



ORIGINAL ARTICLE

Association of handgrip strength with suicidal ideation among adults aged ≥ 50 years from low- and middle-income countries

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Abstract

Introduction: This study aimed to investigate the association between handgrip strength and suicidal ideation in representative samples of adults aged ≥ 50 years from six LMICs (China, Ghana, India, Mexico, Russia, and South Africa).

Methods: Cross-sectional, community-based data from the World Health Organization's Study on Global Aging and Adult Health were analyzed. Handgrip strength quintiles by sex were created based on the average value of two handgrip measurements of the dominant hand. Self-reported information on past 12-month suicidal ideation was collected. Multivariable logistic regression analysis was conducted to assess associations.

Results: Data on 34,129 individuals were analyzed [mean (SD) age 62.4 (16.0) years; age range 50–114 years; 52.1% females]. After adjustment for potential confounders, in the overall sample, compared to the handgrip strength quintile with the highest values [Quintile 1 (Q1)], Q2, Q3, Q4, and Q5 were associated

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with significant 2.15 (95% CI=1.05–4.39), 2.78 (95% CI=1.06–7.32), 3.53 (95% CI=1.68–7.42), and 6.79 (95% CI=2.80–16.48) times higher odds for suicidal ideation.

Conclusions: Lower handgrip strength was significantly and dose-dependently associated with higher odds for suicidal ideation in adults aged ≥ 50 years from LMICs. Future longitudinal studies are needed to understand the underlying mechanisms, and whether increasing general muscular strength and physical function may lead to reduction in suicidal ideation.

KEYWORDS

epidemiology, grip strength, middle-aged adults, older adults, suicidality

INTRODUCTION

More than 700,000 people die by suicide each year, and there are many more people who attempt suicide (World Health Organization, 2021). Importantly, while low- and middle-income countries (LMICs) have lower suicide rates compared to high-income countries (HICs) (11.2 vs. 12.7 per 100,000), 75.5% of suicides occur in LMICs (World Health Organization, 2014). The rate of suicide increases with age among people older than 60 years (Shah et al., 2016), while the highest suicide rates are found in the older population (≥ 65 years) in almost all countries (Conejero et al., 2018; World Health Organization, 2019). People with suicidal ideation (i.e., contemplations and preoccupations with suicide (Harmer et al., 2020)) are at increased risk of suicide attempts, while all forms of suicidal thoughts and behaviors are associated with greater risk for death by suicides (Slade et al., 2009). However, although those with suicidal ideation are at greater risk of suicide attempt when compared to those without suicidal ideation, it is important to note that the majority of ideators will never attempt suicide (Harmer et al., 2020). Indeed, among individuals with a lifetime history of suicidal ideation, the probability of ever making a plan is approximately 33 percent, and the probability of ever making a suicide attempt is approximately 30 percent (Schreiber et al., 2010). Importantly, in addition to an increased risk of suicide attempts, suicidal ideation has also been identified to be associated with detrimental health outcomes including, for example, illicit drug use (Zhang & Wu, 2014) and poor health-related quality of life (Goldney et al., 2001). Thus, identification of the risk factors for suicidal ideation, especially in the older population of LMICs, is important to aid in targeted interventions to prevent death by suicides, and potentially other detrimental health outcomes.

While a myriad of risk factors or correlates of suicidality have been identified in the literature (Smith et al., 2021,

2022), one potentially important risk factor or correlate that has been little studied to date is that of handgrip strength. The handgrip strength test is commonly used to evaluate the integrated performance of the muscles by determining the maximal grip force that can be produced in muscular contraction, which further serves as a marker for general muscle strength. Handgrip strength is a valid measure of physical function and has been widely employed in observational research and clinical settings (Soysal et al., 2021). Low general muscular strength and physical function may increase risk for suicidality, for instance, via a proinflammatory state that may operate in the pathway to suicidal ideation, through abnormal levels of cytokines (Cao et al., 2020). Moreover, low handgrip strength reflects poor overall physical activity in older adults, and is associated with increases in feelings of helplessness, fear of falling, fatigue, and fewer social activities, which can lead to suicidality (van Milligen et al., 2011; Veronese et al., 2017). Importantly, depression and suicidality and dynapenia share several common pathophysiological pathways mediated by oxidative stress, chronic inflammation, metabolic dysfunction, and decreased concentration of brain-derived neurotrophic factor (BDNF) (Han et al., 2019).

