

Comparison Between Korean Version of Physical Activity Scale for the Elderly and International Physical Activity Questionnaire-Short Form in Evaluation of Frailty Phenotype

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Background: Evaluation of frailty in older people requires assessment of their physical activity level. The Korean version of the Physical Activity Scale for the Elderly (K-PASE) questionnaire is more comprehensive, yet it can be time-consuming and costly to administer on a large scale. The International Physical Activity Questionnaire (IPAQ) short form, which is simpler and free of charge, may replace the K-PASE for defining the Cardiovascular Health Study (CHS) frailty phenotype. **Methods:** We analyzed data from 160 community-dwelling older adults (mean age: 75 years) who were administered both the K-PASE and IPAQ short form questionnaires as part of the assessments in the Aging Study of Pyeongchang Rural Area. We compared agreements between the 2 physical activity questionnaires and between the CHS frailty phenotype defined using the K-PASE and IPAQ short form. Correlations between each CHS frailty phenotype definition and common geriatric syndromes were assessed. **Results:** The physical activity level measured using the K-PASE correlated modestly with the level measured using the IPAQ short form (correlation coefficient, 0.250; $p=0.001$). However, the agreement was substantially higher between the CHS frailty phenotype based on the K-PASE and the definition based on the IPAQ short form (Cohen kappa, 0.625; $p<0.001$). Both frailty phenotype definitions were positively correlated with most geriatric conditions. **Conclusion:** The simpler IPAQ short form may replace the more comprehensive K-PASE for assessing CHS frailty phenotype in older people. Our results should inform frailty assessment in research and clinical care settings.

Key Words: Frail elderly, Cohort studies, Exercise, Motor activity, Physical activity

INTRODUCTION

With the unprecedented trend of aging around the world, the importance of screening frailty in older people is ever increasing¹. Frailty is a consequence of aging defined by a decreased physiological reserve to various stressors². In other words, frailty can reflect the physiologic age of a person³. Since frailty status can predict adverse health events in older people more effectively than do age and comorbidities⁴, accounting for frailty in therapeutic decision making is essential⁵. Therefore, evaluating frailty in older people has become a critical component of geriatric medicine and aging research.

To date, numerous measures have been proposed to assess

frailty status in older people. In general, most tools can be categorized as either a phenotype model or an accumulation-of-deficit model^{2,3,6}. Many clinical and preclinical studies used the Cardiovascular Health Study (CHS) frailty phenotype as a reference standard method⁷⁻¹⁰. As the construct validity and predictive validity of the CHS frailty phenotype have also been demonstrated in older Koreans⁵, the CHS frailty phenotype is widely used for varying purposes in Korea^{8,11}.

Regarding the frailty phenotype, measuring physical activity level is necessary to define a low activity status. One of the most commonly used methods to measure this component is the Physical Activity Scale for the Elderly (PASE). Although the feasibility and construct validity of the Korean translated version of PASE (K-PASE) were established, its association with outcome measures has not been evaluated¹².

There are barriers to administering the K-PASE in a large-scale population-based study owing to its proprietary right (which requires a license fee) and its length (which takes up to 10 minutes to administer). Furthermore, results from the PASE cannot be converted to a standardized quantity, such as the total metabolic equivalent task minutes per week (MET-min/wk).

Alternatively, the Korean translated International Physical Activity Questionnaire (IPAQ) short form is a free tool that measures activity level in MET-min/wk. In older Koreans, the quantitative results calculated from the IPAQ short form was validated against the activity level obtained using an accelerometer¹³. Owing to these advantages, the IPAQ short form is currently used in nationwide studies, such as the Korea National Health And Nutrition Examination Survey (KNHANES)¹⁴ and the Korean Frailty and Aging Cohort Study (KFACS)⁹. Although the IPAQ short form may substitute K-PASE for identifying the CHS frailty phenotype in older Koreans, no studies have examined the agreement of the CHS frailty phenotype definitions based on the K-PASE and IPAQ short form.

In this study, we aimed to assess the correlations between the K-PASE and IPAQ short form in community-dwelling older people and the validity of substituting the K-PASE with the IPAQ short form for defining the CHS frailty phenotype.

