BRIEF REPORTS

Exercise Maintenance in Older Adults 1 Year After Completion of a Supervised Training Intervention

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BACKGROUND/OBJECTIVE: Barriers and facilitators of exercise maintenance and residual effects of exercise training intervention on physical and cognitive function after the cessation of training are inadequately described in older adults.

DESIGN AND SETTING: One year after the cessation of a supervised exercise training intervention, a mixed methods approach employed a quantitative phase that assessed body composition and physical and cognitive function and a qualitative phase that explored determinants of exercise maintenance after participation in the intervention.

PARTICIPANTS: Community-dwelling older Irish adults (aged >65 years) who had completed 12 weeks of supervised exercise training 1 year previously.

MEASUREMENTS: Fifty-three participants (male/female ratio = 30:23; age = 70.8 ± 3.9 years) completed the follow-up testing comprising body composition and physical and cognitive function. Semistructured interviews were conducted with 12 participants (male/female ratio = 6:6) using the Theoretical Domains Framework to inform the interview guide.

RESULTS: At 1 year follow-up, body fat increased (mean = 4.3%; 95% confidence limit = 2.2% to 6.3%), while lean body mass (mean = −0.6%; 95% confidence limit = −1.2% to −0.1%), strength (leg press, mean = −5.6%; 95% confidence limit = −8.3% to −2.8%; chest press, mean = −11.0%; 95% confidence limit = −14.8% to −7.8%), and cognitive function (mean = −3.7%; 95% confidence limit = −5.7% to −1.8%) declined (all $P < .05$). Interviews revealed key facilitators (social aspects and beliefs about benefits of exercise) and barriers (affordability and general aversion to gyms) to exercise maintenance in this population.

CONCLUSION: Key barriers and facilitators to exercise maintenance were identified, which will inform the development of future behavior change interventions to support exercise participation and maintenance in older adults to mitigate adverse changes in body composition and physical and cognitive function with advancing age. **J Am Geriatr Soc 68:163-169, 2020.**

Key words: adherence; barriers; cognition; facilitators; strength

Rates of participation in physical activity in older adults (>65 years) are low, with only a small proportion of older adults meeting the recommended guidelines of 150 minutes of moderate-to-vigorous aerobic (AER) exercise per week[1] and a minimum of two sessions of resistance (RES) exercise training per week.[2] Indeed, even when older adults initiate an exercise program, they often discontinue involvement within 6 months.[3] Therefore, there is an urgent need to explore how older adults can be encouraged to maintain regular exercise, in particular RES exercise training, to accrue related physical and mental health benefits.

While there is some evidence for sustained improvements in physical activity in adults aged 55 to 70 years 12 months after the completion of an exercise intervention,[4] in general, the findings have been somewhat inconsistent.[5] Thus, there is a need to develop an understanding as to how and why interventions might change and successfully maintain a person's exercise behavior. An important step in this process is to examine the likely determinants of that behavior change.[6] Encouragingly, several studies have reported on factors related to older adults' participation in physical activity or an exercise program.[7,8] However, most studies have tended to be atheoretical in nature, and this has led to an increased call for the use of theory to underpin and explain exercise interventions.[9] One such theoretical approach is the Theory Domain Framework

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(TDF).[10] This framework provides a broad method with which to examine determinants of behavior change, by synthesizing key constructs from 33 behavior change theories into 14 domains. Importantly, the TDF has been used to explore the perceived determinants of physical activity behavior in older adults,[11,12] but has not focused on the effects of a prior exercise training intervention on such behaviors in the period after cessation of exercise training.

Therefore, situated within the context of a 12-week supervised exercise training intervention,[13] and utilizing mixed methods, the aim of this study was, first, to assess the changes in body composition and physical and cognitive function of older adults at 1 year after the cessation of the exercise intervention. Second, we explored the factors related to the maintenance of exercise and, in particular, RES exercise training in older adults.

METHODS

Design

A mixed methods design was employed (Figure 1), based on previous work.[14] Ethics approval was granted through the University College Dublin Human Research Ethics Committee (permit number LS-15-35 [Timmons-Egan]), in accordance with the Declaration of Helsinki, and for which all participants gave written, informed consent to participate.

