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A comparison of two pre-race medical screening tools in 5771 running race entrants—SAFER XXVIII

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Abstract

Objective: To determine if two pre-race screening tools (abbreviated tool of two open-ended pre-race medical screening questions [ABBR] vs. a full pre-race medical screening tool [FULL]) identify running race entrants at higher risk for medical encounters (MEs) on race day.

Methods: 5771 consenting race entrants completed both an ABBR and a FULL pre-race screening questionnaire for the 2018 Comrades Marathon (90 km). ABBR tool questions were (1) allergies, and (2) known medical conditions and/or prescription medication use. The FULL tool included multiple domains of questions for chronic diseases including cardiovascular disease (CVD), symptoms, risk factors, allergies and medication use. ABBR responses were manually coded and compared to the FULL tool. The prevalence (%: 95%CI), and the test for equality of prevalence of entrants identified by the ABBR vs. FULL tool is reported.

Results: The ABBR identified fewer entrants with allergies (ABBR = 7.9%; FULL = 10.4%: $p = 0.0001$) and medical conditions/medication use (ABBR = 8.9%; FULL = 27.4%: $p = 0.0001$). The ABBR tool significantly under-reported entrants with history of cardiovascular disease (CVD), CVD risk factors, other chronic diseases and prescription medication vs. the FULL tool ($p = 0.0001$). The ABBR tool identified fewer entrants in the "high" (ABBR = 3.4%; FULL = 12.4%) and "very high" risk (ABBR = 0.5%; FULL = 3.4%) categories for race day MEs ($p = 0.0001$).

Conclusions: An abbreviated pre-race screening tool significantly underestimates chronic medical conditions, allergies, and race entrants at higher risk for MEs on race day, compared with a full comprehensive screening tool. We recommend that a full pre-race medical screening tool be used to identify race entrants at risk for MEs.

KEYWORDS

athletes, cardiovascular disease, marathon, medical encounters (MEs), pre-race screening, risk profile

1 | INTRODUCTION

Regular physical exercise is recommended as part of a healthy lifestyle to reduce the risk and treat non-communicable diseases (NCDs).[1–4] The often recommended 'dose' for regular exercise is >150 min/week of moderate- to high-intensity aerobic physical activity,[5] and distance running is a popular form of exercise to gain these health benefits.

Paradoxically, moderate- to high-intensity physical exercise is associated with an increased risk for serious life-threatening medical encounters (MEs) including cardiac events (sudden cardiac arrest and sudden cardiac death), exertional heatstroke, acute kidney injury and serum electrolyte abnormalities e.g. hyponatraemia.[6] Individuals at higher risk of MEs should be identified and are usually older male athletes with underlying cardiovascular disease[2,6–8] and other chronic diseases.[9,10] In most mass community-based endurance sports events, male entrants still predominate and over the past 2–3 decades the number of older participants has increased. There are several studies reporting that older males are at highest risk for serious MEs during long distance running events,[11–14] and this is likely due to a higher prevalence of cardiovascular disease and other chronic diseases in older male athletes. There are two studies that support the role of pre-event screening and risk stratification based on a history of CVD and other chronic disease. In a previous paper,[15] an association was shown between risk category and adverse events, and in the other paper a pre-race medical screening and educational intervention specific for higher risk categories, significantly reduced serious MEs.[4]

The 90 km Comrades Marathon is an ultra-distance running event that attracts over 20 000 participants each year. The race is run between the cities of Durban and Pietermaritzburg (in Kwa-Zulu Natal province of South Africa), alternating directions each year. We recently reported that the incidence of MEs during this event is one of the highest, compared with other marathon and ultra-marathon races, with 1 in 556 race starters developing a serious/life-threatening ME.[16]

In an attempt to reduce serious MEs during physical activity, various international guidelines have been created to screen individuals deemed to be at higher risk of having a ME when engaging in moderate- to high-intensity physical activity.[2,7,15,17–21] These guidelines were used as a framework to develop a comprehensive pre-race medical screening and educational intervention tool for race entrants to identify risk factors for cardiovascular disease (CVD), symptoms of CVD, known CVD, and other chronic diseases. The full pre-race medical screening tool is predictive of MEs,[15,22,23] can be used to risk stratify entrants and advise race entrants on medical clearance,[4] and includes disease-specific educational intervention programmes for participants. This pre-race medical screening and educational intervention tool has been shown in another event to significantly reduce serious/life-threatening MEs.[4]