However, to the authors' knowledge, there are only three studies that have investigated the association between handgrip strength and suicide morbidity or death by suicide. First, in one million adolescent males, using the Swedish military conscription register, it was found that higher muscular strength (highest 10th vs. lowest 10th knee extension and handgrip strength) was associated with a 20%–30% lower risk of death from suicide (Ortega et al., 2012). In another study including 8903 US adults, each 5 kg increase in handgrip strength was associated with a 16% reduced odds of having suicidal ideation (OR = 0.84; 95% CI = 0.74–0.95) among the male population. In contrast, no associations were observed in females (Cao et al., 2020). Finally, in one study

including 14,325 adults from the Korean National Health and Nutrition Survey, it was concluded that handgrip strength (per 1 kg increase) is associated with lower odds for suicidal ideation among males (OR = 0.96; 95% CI = 0.94–0.99) and females (OR = 0.97; 95% CI = 0.95–1.00) (Hwang & Ahn, 2021).

An important limitation of all these previous studies is that they all focus on single high-income-countries. Clearly, more research is needed from LMICs where most suicides in the world occur, and where mental health care is often severely limited. It is possible that poor mental health care compounded with higher rates of frailty in LMICs (Siriwardhana et al., 2018) may lead to a stronger association between low handgrip strength and suicidal ideation in this setting. Furthermore, multi-country studies using standard methods across countries are important as they can provide information on whether associations are context specific. Given this background, the aim of the present study was to investigate the association between handgrip strength and suicidal ideation in representative samples of adults aged ≥ 50 years from six LMICs (China, Ghana, India, Mexico, Russia, and South Africa). We hypothesized that low handgrip strength will be associated with a higher odds for suicidal ideation.

METHODS

Data from the Study on Global Ageing and Adult Health (SAGE) were analyzed. This survey was undertaken in China, Ghana, India, Mexico, Russia, and South Africa between 2007 and 2010. Based on the World Bank classification at the time of the survey, Ghana was the only low-income country, and China and India were lower middle-income countries although China became an upper middle-income country in 2010. The remaining countries were upper middle-income countries. Details of the survey methodology have been published elsewhere (Kowal et al., 2012). Briefly, in order to obtain nationally representative samples, a multistage clustered sampling design method was used. The sample consisted of adults aged ≥ 18 years with oversampling of those aged ≥ 50 years. Following a common research protocol across countries, trained interviewers conducted face-to-face interviews using a standard questionnaire to collect information with either the use of a computer-assisted personal interview (CAPI) or a paper and pencil interview (PAPI) depending on the setting. Standard translation procedures were undertaken to ensure comparability between countries. The survey response rates were: China 93%; Ghana 81%; India 68%; Mexico 53%; Russia 83%; and South Africa 75%. Sampling weights were constructed to adjust for the population structure as reported by the United Nations

Statistical Division. Ethical approval was obtained from the WHO Ethical Review Committee and local ethics research review boards. Written informed consent was obtained from all participants.

Suicidal ideation

Information on suicidal ideation was assessed in the same way as in previous SAGE publications (Cabello et al., 2020; Ghose et al., 2019; Smith et al., 2021), using an adapted version of the depression module of the WHO Composite International Diagnostic Interview (Kessler & Üstün, 2004). Those who screened positive in the depression module were further asked about suicidal ideation. A positive screen referred to having at least one of the three following conditions for more than 2 weeks in the past 12 months: sadness, loss of interest, or low energy. Suicidal ideation was assessed by the question “Did you think of death, or wish you were dead?” with “yes” and “no” answer options (Cabello et al., 2020; Ghose et al., 2019).

Handgrip strength

Handgrip strength was measured twice for both hands with the use of the Smedley's hand dynamometer. This device has demonstrated excellent reliability when implemented among adults (Benton et al., 2022). If the participant had any surgery in the last 3 months or arthritis or pain in the hand/wrist/arm, handgrip strength was not measured for that hand. Thus, if a measurement of one hand was possible, the individual was included in the study. If measurements of both hands were not possible, then that individual was not included. Quintiles by sex were created with higher quintiles representing lower handgrip strength (Pham et al., 2023). The actual cutoffs of the sex-wise quintiles are provided in Table S1 of the Appendix.