Quantitative Data Collection Phase

Eighty-four community-dwelling men and women (male/female ratio = 45:39; age = 69.3 ± 3.5 years) had previously completed a randomized controlled trial of 12 weeks of supervised exercise training consisting of time-matched groups of AER (n = 21), RES (n = 21), or concurrent AER and RES exercise training (CEX; n = 21), and a control group who continued their usual physical activity habits (CON; n = 21).[13] After the cessation of the exercise training intervention, there was no transition period, such as ongoing supervision or of gradually reducing contact. Instead, participants were debriefed on the study outcomes and provided an information session on current guidelines for exercise in older adults. The data recorded at the end of the training intervention were the starting point for this 1-year follow-up study, with that time point termed POST in the present study. All 63 participants from the exercise training groups (AER, RES, and CEX) were contacted for follow-up assessments. The CON group was not contacted because these participants were subsequently offered training advice and supervision after the initial exercise training intervention and, therefore, could not be considered as a control group for the purposes of this follow-up. Ten participants were lost to follow up for different reasons, including death, ill health, moved house, and vacation. There was an overall response rate of 84% (n = 53) who volunteered to participate in the follow-up assessments, with similar response rates between groups (AER = 86%, RES = 86%, and CEX = 81%).

The assessment battery of physical and cognitive function was identical in content and sequence at each time point, and performed by the same personnel as described in our previous work.[13] Participants completed the Community Health Activities Model Program for Seniors (CHAMPS) questionnaire to estimate weekly frequency of participation and energy expenditure in physical activities.[15]

Quantitative data were analyzed using Prism v7 (GraphPad Software, Inc), and are presented as mean ± SD or mean (95% confidence limit), as appropriate. Data were assessed for normality using the Shapiro-Wilk test. Differences between groups from POST to 1-year follow-up for parameters that were normally distributed were compared using a Student's paired *t*-test, whereas for parameters that

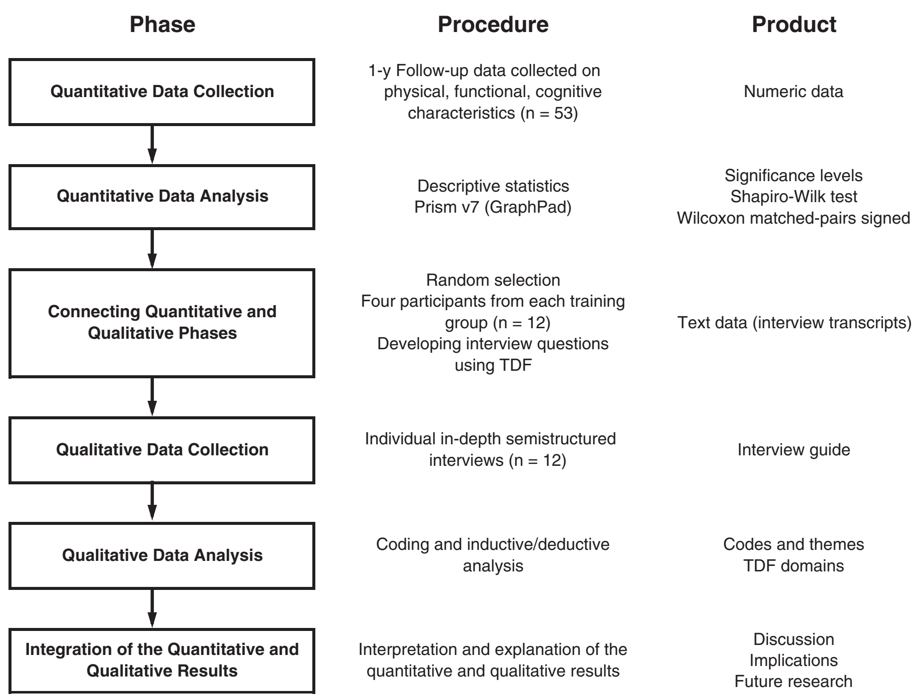

Figure 1. Visual model for mixed methods sequential explanatory design procedure. TDF indicates Theory Domain Framework.

were not normally distributed, a Wilcoxon matched-pairs signed rank test was used. For all analyses, statistical significance was accepted at $P < .05$.