At the Comrades Marathon, limited pre-race medical information has, for many years, been obtained through an abbreviated pre-race screening tool consisting of two open-ended medical questions that were included as part of the race entry process. However, no scientific evidence supports the use of two screening questions to identify runners at risk for MEs on race day. We recently showed that the positive responses to these questions are predictive of MEs on race day, but that the voluntary completion of two open-ended questions was considerably lower than that reported for other races that implemented compulsory completion of a more comprehensive pre-screening questionnaire.[23] Currently, it is unknown to what extent the information from the abbreviated tool (two open-ended medical questions) during the race entry process compares to a full and comprehensive pre-race medical screening questionnaire. It has also been shown that MEs are reduced if comprehensive pre-race screening was performed and an educational intervention is implemented in "very high risk" and "high risk" athletes.[4]

The aim of this study was to determine if two pre-race screening tools (abbreviated tool of two open-ended pre-race medical screening questions vs. a full pre-race medical screening tool) identify the same proportion of 90 km running race entrants at higher risk for medical encounters. Comparing the abbreviated pre-screening tool to a full pre-race screening questionnaire will assist organizers and race medical directors decide which pre-race screening tool to use in future. We hypothesize that the abbreviated tool will identify fewer participants at higher risk for medical encounters compared to the full pre-race screening questionnaire.

2 | MATERIALS AND METHODS

2.1 | Study design

A descriptive cross-sectional study.

2.2 | Setting

The 2018 Comrades ultramarathon (90 km) road running race. This study forms part of the Strategies to reduce Adverse events For the ExerciseR (SAFER) studies.[24]

2.3 | Participants

In 2018, all race entrants (23 412) completed an abbreviated tool consisting of two open-ended online pre-race questions (ABBR), and 5771 of the entrants also completed a full online pre-race medical screening tool (FULL). The participants for this study were the 5771 entrants who completed the ABBR and the FULL tool. Research ethics approval was granted by the University of Pretoria, Faculty of Health Sciences (HREC 454/2021 and 431/2015).

2.4 | Data collection

2.4.1 | Abbreviated screening tool (ABBR)

The ABBR pre-race screening tool consisted of two open-ended medical questions asked at the time of race entry. The two questions were: (1) "Do you have any known allergies?" and (2) "Do you have any known medical conditions (medical history) and/or prescription medication use?"

Data from the race entrants who completed the two questions of the abbreviated tool were analyzed as follows: (1) un-coded data, by counting any response (yes, no, or no answer) to the two screening questions, and (2) coded data, where each open-ended response to the medical history and allergy question was individually analyzed, interpreted and then coded (using a predefined list of conditions) by the principal investigator (medical doctor) (JL). Another medical doctor independently checked a subset of the responses for reliability. This coding process and reliability have previously been described in detail.[23]

2.4.2 | Full detailed online medical screening tool (FULL)

The development of the FULL screening tool has been described and used in previous SAFER studies.[4] The tool was developed using available international pre-exercise screening guidelines to identify athletes at risk of medical encounters during moderate- to high-intensity exercise. The questions included in the FULL screening tool were based on the ESC (European Society of Cardiology) and the EACPR (European Association for Cardiovascular Prevention and Rehabilitation) guidelines for pre-participation screening of leisure athletes engaging in moderate- to high-intensity exercise.[2,7] All the questions in the AHA/ACSM (American Heart Association/American College for Sports Medicine) pre-participation screening questionnaire were also included.[17,18] Therefore, the FULL screening tool was based on the tools developed by several international organizations to create a comprehensive pre-exercise screening tool.[2,7,17,18] The specific domains included in the questionnaire were as follows: known cardiovascular disease (CVD), symptoms of CVD, CVD risk factors, metabolic/hormonal disease, respiratory disease, gastrointestinal disease, central nervous system disease, kidney/bladder disease, blood/immune disease, cancer history, allergies, prescription medicine use and running specific issues—history of collapse after training/racing, recent running injuries, and muscle cramping history. Specific types of diseases, symptoms and risk factors were listed in the relevant domains.