Control variables

The selection of control variables was based on past literature (Cao et al., 2020), and included age, sex, wealth quintiles based on income, years of education received, marital status (currently married/cohabiting or other), physical activity, body mass index (BMI), smoking (never, current, past), and number of chronic physical diseases. Levels of physical activity were assessed with the Global Physical Activity Questionnaire and were classified as low, moderate, and high based on

conventional cutoffs (Bull et al., 2009). BMI was calculated as weight in kilograms divided by height in meters squared. BMI was categorized as $<18.5 \text{ kg/m}^2$ (underweight), $18.5\text{--}24.9 \text{ kg/m}^2$ (normal weight), $25.0\text{--}29.9 \text{ kg/m}^2$ (overweight), and $\geq 30.0 \text{ kg/m}^2$ (obesity) (World Health Organization, 2000). Information on 11 chronic physical diseases (angina, arthritis, asthma, chronic back pain, chronic lung disease, diabetes, edentulism, hearing problem, hypertension, stroke, and visual impairment) were obtained. The details on the diagnosis of these conditions are provided in Table S2 (Appendix). The number of chronic conditions were summed for each participant, and categorized as 0, 1, and ≥ 2 .

Statistical analysis

The statistical analysis was performed with Stata 14.2 (Stata Corp LP, College station, Texas). The analysis was restricted to those aged ≥ 50 years. The difference in sample characteristics by suicidal ideation were tested by Chi-squared tests and Student's *t*-tests for categorical and continuous variables, respectively. The association between handgrip strength (exposure) as a categorical variable with the highest quintile being the reference category and suicidal ideation (outcome) was assessed with multivariable logistic regression analysis using the overall sample, sex-stratified samples, and samples stratified by age groups (i.e., 50–64 years and ≥ 65 years). We also conducted a test for trend by including the handgrip strength quintile variable (exposure variable) in the model as a continuous variable. Interaction for sex and age groups was also tested by including the interaction term handgrip strength quintile (continuous variable) X age or sex in the model. Furthermore, country-wise analysis was also conducted using the continuous handgrip strength quintile variable as the exposure variable. The regression analyses were adjusted for age, sex, wealth, education, marital status, physical activity, body mass index, smoking, chronic physical diseases, and country, with the exception of the sex- and country-stratified analyses which were not adjusted for sex and country, respectively. Adjustment for country was done by including dummy variables for each country in the model as in previous SAGE publications (Koyanagi et al., 2014, 2018). All variables were included in the models as categorical variables except for age and education (continuous variables). The sample weighting and the complex study design were taken into account in the analyses with the use of the Stata *svy* command, which uses Taylor linearization methods. Results from the regression analyses are presented as odds ratios (ORs) with 95% confidence intervals (CIs). The level of statistical significance was set at $p < 0.05$.

RESULTS

Data on 34,129 individuals aged ≥ 50 years (range 50–114 years) were analyzed (China $n = 13,175$; Ghana $n = 4305$; India $n = 6560$; Mexico $n = 2313$; Russia $n = 3938$; South Africa $n = 3838$). The sample characteristics are provided in Table 1. The mean (SD) age was 62.4 (16.0) years and 52.1% were females. The prevalence of suicidal ideation was 3.4%. Those who had suicidal ideation were more likely to be females, unmarried, underweight, economically disadvantaged, less educated, with greater number of chronic physical conditions than those without suicidal ideation. The prevalence of suicidal ideation increased with lower levels of handgrip strength (Figure 1). For example, in the overall sample, the prevalence of suicidal ideation was only 0.9% among those in the highest quintile of handgrip strength but this increased to 6.7% among those in the lowest quintile. After adjustment for potential confounders, in the overall sample, compared to the quintile of handgrip strength with the highest values [Quintile 1 (Q1)], Q2, Q3, Q4, and Q5 were associated with significant 2.15 (95% CI = 1.05–4.39), 2.78 (95% CI = 1.06–7.32), 3.53 (95% CI = 1.68–7.42), and 6.79 (95% CI = 2.80–16.48) times higher odds for suicidal ideation (Table 2). Test for trend showed that there was a dose-dependent association between decreasing levels of handgrip strength and suicidal ideation in the overall sample and also sex- and age group-stratified samples ($p \leq 0.001$). Interaction analysis showed that there is no significant effect modification by sex or age group in the association between decreasing levels of handgrip strength and suicidal ideation ($p > 0.05$). Country-wise analysis showed that a one-unit increase in handgrip strength quintile (with higher quintiles representing lower levels of handgrip strength) is positively associated with suicidal ideation (i.e., OR > 1) in all countries with the exception of Mexico, although the estimates from South Africa did not reach statistical significance (Figure 2).