Qualitative Data Collection Phase

Four participants from each training group (n = 12; male/female ratio = 6:6; age = 71.8 ± 4.3 years) agreed to take part in a semistructured interview with an experienced qualitative researcher, within 4 weeks of their functional assessments at the 1-year follow-up time point.

This phase explored participants' experience of the exercise intervention and the factors that influenced their maintenance, or otherwise, of exercise training after cessation of the supervised intervention. The interview guide was informed by the TDF, with open-ended questions developed to assess each of the 14 domains and elicit participants' perceptions of these factors. The interviews ranged from 27 to 42 minutes in length (34 ± 5 minutes), and generated 145 pages of single-spaced text. Data analysis followed a framework approach,[16] and the integration and triangulation of qualitative and quantitative data are described in the Supplementary Methods.

RESULTS

Quantitative Findings

From the CHAMPS questionnaire, estimated weekly average caloric expenditure of these participants was 748 ± 579 kcal in moderate-intensity activities (metabolic equivalent (MET) > 3.0) and 1309 ± 816 kcal in physical activities of any intensity, and equated to 1907 ± 1185 and 3428 ± 1728 MET-min wk^{-1}, respectively. Of participants, 91% were participating in planned exercise activities, with the average frequency being 4.5 ± 3.5 times per week. All but two respondents were achieving physical activity greater than the minimum threshold of 500 MET-min wk^{-1} recommended for health benefits,[17] and 78% of respondents were achieving physical activity greater than 1000 MET-min wk^{-1}. Of respondents, 73% were participating in structured AER exercise equivalent to, or greater than, the three sessions per week prescribed in the supervised intervention. However, only 19% of respondents were participating in any form of RES exercise training, with the average frequency of RES exercise training in these individuals being 2.7 ± 1.4 times per week.

Body mass increased (mean = 0.8%; 95% confidence limit = 0.1% to 1.4%; $P < .05$) during the follow-up period as a result of deleterious patterns of gain of total fat mass (mean = 3.1%; 95% confidence limit = 1.2% to 5.0%; $P < .05$) and trunk fat mass (mean = 3.8%; 95% confidence limit = 1.5% to 6.1%; $P < .05$) and loss of lean body mass (LBM) (mean = −0.6%; 95% confidence limit = −1.2% to −0.1%); $P < .05$), which included loss of appendicular lean mass, an indicator of sarcopenia incidence and risk (mean = −1.1%; 95% confidence limit = −1.9% to −0.2%; $P < .05$) (Table 1).

Regressions in upper and lower body strength were observed during the 1-year follow-up period as declines in one repetition maximum for the chest press (mean = −11.0%; 95% confidence limit = −14.1% to −7.8%; $P < .05$) and leg press (mean = −5.6%; 95% confidence limit = −8.3% to −2.8%; $P < .05$) (Table 1). Other measures of physical function (handgrip strength, sit to stand, timed-up-and-go test, gait speed, and stair climbing test) were unchanged, but cognitive function assessed by the Montreal Cognitive Assessment declined (mean = −3.7%; 95% confidence limit = −5.6% to −1.8%;

Table 1. Changes in Body Composition and Physical and Cognitive Function 1 Year After the Cessation of a Supervised Exercise Training Intervention

Variable	Post training (n = 53), mean ± SD	1-y Follow-up (n = 53), mean ± SD	% Change, mean (95% CL)	*P* value
Anthropometry				
M/F ratio	30:23			
Age, y	70.8 ± 3.9			
Height, m	169.9 ± 8.0			
Body mass, kg	75.0 ± 14.7	75.6 ± 15.1	0.8 (0.1 to 1.4)	.021*
BMI, kg m^{-2}	25.8 ± 3.6	26.0 ± 3.8	0.8 (0.1 to 1.4)	.018*
Body fat, %	31.9 ± 7.4	33.2 ± 7.6	4.3 (2.2 to 6.3)	<.001***
Fat mass, kg	23.72 ± 8.12	24.42 ± 8.54	3.1 (1.2 to 5.0)	.002**
Trunk fat mass, kg	13.50 ± 5.78	14.06 ± 6.17	3.8 (1.5 to 6.1)	<.001***
LBM, kg	48.33 ± 9.32	48.00 ± 9.16	−0.6 (−1.2 to −0.1)	.022*
ALM, kg	21.57 ± 4.79	21.33 ± 4.68	−1.1 (−1.9 to −0.2)	.010*
Function				
Handgrip strength, kg	35.1 ± 9.2	34.7 ± 9.2	−0.5 (−3.7 to 2.6)	.478
Gait speed, m s^{-1}	1.62 ± 0.29	1.60 ± 0.32	0.4 (−6.1 to 5.3)	.967
Sit to stand, s	9.28 ± 1.83	9.32 ± 2.20	1.2 (−3.7 to 6.1)	.373
TUGT, s	5.74 ± 0.93	5.64 ± 0.82	−0.7 (−4.5 to 3.2)	.730
SCT, W	433.5 ± 112.4	440.9 ± 118.7	1.9 (−0.7 to 4.6)	.179
1RM chest press, kg	48.5 ± 15.9	43.1 ± 14.5	−11.0 (−14.8 to −7.8)	<.001***
1RM leg press, kg	142.8 ± 38.5	134.5 ± 37.7	−5.6 (−8.3 to −2.8)	<.001***
MoCA	28 ± 1	27 ± 2	−3.7 (−5.7 to −1.8)	<.001***