2.5 | Risk stratification

Using the information from the coded data obtained using the ABBR tool and the FULL tool entrants were risk stratified into four risk categories that have been described in detail in a previous SAFER study.[4] The risk categories were as follows:

1. Very high risk (an entrant reporting known CVD, or symptoms suggestive of CVD).
2. High risk (an entrant reporting multiple CVD risk factors).
3. Intermediate risk (an entrant reporting a single CVD risk factor and/or any other chronic disease, prescription medication use, allergies).
4. Low risk (an entrant reporting no CVD risk factors and no other chronic disease).

2.6 | Outcome measures

The main outcome measure was the estimated prevalence of entrants (%) identified by the two pre-race screening tools (ABBR and FULL). The prevalence is reported for the following variables.

- Any allergy history (using the un-coded data (a yes/no response) from the two open-ended questions)
- Any medical condition/medication use history (using the un-coded data (a yes/no response) from the two open-ended questions)
- Specific medical conditions: history of CVD, CVD risk factors, metabolic disease, respiratory disease, endocrine disease, nervous/psychiatric system, hematological/immune disease, gastrointestinal (GIT) disease (using the coded and analyzed data from the two open-ended questions)
- Prescription medication use (using the coded and analyzed data from the two open-ended questions)
- Risk categories: very high, high, intermediate, and low risk (using the coded and analyzed data from the two open-ended questions)

2.7 | Statistical analysis

All data from the two questions and medical screening database were entered into an Excel spreadsheet (Microsoft 2010) and analyzed using the SAS (V9.4) statistical program. The analysis obtained the following: (1) prevalence estimates and log-linear modeling (%: 95% CIs) for the identification of an allergy as well as medical condition/medication using two data collection tools: (a) the open-ended question and (b) the pre-race questionnaire, (2) prevalence estimates for each of the specific medical conditions, (3) prevalence in each of the risk categories (defined using the risk factors) for the two types of data tools (a) and (b) above.

3 | RESULTS

3.1 | Demographics of race entrants

23 412 runners entered the 2018 Comrades marathon race and all of them completed the ABBR screening tool as part of the pre-race entry process (6–8 months before the race). In the same year, a sample of 6394 race entrants also completed the FULL detailed online pre-race medical screening tool administered 2–4 months before the event. 5771 (90% consent) of those race entrants, who had completed both the two open-ended questions as well as the detailed online pre-race medical screening questionnaire, consented for their data to be used for research purposes. The demographics of entrants and consenters by age category and sex are depicted in Table 1.

There was a significantly higher percentage of females participating in the study compared to all female entrants (28.0% vs. 22.5%) ($p < 0.0001$).

TABLE 1 The demographics of all entrants in 2018 compared to consenting entrants completing the FULL pre-race screening questionnaire.

	All race entrants ($n = 23\,412$)	Study population of consenting race entrants ($n = 5771$)	
	n (%)	*n* (%)	*p*-value
Age category (years)			
≤30	1795 (7.7)	461 (7.9)	0.8708
31–40	8834 (37.7)	2175 (37.8)	
41–50	8473 (36.3)	2074 (35.9)	
>50	4310 (18.4)	1061 (18.4)	
Sex			
Males	18 136 (77.5)	4154 (71.9)	<0.0001
Females	5276 (22.5)	1617 (28.0)	

3.2 | Responses for allergies and medical conditions/medication use, overall and by gender and age categories

The responses to the ABBR tool in all entrants and the subset of entrants ($n = 5771$) are shown in Table S1. The positive response rates are similar, except for some categories where there are more positive responses in the subset compared to all entrants.

The breakdown of responses for allergies and medical conditions/medication use using the un-coded data from the ABBR tool and the data from the FULL tool are shown in Table 2, overall and by sex (and age group for medical conditions/medication use).

In comparison to the ABBR tool, the FULL tool detected a higher % of positive responses overall, as well as for both sexes and all four age groups. Overall, 10.4% (599) responded "yes" to allergies in the FULL tool and 2.5% less in the ABBR tool. However, there was a discrepancy between males' and females' responses between the FULL tool and ABBR tool ($p = 0.012$). Male "yes" responses were 1.9% less ($p < 0.0001$) and female "yes" responses 4% less ($p < 0.0001$) for the ABBR tool compared to the FULL tool. The responses by age groups were not significantly different for allergies ($p = 0.82$).