DISCUSSION

Main findings

In this large nationally representative sample of 34,129 people aged ≥ 50 years, we found that lower levels of handgrip strength are dose-dependently associated with higher odds for suicidal ideation. Specifically, compared to the highest quintile, the lowest quintile was associated with a nearly seven times higher odds for suicidal ideation (OR = 6.79; 95% CI = 2.80–16.48). We found no evidence of interaction by sex or age in our study. Country-wise

TABLE 1 Sample characteristics (overall and by suicidal ideation).

Characteristic	Overall	Suicidal ideation		p-Value
		No	Yes	
Age (years)				
Mean (SD)	62.4 (16.0)	62.4 (16.0)	63.1 (16.6)	0.424
Sex				
Female	52.1	51.5	68.2	<0.001
Male	47.9	48.5	31.8	
Wealth				
Most economically disadvantaged	17.1	16.9	20.5	0.006
Economically disadvantaged	19.0	18.7	26.9	
Middle	19.5	19.5	20.9	
Richer	21.3	21.6	15.5	
Richest	23.1	23.4	16.1	
Education (years)				
Mean (SD)	6.0 (8.9)	6.1 (8.9)	4.3 (8.0)	<0.001
Marital status				
Married/cohabiting	75.5	76.0	63.6	<0.001
Other	24.5	24.0	36.4	
Physical activity				
High	49.1	49.2	47.9	0.887
Moderate	22.8	22.8	22.9	
Low	28.1	28.0	29.2	
Body mass index				
Underweight	16.7	16.2	34.6	<0.001
Normal	47.6	47.9	38.3	
Overweight	24.2	24.4	17.2	
Obese	11.5	11.5	9.9	
Smoking				
Never	58.6	58.7	53.0	0.122
Current	34.9	34.8	38.0	
Former	6.6	6.5	9.0	
No. of chronic conditions				
0	23.6	24.1	11.5	<0.001
1	34.3	34.7	22.1	
≥2	42.1	41.2	66.5	

Note: Data are % unless otherwise stated. *p*-value was based on chi-squared test and Student's *t*-tests for categorical and continuous variables, respectively.

Abbreviation: SD, Standard deviation.

analysis showed that lower handgrip strength is strongly associated with suicidal ideation in countries such as Ghana and India. To the best of our knowledge, this is the first study on handgrip strength and suicidal ideation from LMICs, while it is also the first multi-country study on this topic.

Interpretation of the findings

The present study supports the existing literature on this topic (Cao et al., 2020; Hwang & Ahn, 2021; Ortega et al., 2012) by confirming that low handgrip strength is associated with suicide morbidity, and specifically suicidal