Abbreviations: 1RM, one-repetition maximum; ALM, appendicular lean mass; BMI, body mass index; CL, confidence limit; LBM, lean body mass; M/F, male/female; MoCA, Montreal Cognitive Assessment; SCT, stair climbing test; TUGT, timed-up-and-go test.

*$P < .05$, **$P < .01$, ***$P < .001$ (significant difference from Post training).

Table 2. Summary of Qualitative Findings Composed of TDF Domains and Sample Participant Quotes

TDF domain	Research finding with sample participant quotes
Knowledge	• Many participants lacked an understanding of appropriate exercise prescription for optimal health prior to the intervention. *"I learnt that aerobic training is not really sufficient for complete health. Resistance training is very important and it's very appropriate for someone of my age"* (Male, 69, Participant 10)
Beliefs about consequences	• Many participants acknowledged the benefits of specific types of exercise prescription after the intervention, in particular resistance exercise training. *"Certainly the benefits that I felt from it were huge from the resistance training. I feel that I have got a lot stronger from doing the resistance yeah no doubts about it"* (Female, 69, Participant 4)
Belief about capabilities	• Confidence appeared to have a significant impact on participants' perception of their capability to exercise. *"It gave me back a lot of confidence because when I entered it I wasn't sure if I had enough strength and energy to go through the program. But it happened I did and I felt great benefit from it, which is largely why I decided then to join a gym and try and maintain a better level of activity"* (Male, 69, Participant 1)
Social influences	• A commonly reported facilitator by participants was the importance of social influences. This was evident in terms of not only increasing social interaction, but also actively supporting participants to maintain an exercise regimen. *"I mean for people over 70 sort of thing, the group activity I think is incredibly important coz there's a social element to it. There's the social interaction"* (Male, 82, Participant 6) *"…When I say go with somebody…I usually go with my wife, so there's two people…one to motivate the other"* (Male, 74, Participant 7)
Intentions	• Participants also discussed motivation as a factor in maintaining their exercise regime. Some participants reported being very motivated, whereas others found it difficult to stay motivated based on how they felt at certain times. *"I have no intention of giving it up, I would not forget about it"* (Female, 69, Participant 4) *"It goes up and down the volume depending on how I feel"* (Male, 82, Participant 6) *"I find that a bit boring to go down on your own, to sit on an exercise bike or rowing machine"* (Male, 69, Participant 1)
Emotion	• Participants discussed mood as an important factor in maintaining an exercise program. For example, one participant noted how concern for her future health prompted her to keep exercising. Whereas other participants highlighted the positive effects exercise had on their mood. *"Yeah I would feel worried now that as I get older if I do not keep up exercising I'll end up fairly decrepit. Yes I do worry about that, which is why I do it at all!"* (Female, 69, Participant 4) *"If I do not exercise I find my mood slips and I'm not as positive about the challenges that face me in everyday life as I would be if I was in an exercise routine or exercising regularly"* (Male, 69, Participant 10) • However, participants also reported how emotions could act as barriers to sustained exercise engagement. *"Well if you are depressed, I think people probably find it difficult to do anything"* (Female, 71, Participant 11)
Behavioral regulation and goals	• Several participants discussed the importance of making exercise a part of their routine to facilitate maintenance. *"I suppose it's important to make it a part of a schedule, something that you follow. I'm a big believer in committing to things…For somebody at my stage of life, I think it helps you manage your time if you have definite landmarks that take you through a week…On such a such a day I do this* etc. *Otherwise good intentions sort of fade away you know"* (Male, 69, Participant 1) *"Em…record it. Be aware of what you are doing and be honest with yourself"* (Male, 69, Participant 10) • Participants also explained how their longer-term exercise goals acted as a facilitator to exercise: *"I want to live a bit longer. I want another 20 years!! And it's in your own hands. Its my life and I have to take charge of my own life so I have to take charge of my exercise and my diet that help me fulfill what I want which is a longer and healthy life"* (Female, 67, Participant 12)
Environmental context and resources	• Participants' opportunities to engage in regular exercise often depended on location and surrounding area. *"It helps because we have a lovely park nearby and that's where we walk. There are plenty of facilities around, lovely walks, we have a lovely park. There's no reason why people cannot get out"* (Female, 67, Participant 12) • Many participants highlighted cost as a barrier to sustained engagement in exercise. *"Cost would certainly be a factor. It (gym) is expensive! So yeah cost is a factor definitely because with a retirement pension you have less disposable income"* (Female, 69, Participant 4)