MATERIALS AND METHODS

1. Study Population

The Aging Study of Pyeongchang Rural Area (ASPRA) is a population-based, prospective cohort study of frailty and geriatric syndromes in 1,350 older adults who are registered in the Community Healthcare Service and reside in Pyeongchang-gun, Gangwon-do, Korea. Detailed information on study design, target population, and measurements in ASPRA were published previously⁷. People were eligible for the study if they were (1) age 65 years or older, (2) registered in the Community Healthcare Service, (3) ambulatory with or without an assistive device, (4) living at home, and (5) able to provide informed consent. We excluded those who were (1) living in a nursing home, (2) hospitalized, or (3) bedridden and receiving nursing home level care at home at the time of enrollment.

Participants were recruited between October 2014 and May 2017 and underwent annual comprehensive geriatric assessments that encompassed the assessment of cognitive and physical function, depression, nutrition, and body composition using bioimpedance analysis. The participation rate was 95%, and the characteristics of ASPRA participants were comparable with those of a nationally representative sample of the Korean rural population^{7,15}, except that a higher pro-

portion of ASPRA participants were working in agriculture and had a little formal education.

This analysis included 160 consecutive participants of ASPRA who were examined from November 2015 to December 2015 and were administered both the IPAQ and K-PASE for the quantification of physical activity level. The protocol of this study was approved by the Institutional Review Board of the Asan Medical Center (IRB No. 2015-0673).

2. Quantification of Physical Activity

1) The K-PASE

The PASE is an instrument designed to assess physical activity in the previous week^{12,16,17}. This tool assesses type of leisure activities (walking, light, moderate, and strenuous sport activities, recreation and muscle strengthening exercise), paid work involving physical activities and participation on housework (lawn work, home repair, gardening, caring for others) in frequency (1–2 days/wk for seldom, 3–4 days/wk for sometimes, 5–7 days/wk for often) and duration (<1 hr, 1–2 hr, 2–4 hr, 4 or more hours). Predefined weights were applied to each activity to calculate a total physical activity level.

2) The Korean translated IPAQ

We used the short form of the IPAQ to quantify physical activity levels. The IPAQ short form¹³ assesses the history of physical activity in the previous 7 days. We adopted the IPAQ questionnaire used in KNHANES, which assessed the duration of 5 types of activities: (1) vigorous physical activity, (2) moderate physical activity, (3) walking, (4) number of days of resistance exercise, and (5) number of days of flexibility exercise. Among these variables, we used total duration (minutes) of vigorous activity, moderate physical activity, and walking to calculate total MET-min/wk. According to the IPAQ scoring protocol, total physical activity level (MET-min/wk) was calculated using the following equation: $8.0 \text{ METs} \times \text{total duration of vigorous activity} + 4.0 \text{ METs} \times \text{total duration of moderate activity} + 3.3 \text{ METs} \times \text{total duration of walking}$.

3. Frailty Assessment

We used the CHS frailty phenotype scale⁶. In this scale, frailty was defined as the presence of at least 3 of the following components: (1) exhaustion: an answer of “moderate or most of the time during the last week” to either of the following: “I felt that everything I did was an effort” or “I could not get going”; (2) low activity: physical activity level in the lowest quintile according to the K-PASE (below the 20th percentile cutoff point in the ASPRA cohort), IPAQ (below the 20th percentile cutoff point in a representative sample of older

Koreans in the KNHANES), or using a cutoff point derived from the regression analysis (described in the statistical analysis section below); (3) slowness: usual gait speed <0.8 m/sec; (4) weakness: dominant handgrip strength <26 kg for men and <17 kg for women; and (5) weight loss: unintentional weight loss of >3 kg during the previous 6 months^{5,18,19}.

4. Assessment of Other Geriatric Conditions

Trained nurses determined the existence of common geriatric conditions using the following instruments: the Korean version of the Mini-Mental State Examination (K-MMSE) for cognitive function, handgrip strength and usual gait speed for physical performance, the Korean version of the Center for Epidemiological Studies Depression (CES-D) scale for depressive mood, the Mini-Nutritional Assessment-Short Form (MNA-SF) score for malnutrition, and the Korean activities of daily living (ADL) and Korean instrumental ADL for dependence, with the previously validated cutoff points⁷. Sarcopenia was defined according to the Asian Working Group on Sarcopenia (AWGS)²⁰ criteria, based on bioimpedance analysis (Inbody 620; Inbody, Seoul, Korea), usual gait speed, and handgrip strength (T.K.K. 5401 Grip-D; Takei, Tokyo, Japan). Low cognition was defined as a K-MMSE score of <24²¹, and high depressive symptoms were defined as a CES-D score of ≥ 21 ²². We defined a risk for malnutrition as an MNA-SF score of ≤ 11 points²³. These conditions were used to test the face validity of physical activity questionnaires and frailty definitions.

