Self-Regulatory Strength Depletion and Muscle-Endurance Performance: A Test of the Limited-Strength Model in Older Adults

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Self-regulation consumes a form of strength or energy. The authors investigated aftereffects of self-regulation depletion on muscle-endurance performance in older adults. Participants ($N = 61$, mean age = 71) were randomized to a self-regulation-depletion or control group and completed 2 muscle-endurance performance tasks involving isometric handgrip squeezing that were separated by a cognitive-depletion task. The depletion group showed greater deterioration of muscle-endurance performance than controls, $F(1, 59) = 7.31, p = .009$. Results are comparable to those of younger adults in a similar study and support Baumeister et al.’s limited-strength model. Self-regulation may contribute to central-nervous-system fatigue; however, biological processes may allow aging muscle to offset depletion of self-regulatory resources affecting muscle-endurance performance.

**Keywords**: self-control, aging, executive function

Self-regulation refers to people’s capacity to alter their inner states or outward responses including actions, thoughts, feelings, desires, and task performances (Baumeister, Heatherton, & Tice, 1994). A growing body of literature speaks to the importance of self-regulation for protecting older adults’ physical and psychological well-being by facilitating healthy, adaptive behaviors (for a review, see Wrosch, Dunne, Scheier, & Schulz, 2006). For example, one study demonstrated that the use of self-regulatory strategies such as goal-setting and time management was positively correlated with the amount of time older adults engaged in physical activity (Umstattd, Wilcox, Saunders, Watkins, & Dowda, 2008). Another study showed that the use of self-regulatory strategies to overcome health problems protected older adults from the negative effects of physical symptoms on depressive symptoms (Wrosch, Schulz, & Heckhausen, 2002). And finally, among a sample of predominantly older adults, those who performed better on a measure of self-regulatory capacity (Stroop task) smoked fewer cigarettes, drank less alcohol, and reported fewer sleep difficulties than people who displayed poorer self-regulatory...
capacity (Hall, Elias, & Crossley, 2006). Taken together, these studies speak to the importance of self-regulation to healthy aging.

Yet, despite the importance of self-regulation, there are considerable data to suggest that in everyday life, older adults frequently experience many self-regulatory failures. For instance, it is estimated that approximately 50% of older adults do not take their medications as prescribed (Murray et al., 2004), which may have devastating consequences such as overdose or harmful drug interactions. Likewise, effective self-regulation in the form of a healthy diet and exercising regularly is also poor among older adults (e.g., Culos-Reed, Rejeski, McAuley, Ockene, & Roter, 2000; Shephard, 1994; U.S. Department of Health and Human Services, 1996). Other data indicate that, compared with younger adults, older adults exhibit deficits in their ability to exert self-regulation over socially inappropriate verbal outbursts and other behaviors (von Hippel & Dunlop, 2005; von Hippel & Gonsalkorale, 2005). One approach that has been used to understand self-regulatory failures such as these, at least in younger adults, is the limited-strength model of self-regulation.

According to the limited-strength model, self-regulatory strength is akin to the colloquial concept of willpower and represents a finite, consumable, and renewable internal resource that is drained when people attempt to control their emotions, thoughts, or behaviors (Baumeister & Heatherton, 1996; Baumeister et al., 1994; Baumeister, Vohs, & Tice, 2007; Muraven & Baumeister, 2000). The self-regulatory strength reserve can be depleted by acts requiring self-regulation, and, because the reserve may not be promptly replenished, the performance of subsequent tasks that require self-regulation is often impaired.