Table 2 (Contd.)

TDF domain	Research finding with sample participant quotes
	• A further constraint was participants' perceptions of the gym environment. *"I just did not like the gym at all really. It's the environment. It's much too claustrophobic for me. I would not be going back"* (Female, 67, Participant 5) *"There's no social aspect in the gym. Gyms are very impersonal. It's different to a club. It's not social! People go in there to do their work and get out again"* (Female, 69, Participant 2) *"...yeah a bit of an intimidating environment! God I hate fit people!!! But you know what I mean"* (Male, 69, Participant 8)

Abbreviation: TDF, Theory Domain Framework.

$P < .05$). The range of interindividual responses for each parameter of body composition and physical and cognitive function measured is illustrated in Figures S1 and S2 in Supplementary Appendix S1.

Qualitative Findings

The data analysis yielded 295 quotes, which were summarized into 19 themes that mapped directly onto nine of the TDF domains. The nine domains were "knowledge," "beliefs about consequences," "beliefs about capabilities," "social influences," "intentions," "emotion," "behavioral regulation," "goals," and "environmental context and resources." The themes established within each domain are reported in Table 2 with selected quotes used to illustrate barriers or facilitators to exercise maintenance and specifically RES exercise training in older adults.

DISCUSSION

To the best of our knowledge, this is the first study in older adults to address the residual impact of 12 weeks of supervised exercise training on body composition and physical and cognitive function. Additionally, the extent to which exercise participation and, in particular, RES exercise training was maintained is described, and barriers and facilitators to participation were explored.

The quantitative data revealed regressions in upper and lower limb strength and deleterious changes in body composition (increased fat mass and reduced LBM) at 1 year of follow-up. Many participants (91%) continued to participate in planned exercise to some extent, and 73% of the participants achieved the frequency (three times per week) prescribed in the supervised intervention. This is similar to another report tracking changes after supervised exercise training in which 80% of older adult participants were physically active during the 6- to 18-month follow-up period.[18] However, in the present study, only 19% of participants reported to be participating in RES exercise training, compared to 42% maintaining unsupervised RES exercise training in this other report.[18] Our findings mirror previous work where the long-term maintenance of any newly acquired behavior, including exercise, is challenging.[19] Moreover, the participation in RES exercise training is similar to that of participation rates of older adults in the United States (13.5% of adults aged >55 years),[2] Germany (10%-15% of adults aged >60 years),[20] and Australia (7%-12% of adults aged >55 years).[21] Based on the CHAMPS self-report data, clearly there are considerable interindividual differences in participation in the various exercise activities, and likewise there is a wide range in the magnitude of change in the various fitness parameters assessed (Figures S1 and S2 in Supplementary Appendix S1). Therefore, while the cohort as a whole remained relatively physically active, we interpret the lack of participation in RES exercise training as being an important determinant of the notable declines in strength and LBM. This finding underscores the importance of RES training in exercise prescription in older adults,[22] as well as reinforcing the importance of long-term exercise maintenance for healthy aging. Given that the American College of Sports Medicine recommendation of at least two times per week RES exercise training in older adults,[22] it is important to understand the barriers and facilitators to participation to inform appropriate exercise promotion strategies.[23] Indeed, this was the focus of our qualitative investigation, which revealed that the main barriers identified fell under the TDF domains of environmental context and resources (cost and aversion to gyms), behavioral regulation (motivation), and emotion (boredom).