In the FULL tool, 27.4% responded "yes" to medical conditions/medication use and in the ABBR tool 8.9% responded yes (18.5% less than the full tool). Again, there was a discrepancy in the responses from males and females between the FULL tool and ABBR tool ($p < 0.0001$). Male "yes" responses were 15.1% less ($p < 0.0001$) and female "yes" responses 27.3% less ($p < 0.0001$) for the ABBR tool compared to the FULL tool.

For medical conditions/medication use, there was a discrepancy in the responses from entrants in different age groups between the FULL tool and ABBR tool ($p = 0.0001$). Age group ≤30 "yes" responses were 15.6%, age group 31–40 "yes" responses 16.2% less, age group 41–50 "yes" responses 19% less and age group >50 "yes" responses were 23.5% less for the ABBR tool compared to the FULL tool ($p < 0.0001$).

3.3 | Responses for specific categories of medical conditions and medication use

The responses to the ABBR tool in all entrants and the subset of entrants ($n = 5771$) for specific categories of medical conditions and medication use are shown in Table S2. The breakdown of responses for specific categories of medical conditions and medication use, from the ABBR and the FULL tool, is shown in Table 3.

TABLE 2 Reported *n* (%) allergies and medical conditions/medication use when using un-coded data from the ABBR tool and the FULL tool.

Condition	ABBR tool yes response 5771 entrants *n* (%)	FULL tool yes responses 5771 entrants *n* (%)	Differences in positive marginal responses[a] % (SE) 5771 entrants	*p*-value test for equality of prevalence
Any allergy (all)	457 (7.9)	599 (10.4)	2.46 (0.36)	0.0001
Males	286 (6.9)	363 (8.7)	1.85 (0.40)	<0.0001
Females	171 (10.6)	236 (14.6)	4.02 (0.77)	<0.0001
Any medical condition or medication use (all)	516 (8.9)	1583 (27.4)	18.49 (0.56)	0.0001
Males	346 (8.3)	971 (23.4)	15.05 (0.61)	<0.0001
Females	170 (10.5)	612 (37.9)	27.33 (1.15)	<0.0001
Age group ≤30	21 (4.6)	93 (20.2)	15.6 (0.2)	<0.0001
Age group 31–40	142 (6.5)	495 (22.8)	16.2 (0.01)	<0.0001
Age group 41–50	199 (9.6)	592 (28.5)	19.0 (0.01)	<0.0001
Age group >50	154 (14.5)	403 (38.0)	23.5 (0.01)	<0.0001

[a]The differences are the % positive marginal responses for FULL-ABBR.

TABLE 3 Reported *n* (%) specific categories of medical conditions and medication use, when using the ABBR and the FULL tool.

	ABBR tool yes response 5771 entrants *n* (%)	FULL tool yes responses 5771 entrants *n* (%)	Differences in positive marginal responses[a] % (SE) 5771 entrants	*p*-value test for equality of prevalence
Any history of CVD	29 (0.50)	115 (1.99)	1.49 (0.17)	0.0001
Any risk factor for CVD	195 (3.38)	789 (13.67)	10.29 (0.41)	0.0001
Any other chronic disease				
Any metabolic endocrine disease	87 (1.51)	199 (3.45)	1.94 (0.20)	0.0001
Any respiratory disease	190 (3.29)	517 (8.96)	5.67 (0.34)	0.0001
Any kidney/bladder disease	1 (0.02)	154 (2.67)	2.65 (0.21)	0.0001
Nervous system/psychiatric	38 (0.66)	180 (3.12)	2.46 (0.23)	0.0001
Hematological/immune disease	19 (0.33)	70 (1.21)	0.88 (0.14)	0.0001
GIT disease	15 (0.26)	206 (3.57)	3.31 (0.24)	0.0001
Any prescription medication use	459 (7.95)	831 (14.40)	6.45 (0.42)	0.0001

Abbreviations: CVD, cardiovascular disease; GIT, gastrointestinal.

[a]The differences are the % positive marginal responses for FULL-ABBR.