5. Statistical Analysis

We summarized the characteristics of the study population using the mean, standard deviation (SD), and proportion. The distribution of and Spearman correlation between total physical activity levels quantified using the K-PASE and IPAQ short form were examined. To compare the face validity of physical activity questionnaires, we calculated Spearman correlation coefficients of each physical activity scale with common geriatric conditions. To evaluate the impact of choice of physical activity scales on the frailty definition, we created separate CHS frailty definitions based on how low activity was defined: frailty using the population-specific cutoff point of the K-PASE in the ASPRA cohort (CHS-PASE) and frailty using the population-independent cutoff point of the IPAQ short form (CHS-IPAQ). The population-independent 20th percentile cutoff point of the IPAQ short form was estimated using data from 8,018 older people in the 6th KNHANES dataset. We then assessed the Cohen kappa agreement and Spearman correlation coefficient between the CHS-PASE and CHS-IPAQ. In addition, since the IPAQ short form is used to measure physical activity level in KNHANES, we derived

a conversion equation that used K-PASE items to predict a low physical activity state defined using the IPAQ short form; this conversion enables a direct comparison of frailty status defined using the K-PASE and IPAQ short form. To develop the conversion equation, we first fitted logistic regression to model a low physical activity state defined by the IPAQ short form as a function of individual K-PASE items. The probability of having a low physical activity level was estimated from the logistic model and a cutoff point was chosen such that it maximized the Youden index²⁴. We defined CHS frailty status (CHS-IPAQ_{PASE}) using the predicted low physical activity state and assessed the Cohen kappa agreement and Spearman correlation coefficient between CHS-IPAQ_{PASE} and CHS-IPAQ. To assure whether replacing the K-PASE with the IPAQ short form in defining frailty can be justified, we evaluated the Spearman correlation between each frailty definition and geriatric conditions. Statistical analysis was carried out using IBM SPSS Statistics ver. 21.0 (IBM Co., Armonk, NY, USA). A 2-sided p-value <0.05 was considered statistically significant.

RESULTS

1. Characteristics of Study Population

The mean age of the 160 ASPRA participants with data from both the K-PASE and IPAQ short form was 75.1 years (SD, 6.3) and 62 (38.8%) were men (Table 1). A total of 104 individuals (65.0%) were currently working and 90 (56.3%) were engaged in agriculture. Geriatric conditions were prevalent: 62 participants (38.8%) with decreased handgrip strength, 60 (37.5%) with multimorbidity, 55 (34.4%) with low cognition, and 54 (33.8%) with sarcopenia according to the AWGS criteria.

2. Use of the K-PASE vs. IPAQ Short Form for Assessment of Physical Activity Level

Physical activity level measured using the K-PASE seemed to follow a normal distribution (Fig. 1), with a mean K-PASE total score 149.2 (SD, 76.3). Participants spend their week sitting for 18.2 hours (SD, 10.7), walking for 10.1 hours (SD, 10.1), and doing light sport activity for 2.0 hours (SD, 5.5), moderate sport activity for 0.3 hours (SD, 1.6), strenuous sport activity for 0.7 hours (SD, 2.8), muscle strengthening for 0.1 hour (SD, 0.6), and paid or volunteer work for 18.6 hours (SD, 19.9).

Physical activity level measured using the IPAQ short form showed a highly skewed distribution (Fig. 1), with a mean total activity level of 1,524.6 MET-min/wk (SD, 2,089.5). Participants spend their week sitting for 50.2 hours (SD, 24.5), walking for 5.1 hours (SD, 5.2), and doing moderate activity

for 2.1 hours (SD, 6.3) and vigorous activity for 0 hour (SD, 0.2).