Financial costs, such as gym membership fees, were a major barrier highlighted by many individuals, thus making it difficult to maintain participation in RES exercise training. This aligns with recent reviews identifying financial considerations as a key exercise barrier.[5,24] Older adults place higher value on exercise characteristics, such as cost, than on exercise benefits; and, hence, their decision on whether to engage in exercise programs is more influenced by outside factors rather than improvements in their health.[25] Consequently, it has been proposed that government health departments and policy makers should facilitate older adults by providing subsidized exercise training programs.[25]

General aversion to the gym environment and a sense of intimidation were evident in the participants' responses. The claustrophobic climate, lack of social setting, and general "youth" environment made the gym less appealing to them. Indeed, a preference has been reported for community venues, both as being a more welcoming environment, which can build a sense of camaraderie in older adults, and to reduce cost.[26] Furthermore, our findings reinforce this, highlighting the importance of social influences, in terms of both emotional and practical support. Therefore, future studies could focus on community center and home-based programs in combination. Our original training study in which these older adults participated involved small training groups of four to six participants,[13] which arguably helped create an intimate and welcoming environment. Therefore, whether the excellent adherence rates

(88% ± 7%) from our initial study could be recapitulated through alternative training methods, including home-based or outdoor programs, such as body weight or resistance elastic band training,[27] or via pseudosupervision via social media platforms, will be an avenue for future research. The latter has been successfully demonstrated using educational videos through DVD in relation to a falls prevention program for older adults.[28] Similarly, the use of self-monitoring tools (eg, physical activity watches) may improve habitual exercise maintenance given that self-regulatory efforts are known to increase exercise maintenance.[29] Moreover, technology offers a safe and well-accepted method for providing independent older adults with exercise opportunities that are enjoyable and motivating.[30]

Motivation and boredom were other commonly reported barriers to exercise maintenance in the present study, and again align with existing research. Thus, there is need to consider how best to support the motivation of older adults to exercise over a sustained period of time. Encouragingly, there is a considerable body of research that indicates a more self-determined motivation for exercise, and exercise that is enjoyable, are associated with exercise habits being maintained over time.[31,32] Thus, strategies to support autonomous motivation and enjoyment in older adults, such as choice of exercise type, and social interaction should be utilized. Indeed, these types of strategies are efficacious in this population.[31,32] However, further research is necessary to develop these findings and to present a better understanding of motivational processes in older adults to maintain an active lifestyle. The exercise benefits that motivated the older adults in our study to maintain exercise were mainly improved health and well-being. This is somewhat antithetical to how the general fitness industry consistently promotes "fitness," which is primarily based on aesthetics. Therefore, there is the potential for a new health market niche of appealing to the silver generation by providing group activities in an intimate and welcoming social setting through targeting increased cognitive and physiological function rather than promoting solely bodily enhancement.

In summary, the integration of qualitative and quantitative findings is a novel use of mixed methods to explore barriers, facilitators, and factors influencing exercise maintenance, in particular RES exercise training, in older adults. Regressions in strength and body composition were obvious in this cohort in the period after the cessation of supervised exercise training, and a low level of engagement with RES exercise training was noted. Facilitators to exercise maintenance were identified at the intrapersonal (knowledge and confidence) and interpersonal (influence) levels and should be targeted within future interventions. However, imperative when working with older adults is to consider environmental constraints because barriers at this level may prevent long-term maintenance. Additional research is needed to create and implement behavioral change strategies that account for these barriers and facilitators in exercise and physical activity interventions in older adults. We propose that older adults require a supervised approach, whether through community venues or home-based programs, to ensure the required exercise training characteristics are achieved, but also facilitate exercise maintenance and, in particular, RES exercise training.

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SUPPORTING INFORMATION

Additional Supporting Information may be found in the online version of this article.

Supplementary Appendix S1: Supplementary methods.