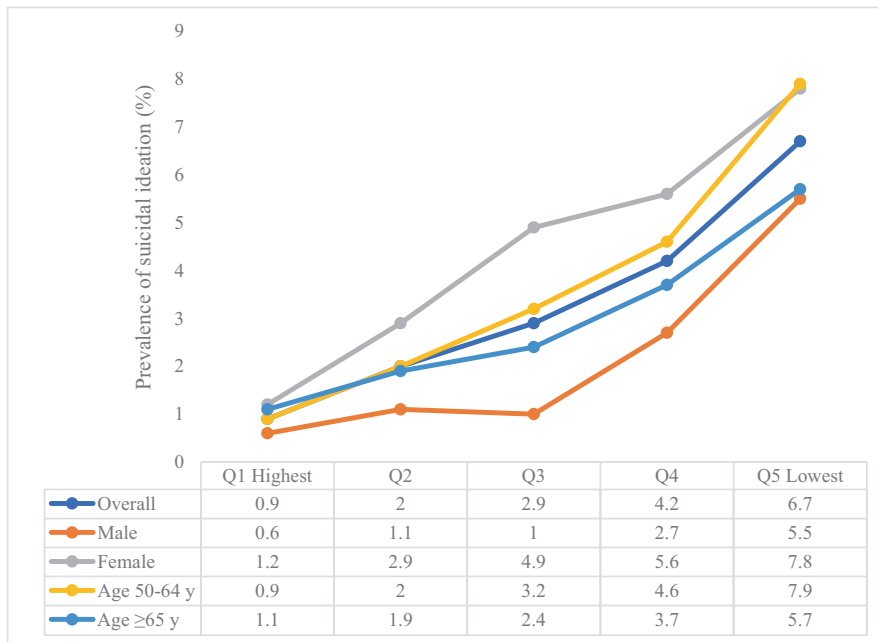


FIGURE 1 Prevalence of suicidal ideation by handgrip strength quintiles (overall, by sex, and by age groups).

ideation. The findings add to the literature by showing that such an association also exists across multiple LMICs.

There are several plausible pathways that likely explain the handgrip strength-suicidal ideation relationship. First, as previously discussed, handgrip strength may be plausibly associated with suicidal ideation owing to the proinflammatory state observed in people with low grip strength. Indeed, abnormal levels of cytokines have been found in serum and prefrontal cortex of those who have died by suicide, suggesting that a possible driver of suicidal behavior might be imbalanced cytokines at a proinflammatory state (Hwang & Ahn, 2021). Next, low handgrip strength has been shown to be a marker of general frailty (Esparza Montero, 2021; Syddall et al., 2003). Frailty per se is associated with greater risk for suicidality, independent of the presence of a mood disorder, possibly owing to, for example, a perceived sense of burden on others and worse social functioning (Bickford et al., 2021). Finally, a low handgrip strength has been shown to be associated with lower levels of quality of life (QoL), possibly due to impaired social functioning and limited interpersonal relationships caused by limitations in mobility (Musalek & Kirchengast, 2017), and QoL per se a strong determinant of suicidality (Alves et al., 2016).

Interestingly, the present study found no difference between handgrip strength and suicidal ideation between males and females. However, one previous study did observe a difference. In the US study including 8903 adults, an association between handgrip strength and suicidal ideation was observed in males only (Cao et al., 2020). Why this discrepancy between findings exists is elusive, and future research of a qualitative nature is required to

further understand sex differences in findings between studies.

Finally, we found that lower handgrip strength is particularly strongly associated with suicidal ideation in India and Ghana but that an association may not exist in Mexico. The reason for this is unclear but India and Ghana were the countries in our study that are most economically disadvantaged, and thus, it is possible that poor quality of mental health care in these countries may be contributing to the particularly strong associations observed. However, this is only speculative and thus, more studies from diverse settings are necessary to understand why there may be between-country differences in the magnitude of the association between low handgrip strength and suicidal ideation.

Implications of the study findings

Findings from the present study suggest that those with low handgrip strength are at higher odds for suicidal ideation. Although longitudinal studies are needed to understand potential causality and direction of the associations, our study results tentatively suggest that improvements in muscle strength may lead to reduction in suicidal ideation by improving frailty, among other potential mechanisms. Mind-body exercises (e.g., yoga and tai-chi) may be best implemented to achieve this. Such exercises have been found to be feasible in LMICs, improve general strength, increase interpersonal relationships, as well as improve mental health (Bridges & Sharma, 2017; Dash & Telles, 2001; Rodríguez-Romero et al., 2021; Valdivia et al., 2020).

TABLE 2 Association between handgrip strength and suicidal ideation estimated by multivariable logistic regression (overall, by sex, and by age groups).

