are shown in Table 1. All research procedures were approved by the Institutional Review Board of Korea Institute of Sport Science and Korea Ministry of Culture, Sports and Tourism and conducted in accordance with the principles outlined in the Declaration of Helsinki.

2.2. Normality levels of human (mental stress levels)

Normality levels of human were classified according to the self-reported responses to the following question: “In general, how chronically mentally stressed (normality levels of human) are you?” The possible responses were:

- very low;
- low;
- normal;
- high;
- very high normality levels of human.

Based on their responses, the participants were divided into three groups for the analysis of variance:

- low (very low + low);
- normal;

- high (high + very high).

The scientific validation of this question was confirmed by the Korea Institute of Sport Science and the Korea Ministry of Culture, Sports and Tourism [10].

2.3. Measurement of physical fitness variables

The physical fitness variables measured for the participants in the adult group were grip strength, sit-ups, standing long jump, 50-m dash, sit-and-reach, and 20-m shuttle-run, whereas in the elderly group they were grip strength, sit-up, sit-to-stand, sit-and-reach, back scratch, one leg standing with eyes open, and six-minute walk. The safety of the adults and elderly participants was considered in all physical fitness tests. Detailed measurements of the physical fitness variables were performed following the procedures described in “Advanced Fitness Assessment and Exercise Prescription” [11] and the guidelines of “The Senior Fitness Test Manual” [12].

2.4. Statistical analysis

All results are presented as mean ± standard deviation or number (%). According to the central limit theorem, if the number of subjects is over thirty, the data should be approximately normally distributed and will have reliability [13]. Each category in the present study had over 30 subjects; therefore, the results of the present study can be considered reliable. For this reason, a one-way analysis of variance was

Table 2 Differences in physical fitness variables based on normality levels of human in adult participants (aged 20 to 64 years).

	Group 1	Group 2	Group 3	Overall F	Overall P
Men	(n = 304)	(n = 950)	(n = 429)		
Grip strength (kg)	42.00 ± 9.16	43.00 ± 9.02	42.74 ± 9.20	1.369	0.255 N/S
Sit-ups (reps/60 sec)	35.20 ± 14.01	34.95 ± 11.44	33.99 ± 11.41	1.237	0.290 N/S
Standing long jump (cm)	196.60 ± 33.97	197.47 ± 31.02	199.03 ± 31.10	0.589	0.555 N/S
The 50-m dash (sec)	8.93 ± 1.68	8.89 ± 1.77	8.87 ± 1.53	0.134	0.874 N/S
Sit-and-reach (cm)	10.08 ± 8.48	9.20 ± 8.59	9.26 ± 7.96	1.304	0.272 N/S
The 20-m shuttle-run (sec)	33.67 ± 18.70	32.71 ± 16.94	32.64 ± 16.49	0.414	0.661 N/S
Women	(n = 209)	(n = 674)	(n = 264)		
Grip strength (kg)	25.10 ± 5.75	25.44 ± 6.05 N/S	23.83 ± 5.87 N/S	6.997	< 0.001***
Sit-ups (reps/60 sec)	20.46 ± 12.98	21.07 ± 12.06	21.27 ± 12.68	0.268	0.765 N/S
Standing long jump (cm)	136.11 ± 26.37	141.18 ± 26.06 ^a	139.40 ± 26.48 N/S	3.035	0.048*
The 50-m dash (sec)	11.63 ± 2.19	11.27 ± 1.93	11.26 ± 1.99	2.857	0.058 N/S
Sit-and-reach (cm)	16.23 ± 7.31	14.42 ± 8.22 ^a	14.28 ± 8.80 ^a	4.383	0.013*
The 20-m shuttle-run (sec)	17.35 ± 9.19	18.50 ± 7.98	17.92 ± 8.16	1.673	0.188 N/S

Results are expressed as mean ± standard deviation. * $P < 0.05$; *** $P < 0.001$; tested by one-way analysis of variance. Group 1 = very low or low normality levels of human; Group 2 = normal normality levels of human; Group 3 = high or very high normality levels of human. N/S: not significant.

^a $P < 0.05$ compared with group 1; Tukey's post-hoc testing.

Table 3 Differences in physical fitness variables based on normality levels of human in elderly participants (aged over 65 years).

	Group 1	Group 2	Group 3	Overall F	Overall P
Men	(n = 94)	(n = 139)	(n = 30)		
Grip strength (kg)	32.09 ± 8.34	32.27 ± 7.56	31.66 ± 6.42	0.080	0.923 N/S
Sit-ups (reps/60 sec)	13.94 ± 10.58	12.50 ± 9.74	14.23 ± 8.39	0.765	0.466 N/S
Sit-to-stand (reps/30 sec)	18.39 ± 7.12	19.52 ± 8.13	21.00 ± 7.80	1.422	0.243 N/S
Sit-and-reach (cm)	4.59 ± 8.99	3.97 ± 8.70	4.16 ± 9.89	0.136	0.872 N/S
Back scratch (cm)	-9.00 ± 12.53	-10.69 ± 12.11	-6.28 ± 11.94	1.765	0.173 N/S
One-leg standing test with eyes open (sec)	30.07 ± 36.84	35.03 ± 33.79	30.89 ± 30.30	0.628	0.535 N/S
Six-minute walk (m)	548.67 ± 124.52	554.23 ± 127.82	559.67 ± 103.38	0.107	0.898 N/S
Women	(n = 107)	(n = 209)	(n = 49)		
Grip strength (kg)	19.61 ± 4.02	21.01 ± 5.92	20.16 ± 5.52	2.499	0.084 N/S
Sit-ups (reps/60 sec)	6.07 ± 8.18	5.29 ± 7.37	3.80 ± 5.78	1.585	0.206 N/S
Sit-to-stand (reps/30 sec)	15.46 ± 6.05	16.72 ± 6.81	15.76 ± 5.27	1.528	0.218 N/S
Sit-and-reach (cm)	11.22 ± 7.98	9.90 ± 8.92	12.32 ± 8.19	1.969	0.141 N/S
Back scratch (cm)	-5.76 ± 9.86	-3.25 ± 10.16	-2.60 ± 10.22	2.660	0.071 N/S
One-leg standing test with eyes open (sec)	21.38 ± 27.43	22.62 ± 24.96	23.29 ± 26.98	0.118	0.889 N/S
Six-minute walk (m)	485.78 ± 131.27	490.60 ± 138.97	464.53 ± 130.79	0.733	0.481 N/S