There was a statistically significant, modest correlation between continuous total K-PASE score and continuous MET-min/wk calculated from the IPAQ short form (Spearman correlation coefficient, 0.250, $p=0.001$). The agreement and correlation between the 2 physical activity instruments were modest with a kappa statistic of 0.286 ($p<0.001$). Forty participants (25%) were classified as having low activity using the IPAQ short form, and 32 (20%) using the K-PASE. Low physical activity level was correlated with most geriatric conditions, regardless of how it was assessed, with some exceptions (Table 2). Depressive mood was statistically significantly correlated with low activity level measured by the K-PASE, but fall history, multimorbidity, and polypharmacy were statistically significantly correlated with low activity level measured using the IPAQ short form.

3. Choice of Physical Activity Questionnaire to Define CHS Frailty Status

Despite the modest correlation between the K-PASE and IPAQ short form, the agreement was higher between the frailty definition based on the K-PASE (CHS-PASE) and the frailty definition based on the IPAQ short form (CHS-IPAQ) (Table 3). Cohen kappa was 0.625 ($p<0.001$), which indicates moderate to high agreement²⁵, and Spearman correlation coefficient was 0.564 ($p<0.001$). We also developed a logistic model that estimates low physical activity status according to the IPAQ short form using the K-PASE items (Supplementary Table 1). When frailty was defined based on the predicted

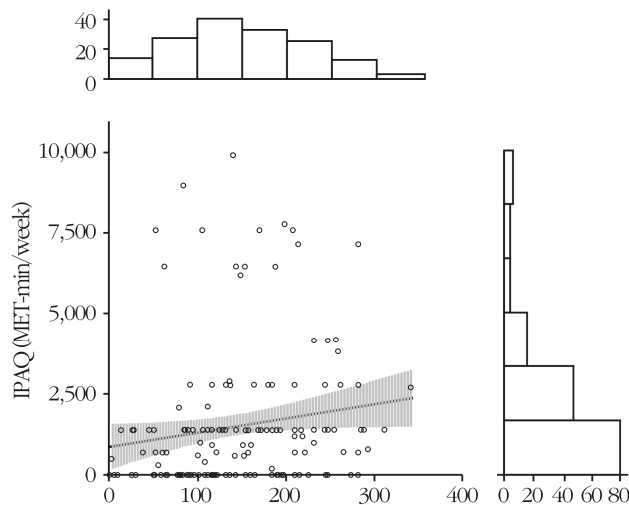


Fig. 1. Comparison of distributions between K-PASE score and energy expenditure calculated from the IPAQ. The line and gray band denote the predicted line by linear regression and standard errors, respectively. K-PASE, Korean Physical Activity Scale of the Elderly; IPAQ, International Physical Activity Questionnaire; MET-min/wk, metabolic equivalent task minutes per week.

low activity level from the K-PASE (CHS-IPAQ_{PASE}), the agreement and correlation between the frailty definition (CHS-IPAQ_{PASE}) and the definition based on the IPAQ short form (CHS-IPAQ) were moderate to high, with a Cohen kappa of 0.711 and Spearman correlation coefficient of 0.598 ($p<0.001$). Both the CHS-PASE and CHS-IPAQ were positively correlated with most geriatric conditions, except for multimorbidity and polypharmacy (Table 4).

Table 1. Assessment of physical activity by the K-PASE or IPAQ short form in the Aging Study of Pyeongchang Rural Area cohort

Characteristic	Value
Sample size	160
Age (yr)	75.1±6.3
Men	62 (38.8)
Educational level (yr)	4.8±5.2
Currently working	104 (65.0)
Engaged in agriculture	90 (56.3)
Sarcopenia	54 (33.8)
Disability	40 (25.0)
Muscle weakness	62 (38.8)
ADL disability	23 (14.4)
IADL disability	43 (26.9)
Cognitive dysfunction	55 (34.4)
Depression	26 (16.3)
Fall in the past year	30 (18.8)
At risk of malnutrition	88 (55.0)
Multimorbidity	60 (37.5)
Polypharmacy	16 (10.0)
Incontinence	14 (8.8)
K-PASE	
Total physical activity score	149.2±76.3
Sitting, hr/wk (1)	18.2±10.7
Walking, hr/wk (2)	10.1±10.1
Light sport activity, hr/wk (3)	2.0±5.5
Moderate sport activity, hr/wk (4)	0.3±1.6
Strenuous sport activity, hr/wk (5)	0.7±2.8
Muscle strengthening, hr/wk (6)	0.1±0.6
Paid or volunteer work, hr/wk (7-10)	18.6±19.9
IPAQ	
Total physical activity level, MET-min/wk	1,524.6±2,089.5
Sitting, hr/wk	50.2±24.5
Walking, hr/wk	5.1±5.2
Moderate activity, hr/wk	2.1±6.3
Vigorous activity, hr/wk	0.0±0.5

Values are presented as mean±standard deviation or number (%). K-PASE, Korean Physical Activity Scale of the Elderly; IPAQ, International Physical Activity Questionnaire; ADL, activities of daily living; IADL, instrumental activities of daily living; MET-min/wk, metabolic equivalent task minutes per week.