Handgrip strength quintile	Sex			Age		
	Overall		Male	Female		≥65 years
	OR [95% CI]	p-Value	OR [95% CI]	p-Value	OR [95% CI]	p-Value
Q1 (Highest)	1.00		1.00		1.00	
Q2	2.15 [1.05, 4.39]	0.036	1.62 [0.60, 4.38]	0.345	2.41 [1.14, 5.09]	0.021
Q3	2.78 [1.06, 7.32]	0.039	1.14 [0.42, 3.04]	0.799	3.47 [1.07, 11.28]	0.039
Q4	3.53 [1.68, 7.42]	0.001	2.75 [1.05, 7.21]	0.040	4.43 [1.80, 10.92]	0.001
Q5 (Lowest)	6.79 [2.80, 16.48]	<0.001	5.83 [2.19, 15.50]	<0.001	9.41 [3.52, 25.16]	<0.001

Note: Models were adjusted for age, sex, wealth, education, marital status, physical activity, body mass index, smoking, chronic physical diseases, and country with the exception of the sex-stratified analysis which was not adjusted for sex. Significant test for trend for all regressions (i.e., $p \leq 0.001$).

Abbreviations: CI, confidence interval; OR, odds ratio.

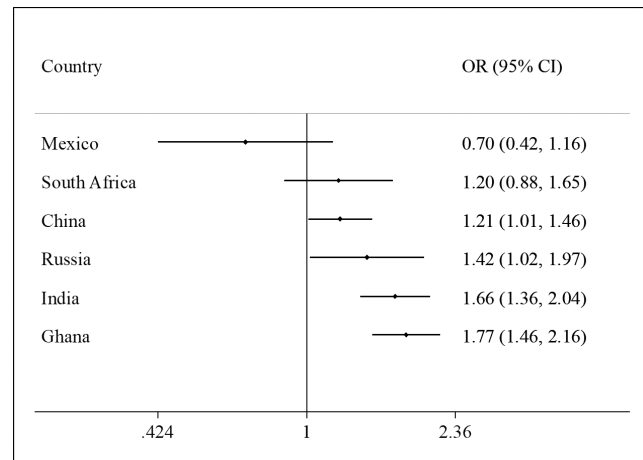


FIGURE 2 Country-wise association between decreasing handgrip strength in quintiles (exposure) and suicidal ideation (outcome) estimated by multivariable logistic regression. CI, confidence interval; OR, odds ratio. The exposure variable was handgrip strength quintiles included in the model as a continuous variable (i.e., Q1 highest coded = 1; Q2 coded = 2; Q3 coded = 3; Q4 coded = 4; Q5 lowest coded = 5). Models were adjusted for age, sex, wealth, education, marital status, physical activity, body mass index, smoking, and chronic physical diseases.

Strengths and limitations

The analysis using large representative samples of middle-aged to older adults across six LMICs are clear strengths of the present study. However, the present findings must be interpreted in light of the study's limitations. First, the study was cross-sectional in nature, and thus, the direction of the association cannot be inferred. For example, it is also feasible that suicidality leads to a reduction in social participation that may subsequently lead to an increase in frailty/ decline in handgrip strength. Second, some variables were self-reported, potentially introducing social desirability and recall bias into the findings. It is also possible that cultural differences may have resulted in different interpretations of the survey questions, in particular, that of suicidal ideation. Third, the variable on suicidal ideation used included the concept of "wish to die," which has been considered to be different from active suicidal ideation. However, "wish to die" has been reported as clinically important as active suicidal ideation (Cabello et al., 2020). Fourth, the study may have underestimated those with suicidal ideation, as suicidal ideation was only assessed among those who had depressive symptoms (sadness, loss of interest, or low energy). Relatedly, those with suicidal ideation but without a positive screen for depression could have been included in the group without suicidal ideation. However, depressive symptoms are extremely common in people with suicidal thoughts (Services, 2014). Finally, it is important to highlight that

although we refer to suicidal ideation (i.e., desire to die by suicide) throughout the present manuscript, the question asked in the survey was “Did you think of death, or wish you were dead?”. Thus, it is possible that some people who were categorized as having suicidal ideation may have had death ideation (i.e., general thoughts of death). However, mechanisms driving the observed association are likely identical, whether the outcome variable captured is suicidal ideation, death ideation, or both.

CONCLUSION

Lower handgrip strength was dose-dependently associated with higher odds for suicidal ideation in adults aged ≥ 50 years from LMICs. Future longitudinal studies are needed to understand the underlying mechanisms, and whether increasing general muscular strength and physical function may lead to reduction in suicidal ideation.

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CONFLICT OF INTEREST STATEMENT

The authors have no conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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