Results are expressed as mean ± standard deviation. N/S: not significant; tested using the one-way analysis of variance. Group 1 = very low or low normality levels of human level; Group 2 = normal normality levels of human level; Group 3 = high or very high normality levels of human.

used to verify the inter-group differences in the physical fitness variables according to the three normality levels of human groups. Tukey's test (post-hoc testing) was conducted to confirm which particular groups showed differences when a difference between groups occurred. The analyses were performed using SPSS version 18.0 (IBM Corp., Armonk, NY, USA) and statistical significance was set at $P < 0.05$.

3. Results

As seen in Table 2, adult men in all three normality levels of human groups (low, normal, and high normality levels of

human groups) showed no significant differences in all physical fitness variables ($P > 0.05$). Adult women in the three normality levels of human groups showed significant differences in grip strength ($P < 0.001$), standing long jump ($P = 0.048$), and sit-and-reach ($P = 0.013$). For adult women, Tukey's test (a post-hoc test) showed that only the normal normality levels of human group had higher standing long jump values and lower sit-and-reach values compared to the low normality levels of human group ($P < 0.05$), whereas the high normality levels of human group had lower sit and reach values compared to the low normality levels of human group ($P < 0.05$). Table 3 shows that no significant differences were recorded in any of the physical fitness variables

of both elderly men and women in the three normality levels of human groups ($P > 0.05$).

4. Discussion

The results of this study indicate that there are almost no significant differences in all physical fitness variables of both adult and elderly men and women with different normality levels of human. Notably, advanced studies have reported that exposure to high levels of stress is related to decreased PA [5,6]. PA is defined as the movement of the body caused by skeletal muscles that results in energy consumption [14]. Therefore, an increase or decrease in physical activity that only results in a modest change in energy expenditure should have a very low impact on the body fitness level.

However, exercise training can be defined as part of a planned and structured repetitive PA for the improvement or maintenance of fitness, and physical fitness improvement can be promoted by the systemic, premeditated, and continuous increase of PA [14]. Stults-Kolehmainen & Sinha [15] reported that a rise in stress level can cause a negative behavioural change toward exercise training and that people with lower stress showed higher motivation to participate in exercise training [16]; therefore, from the long-term point of view, stress level can increase or decrease physical fitness by changing exercise behaviour. Furthermore, a long-term follow-up study also showed that people with high levels of stress had a 2.6 times higher chance of non-participation in exercise as well as a 1.9 times higher likelihood of not participating in exercise after ten years [17]. This implies that stress can lead to a decreased fitness level in the long-term. Additionally, a four-year longitudinal study of elderly people with low psychological stress showed a doubled chance of starting or maintaining exercise compared with people with high stress levels [18].

In contrast, one study showed no relationship between stress and exercise [19]; however, yet another reported that people with high stress levels are more physically active [20]. The conflicting results of these studies indicate that there is still some uncertainty regarding the relationship between normality levels of human and PA. The present study showed that there are no differences in the various fitness variables of Korean subjects under different normality levels of human, suggesting that there is no relationship between stress and fitness level. More well-designed studies are needed in the future to clarify the reason for differences in available results.

This study has certain limitations. Firstly, people under stress with a decrease in self-motivation, have a tendency to avoid PA and select unhealthy emotion-based activities such as smoking, drinking, overeating, and non-PA [21,22]. This study did not consider these and other confounding variables, such as medical condition, drinking and smoking behaviour, sleep patterns, and lifestyle habits. Secondly, this study was a retrospective cohort study that only examined the differences in the physical fitness levels of individuals according to three normality levels of human groups; only inter-relationship was evaluated, not cause and effect. Moreover, this study only tested physical fitness levels one time. No intervention study, no baseline data, and no measure of how long mental depression had been in place

were evaluated. Thirdly, this study used self-report questionnaires for the assessment of normality levels of human; therefore, there is the possibility of subjective or inappropriate responses. Nevertheless, this study was conducted using data from The Survey of National Physical Fitness project, which was a cross-sectional, retrospective, nationwide, cohort study conducted in Korea. Given the sample size of this survey, it should be possible to generalise our study's findings to other demographics in Korea.

5. Conclusion

There is little or no significant difference in the physical fitness variables of Korean adults and elderly persons under different levels of normality of human. We conclude that normality levels of human are not associated with physical fitness variables among the Korean population.

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Disclosure of interest

The authors declare that they have no competing interest.

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