The ABBR tool significantly under-reported every variable compared to the FULL tool ($p=0.0001$), especially for the following: CVD risk factors (10.3% less), prescription medication use (6.5% less) and respiratory disease (5.7% less).

3.4 | The prevalence of race entrants in each of the four risk categories when using the ABBR and the FULL pre-race screening tools

Using the coded responses to the ABBR tool in all entrants ($n=23\,411$) and the subset of entrants ($n=5771$) and categorizing the entrants into risk categories are shown in Table 4. There was minimal difference between all entrants and the subset of entrants using only the ABBR tool when categorizing the entrants into risk categories.

The prevalence of race entrants in each of the four risk categories when using the ABBR and the FULL pre-race screening tools in the four risk categories is shown in Table 5.

The ABBR tool significantly under-estimated % entrants in the "very high" and "high" and "intermediate" risk categories and over-estimated the % entrants in the "low" risk category ($p<0.0001$).

TABLE 4 All race entrants (23 411) and the subset of entrants' (5771) coded responses and classified into each of the four risk categories.

Risk category	Criteria	ABBR tool all 2018 entrants 23 411 *n* (%)	ABBR tool subset 5771 *n* (%)
Very high	• Existing CVD • Symptoms suggestive of existing CVD	59 (0.3)	29 (0.5)
High	• Risk factors for CVD (≥2 risk factors) • One risk factor CVD and >45 years male or >55 years female	557 (2.4)	194 (3.4)
Intermediate	• Existing chronic disease in other organ systems • History of allergies • Use of prescription medication • Age (>45 years male, >55 years female)	7852 (33.5)	1890 (32.8)
Low	• None of the criteria in the very high, high and intermediate risk categories	14 944 (63.8)	3658 (63.4)

Abbreviation: CVD, cardiovascular disease.

TABLE 5 The prevalence *n* (%) of race entrants in each of the four risk categories when using the ABBR compared to the FULL pre-race medical screening questionnaire.

Risk category	Criteria	ABBR tool *n* (%)	FULL tool *n* (%)	Differences in positive marginal responses[a] % (SE) 5771 entrants	*p*-value test for equality of prevalence
Very high	• Existing CVD • Symptoms suggestive of existing CVD	29 (0.5)	190 (3.3)	2.79 (0.22)	<0.0001
High	• Risk factors for CVD (≥2 risk factors) • One risk factor CVD and >45 years male or >55 years female	194 (3.4)	717 (12.4)	9.06 (0.40)	
Intermediate	• Existing chronic disease in other organ systems • History of allergies • Use of prescription medication • Age (>45 years male, >55 years female)	1890 (32.8)	2178 (37.7)	4.99 (0.56)	
Low	• None of the criteria in the very high, high and intermediate risk categories	3658 (63.4)	2686 (46.5)	−16.8 (0.53)	

Abbreviation: CVD, cardiovascular disease.

[a]The differences are the % positive marginal responses for FULL-ABBR.

4 | DISCUSSION

The main findings of this study are as follows: (1) significant under-reporting of broad categories of runners with allergies or medical conditions when using the ABBR compared with the FULL screening tool, (2) significant under-reporting of specific medical conditions by runners when using the ABBR compared with the FULL screening tool, and (3) compared to the FULL screening tool, the ABBR tool identified a significantly lower % of entrants in the "very high risk" and "high risk" categories.

Both allergies (7.92% vs. 10.3%) and medical conditions (8.94% vs. 27.43%) in the ABBR compared to the FULL pre-race screening tool were underreported. The practical application of this finding is that the FULL tool identifies more participants who have an allergy or medical condition/medication use. This is of clinical significance because both allergies and chronic disease are associated with a higher incidence of MEs during a race,[23] and the ME risk may have been reduced by an educational intervention.