Indeed, a considerable body of research has shown that performance impairments occur when two acts requiring self-regulation occur simultaneously (e.g., dual-task paradigms; Pashler, 1994; Szmalec, VanDierendonck, & Kemps, 2005). However, research based on Baumeister and colleagues’ model has convincingly shown that performance impairments also occur when tasks requiring self-regulation are performed in succession (Hagger, Wood, Stiff, & Chatzisarantis, 2010; Muraven & Baumeister, 2000; Schmeichel & Baumeister, 2004). For example, in a series of studies by Muraven, Tice, and Baumeister (1998), participants who suppressed unwanted thoughts or emotional responses showed impaired performance on subsequent tasks involving cognition (anagram solving) and physical-effort regulation (submaximal handgrip-squeezing endurance). Consistent with the limited-strength model, self-regulatory depletion using emotion or cognitive-regulation tasks imparted performance decrements on the criterion tasks when both tasks were similar (e.g., emotion regulation–emotion regulation) or different (e.g., cognitive regulation–physical-effort regulation). Recently, Bray, Martin Ginis, Hicks, and Woodgate (2008) extended Muraven et al.’s study investigating physical-effort regulation by examining muscle-force production and muscle activation during submaximal isometric handgrip squeezing after self-regulation depletion using a cognitive task. They replicated the finding that participants experienced decrements in their muscle-endurance performance after cognitive depletion and, furthermore, found evidence of greater muscle activation despite poorer muscle-endurance performance. In line with the limited-strength model, they hypothesized that self-regulation depletion may lead
to central-nervous-system fatigue, which causes impaired neuromuscular function during submaximal muscle-endurance tasks.

In the current study, we aimed to extend previous work investigating the aftereffects of a self-regulatory depletion task on muscle-endurance performance in a sample of older adults. Justification for investigating the limited-strength model among older adults can be drawn from evidence indicating that older people experience substantial declines in executive control processes including cognition, memory, and reaction time (DeLuca et al., 2003; West, 1996). Although the biological structures and processes governing the self-regulatory strength reserve are unspecified, this important self-regulating capacity is theorized to be governed by executive control processes in the prefrontal cortex (Banfield, Wyland, Macrae, Münte, & Heatherton, 2004; Gailliot et al., 2007). The prefrontal cortex is a region of the brain that is susceptible to structural degradation and age-related declines in activity (Dickstein et al., 2007; Pardo et al., 2007). The limited-strength model of self-regulation posits that tasks involving executive control processes deplete the self-regulatory reserve (Baumeister, 2002; Baumeister & Vohs, 2007). According to this perspective, executive control processes require expenditure of effort in ways that involve self-control (Baumeister & Vohs, 2007; Muraven & Baumeister, 2000). However, not all effortful tasks require self-control. Self-control operates when effortful tasks require one to override habitual or automatic tendencies such as continuing to hold an uncomfortable handgrip squeeze even after one starts to feel fatigued or striving to solve a puzzle even when a solution appears impossible (Muraven & Baumeister, 2000). Studies investigating self-regulation strength have involved tasks relating to executive control functions such as memory retrieval, active information processing, thought or emotion suppression, decision making, and physical-effort regulation (e.g., muscle-endurance performance). Findings from those studies have shown that prior performance of executive control tasks has deleterious aftereffects on subsequent tasks that are also under executive control (Hagger et al., 2010). Therefore, examination of self-regulatory-depletion effects among older adults may lend some insight into processes underlying self-regulatory failures.

The limited-strength model of self-regulation has received considerable research attention (Hagger et al., 2010); however, virtually all the evidence established thus far has been derived from studies involving younger adults. Although younger adults and older adults may not be expected to differ in terms of their failures at self-regulation after a laboratory-based self-regulatory depletion task, evidence drawn from an older adult population would help establish the broader validity of the limited-strength model. Such evidence would also speak to the model’s utility for explaining self-regulatory lapses among older adults.

The primary purpose of the current study was to examine the effects of a cognitive self-regulatory strength-depletion manipulation on older adults’ performance of a muscle-endurance performance (isometric handgrip squeezing) task. Consistent with previous research involving samples of undergraduates (Bray et al., 2008; Muraven et al., 1998), we hypothesized that older adults who were exposed to a self-regulatory strength-depletion task would show greater decrements in their subsequent performance of a muscle-endurance performance task than a control group of older adults who were not depleted.
Method

Participants
The sample consisted of 61 older adults (20 women) with a mean age of 71 ± 7.02 years. Most participants were White (93%), 52 had completed high school, and 27 had at least one university degree. Participants were stratified by gender and randomized into either the self-regulatory-depletion (n = 33) or control (n = 28) condition.