Table 2. Correlations between 2 physical activity questionnaires and geriatric conditions

Geriatric condition	K-PASE		IPAQ	
	Correlation	p-value	Correlation	p-value
Sarcopenia	-0.206	0.009	-0.265	0.001
Dismobility	-0.394	<0.001	-0.318	<0.001
Muscle weakness	-0.375	<0.001	-0.208	0.008
ADL disability	-0.364	<0.001	-0.196	0.013
IADL disability	-0.347	<0.001	-0.251	0.001
Cognitive dysfunction	-0.238	0.003	-0.333	<0.001
Depression	-0.232	0.003	-0.119	0.137
Fall in the past year	-0.151	0.056	-0.282	<0.001
At risk of malnutrition	-0.209	0.008	-0.195	0.014
Multimorbidity	-0.125	0.116	-0.162	0.041
Polypharmacy	-0.022	0.786	-0.197	0.012
Incontinence	-0.252	0.001	-0.157	0.048

K-PASE, Korean Physical Activity Scale of the Elderly; IPAQ, International Physical Activity Questionnaire; ADL, activities of daily living; IADL, instrumental activities of daily living.

Table 3. Comparisons of CHS frailty status calculated using physical activity items from the IPAQ (CHS-IPAQ) and CHS frailty status using the K-PASE (CHS-PASE) or IPAQ estimated from the K-PASE by a regression equation (CHS-IPAQ_{PASE})

	CHS-IPAQ			
	Nonfrail	Frail	Cohen kappa	Spearman rho
CHS-PASE				
Nonfrail	119	11	0.625	0.626
Frail	8	22	-	-
CHS-IPAQ _{PASE}				
Nonfrail	122	9	0.720	0.598
Frail	5	24	-	-

CHS, Cardiovascular Health Study; IPAQ, International Physical Activity Questionnaire; K-PASE, Korean Physical Activity Scale of the Elderly.

DISCUSSION

In geriatric research and clinical medicine, evaluating frailty status in older people has become indispensable, and measurement of physical activity is needed as a component of the physical frailty phenotype. In this study, we compared physical activity measures using the K-PASE and IPAQ short form and observed a statistically significant, positive correlation between the 2 measures. In addition, we found moderate to high agreement between CHS frailty phenotype definitions based on the K-PASE or IPAQ short form. These results suggest that the IPAQ short form might replace the K-PASE as a component of the CHS frailty phenotype in older Koreans.

There are various approaches to measuring physical activity levels, including self-reported questionnaires, self-reported activity diaries, direct observation, accelerometers, and pedometers²⁶⁾. Among these, self-reported questionnaires

have been the most used method in large-scale epidemiological research studies and busy outpatient clinics because of its feasibility for administration and despite its possible inaccuracy due to the recall process and inevitable intervening of subjective judgment. The PASE, a proprietary, widely accepted questionnaire initially developed and validated from 23 cities in Massachusetts in the United States¹⁶⁾, includes activities such as chopping down trees and carrying wood as household-related activities, which are less conceivable in environments such as Korea or China^{27,28)}, and does not assume that older people might spend their energy engaging in agricultural activities that are, however, inevitable in rural area of developing countries. On the other hand, the IPAQ-short form, which has been translated into multiple languages, is less vulnerable to cultural and socioeconomic variation owing to its simplicity and objectivity in questionnaire items²⁹⁾.

Although the IPAQ short form consisted of much fewer items than the K-PASE, the results can be converted easily to standardized quantified units (MET-min/wk), which is one of the most advantageous features of the IPAQ short form. With increasing accessibility for objective, wearable instruments such as an accelerometer to be used in community-based research studies, these data from the IPAQ short form can be easily compared with data obtained using other objective instruments. In addition, given this compatibility, the IPAQ short form can be better used to assess the efficacy of exercise-based interventional studies for older people in various settings.