The FULL pre-race screening tools identify more runners at risk. Entrants with these underlying risk factors and chronic medical conditions are at higher risk of a ME on race day. CVD risk factors, history of CVD, respiratory disease and medication use are the most important risk factors and medical conditions in screening tools.[15,16,20] The most significant under-reporting was in the CVD risk factors category (10.3% lower using the ABBR tool) followed by prescription medication use (6.5% less) and respiratory disease (5.7% less). Significant under-reporting of CVD risk factors and history of CVD is of particular concern as they form the basis of pre-exercise screening and risk stratification tools.[4,15]

The abbreviated screening tool identified significantly fewer race entrants in the "high risk" (ABBR = 3.4%; FULL = 12.4%) and "very high risk" categories (ABBR = 0.5%; FULL = 3.3%). The observed difference between the two screening tools can be attributed to limited and non-specific nature of the open-ended questions, which do not include specific questions on types of diseases, risk factors and symptoms. The FULL pre-race screening questionnaire is comprehensive and prompts responses by listing specific diseases, risk factors and symptoms.

Age and sex are important factors to consider in pre-race screening. Older athletes are at an increased risk of MEs during races, including sudden cardiac arrest or sudden cardiac death.[2,4,8,17,25] Current international pre-exercise screening guidelines recommend medical screening and possible medical assessment before engaging in high-intensity exercise.[7] The demographics in our study, 77.5% male and 54.7% total entrants over the age of 40 years, support the importance of pre-race screening processes and educational interventions for a race such as the Comrades Marathon.

The FULL pre-race screening tool has an automated algorithm that identifies participants in the "very high" and "high" risk categories and advises them to seek medical clearance prior to the event.[4] Specific educational information is also distributed to participants reporting chronic diseases, to decrease MEs during the event. Apart from these pre-race interventions following pre-race screening, the race day medical team have access to the medical information of the participants supplied by pre-race screening tools that can assist in the acute management of participants if a ME occurs. Whilst participants who are identified as "very high" and "high" risk are advised to seek medical clearance, no participant was refused participation on race day. It should be noted that the Comrades Marathon has now implemented the FULL pre-race screening questionnaire and risk stratification/educational intervention as a compulsory component of the entry process.

Our study has several limitations. First, we could only include a sample of 5771 of 23 412 entrants (25%) who completed both the two open-ended questions and the full pre-race screening questionnaire for the 2018 Comrades Marathon. This sample differed from all race entrants in the sex distribution (increased female proportion: 22.5% of all entrants vs. 28% in the study population). Second, the data were self-reported.

The strengths of the study are that: (1) this study compares an abbreviated pre-race medical screening tool (consisting of two open-ended medical questions), with a full pre-race medical screening tool at a mass-participation distance running event, (2) a large sample size to analyze the differences between the two screening tools using several techniques including the difference in positive responses, differences between males and females, and *p*-value test for equality of prevalence (3) the responses to the ABBR of the sample (5771) were similar to that of all entrants.

Pre-exercise screening tools have been recommended by several international organizations, particularly for higher risk individuals such as masters athletes participating in moderate- to high-intensity exercise. Although abbreviated pre-race screening tools have been used, this study indicates that an abbreviated pre-race medical screening tool significantly under-reports allergies, medical conditions, specific medical conditions, and race entrants at high risk of medical encounters. We recommend race organizers implement a full pre-race medical screening tool rather than an abbreviated tool. A full pre-race medical screening tool will identify participants at high risk. This information can assist the race medical directors to better plan race day medical care and identify entrants at risk who should seek medical clearance prior to the event.

5 | PERSPECTIVE

An abbreviated pre-race screening tool significantly under-estimates chronic medical conditions, allergies, and race entrants at higher risk for MEs on race day, compared with a full comprehensive screening tool.

AUTHOR CONTRIBUTIONS

Jordan Leppan: study concept, study planning, data collection, data interpretation, manuscript (first draft), manuscript editing. **Martin Schwellnus**: principal investigator, responsible for the overall content as guarantor, study concept, study planning, data collection, data interpretation, manuscript (first draft), manuscript editing, facilitating funding. **Nicola Sewry**: study concept, study planning, data collection, data interpretation, manuscript (first draft), manuscript editing. **Dina (Christa) Janse van Rensburg**: study concept, study planning, data interpretation, manuscript editing. **Jeremy Boulter**: data collection, data interpretation, manuscript editing. **Marlise Dyer**: data analysis including statistical analysis, data interpretation, manuscript editing. **Esme Jordaan**: study planning, data analysis including statistical analysis, data interpretation, manuscript editing.

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CONFLICT OF INTEREST STATEMENT

None.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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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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