We observed that the physical activity level assessed by using the K-PASE and by using the IPAQ short form had a modest agreement, possibly owing to the differences in the questionnaires. Despite this discrepancy, frailty status

Table 4. Correlations between frailty status, defined based on physical activity items assessed using the K-PASE or IPAQ or estimated IPAQ from K-PASE by regression equation (CHS-IPAQ_{PASE})

Geriatric condition	Frail vs. nonfrail by K-PASE		Frail vs. nonfrail by IPAQ		Frail vs. nonfrail by IPAQ _{PASE}	
	Correlation	p-value	Correlation	p-value	Correlation	p-value
Sarcopenia	0.233	0.003	0.224	0.004	0.271	0.001
Disability	0.610	<0.001	0.491	<0.001	0.550	<0.001
Muscle weakness	0.407	<0.001	0.229	0.004	0.372	<0.001
ADL disability	0.397	<0.001	0.275	<0.001	0.346	<0.001
IADL disability	0.431	<0.001	0.248	0.002	0.353	<0.001
Low cognition	0.309	<0.001	0.278	<0.001	0.419	<0.001
Depression	0.319	<0.001	0.227	0.004	0.227	0.001
Fall in the past year	0.138	0.081	0.151	0.057	0.278	<0.001
Malnutrition	0.306	<0.001	0.306	<0.001	0.304	<0.001
Multimorbidity	0.058	0.467	0.116	0.145	0.014	0.856
Polypharmacy	0.000	1.000	0.088	0.271	-0.019	0.258
Incontinence	0.248	0.002	0.225	0.004	0.255	0.001

K-PASE, Korean Physical Activity Scale of the Elderly; IPAQ, International Physical Activity Questionnaire; ADL, activities of daily living; IADL, instrumental activities of daily living.

according to the CHS-PASE and CHS-IPAQ agreed highly with each other. Furthermore, frailty status according to both the CHS-PASE and CHS-IPAQ correlated with common geriatric syndromes including functional impairment and fall history. Therefore, instead of the K-PASE, the IPAQ short form might be used as a component of the CHS phenotype for evaluating frailty status in community-dwelling older people.

To our knowledge, this study is the first to directly compare two commonly used physical activity questionnaires to assess CHS frailty phenotype and common geriatric syndromes. In particular, several nationwide epidemiological studies that used the IPAQ short form are currently underway in Korea^{8,14}. Thus, establishing the validity of the IPAQ short form to assess frailty and developing a conversion equation from the K-PASE to the IPAQ short form are timely to facilitate interpretations of data in comparison with the findings from these studies.

However, there are limitations in the study. Since our study is based on community-dwelling older people in rural agricultural areas, generalizability to urban-dwelling older people may be limited. In this study, we used the ASPRA cohort-specific 20th percentile cutoff point of the K-PASE owing to lack of a nationwide cutoff point for the older Korean population. Although we compared CHS frailty phenotype definitions based on the ASPRA-specific K-PASE cutoff point vs. the nationwide IPAQ cutoff point, it was reassuring to observe moderate to high agreement between the 2 definitions and a similar correlation between each definition and most geriatric conditions. Furthermore, although a large proportion of the study population is engaged in agriculture, neither the K-PASE nor the IPAQ short form has specific items to capture their agricultural work as a physical activity. An objective measurement (e.g., accelerometer) will be useful for

more accurate assessment of physical activity. An ongoing nationwide aging cohort, the KFACS, that employs the IPAQ short form and a wearable device, is expected to provide additional information on validity⁸. Future research should assess the predictive validity of these tools for adverse health events.

In conclusion, our study provides supporting evidence that the IPAQ short form, a simple and free questionnaire, may replace the K-PASE for assessing CHS frailty phenotype in older Koreans. Our results should inform frailty assessment in various research and clinical settings.

Conflicts of Interest Disclosures: Dr. Dae Hyun Kim is a consultant to Alosa Health, a nonprofit educational organization with no relationship to any drug or device manufacturers. The other authors have no potential conflicts of interest to disclose.

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Supplementary Material

Supplementary Table 1 can be found *via* <http://www.e-agmr.org/src/sm/agmr-21-101-s001.pdf>.

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