Measures

Muscle-Endurance Performance. The dependent variable was change in the amount of time participants maintained an isometric handgrip contraction at 50% of their maximum voluntary contraction (MVC) across two trials of a muscle-endurance performance task. Participants performed the muscle-endurance performance task with their dominant hand squeezing an isometric handgrip dynamometer (model MLT003/D; ADInstruments, Toronto, Canada) with a graphic computer interface (PowerLab 4/25T; ADInstruments, Toronto, Canada). Before each muscle-endurance performance trial, participants performed two 5-s 100% MVCs on the dynamometer. The average force recording obtained from a 1-s window at the peak of each 5-s 100% MVC was analyzed to determine peak-force generation. The peak-force value obtained from the 5-s 100% MVC yielding the greatest force was then halved to determine the 50% MVC target value for the muscle-endurance performance trial. To perform the muscle-endurance performance-task contraction, participants squeezed the handgrip dynamometer and were provided feedback on a 17" computer monitor in the form of a force tracing (i.e., a real-time graphed line indicating how much force was being generated). The target force level (50% MVC) was shown as a static line on the screen. Participants were instructed to maintain a hand squeeze for as long as possible in order to keep the force-tracing line at, or above, the target level. When the force tracing fell below the 50% MVC for longer than 1 s, the experimenter signaled to the participant that the trial was complete. The number of seconds participants maintained an isometric handgrip squeeze at ≥50% MVC was used as the muscle-endurance performance score for each trial. The feedback monitor was set up so participants had no knowledge of elapsed time or the magnitude of force generation during the muscle-endurance performance trials (other than whether they were maintaining their force at or above the target force line).

Self-Regulatory Manipulation. Self-regulatory strength was manipulated using a cognitive-depletion task in the form of a modified version of the Stroop color–word task developed by Wallace and Baumeister (2002). Participants in the control condition were instructed to read colored words presented on a list in which the color and text of the printed words were matched. In the depletion condition, participants were presented with a list of words in which the print ink color and printed text were mismatched. Participants were required to read aloud the color of the print ink and ignore the text for each word presented. In addition, when they encountered a word printed in red ink, they were required to override their general instructions and state aloud the printed word (e.g., “blue” or “green” rather than “red”). The interference generated by the Stroop task challenges specific executive functions
sharing common capacity-limited resources with self-regulation processes. Wallace and Baumeister argued that this latter modification should provide more robust depletion of the central executive because participants have to not only inhibit their verbal tendencies to read the text but also override the general instructions of the task.

**Manipulation Checks.** Similar to previous studies examining self-regulation depletion (Bray et al., 2008; Muraven & Slessareva, 2003; Muraven et al., 1998), manipulation-check measures of fatigue, effort, pleasantness of the task, and frustration were administered to participants in both conditions after the manipulation. Participants reported how tired they felt after performing the modified Stroop task on a Likert-type scale of 1 (*not tired at all*) to 7 (*extremely tired*). How much mental effort they exerted while performing the modified Stroop task was rated on a scale of 1 (*little effort*) to 7 (*extreme effort*). How pleasant they found performing the modified Stroop task was scored on a scale of 1 (*extremely unpleasant*) to 7 (*extremely pleasant*). Participants reported how frustrated they felt when performing the modified Stroop task on a scale of 1 (*not at all frustrated*) to 7 (*extremely frustrated*). They also completed the 16-item Brief Mood Introspection Scale (Mayer & Gaschke, 1988) to assess mood and arousal. Participants indicated the extent to which each item/adjective (e.g., “lively,” “drowsy”) described their current mood or arousal. Responses were made on a scale ranging from 1 (*definitely do not feel*) to 7 (*definitely feel*).

**Procedure**

The study employed a single-blind randomized controlled design with stratification by gender. On arrival at the laboratory, participants were greeted and given a general description of the study procedures, and they provided informed consent. They completed a paper-and-pencil survey to provide demographic information, after which they performed a baseline trial involving determination of 100% MVC followed by the 50% MVC muscle-endurance performance task. After the baseline trial, participants were randomly assigned to the depletion or control condition. They then completed either the modified Stroop task (depletion) or the control task for 3 min and 40 s (to allow equivalent rest time for recovery from the muscle-endurance performance task between trials). On completion of the Stroop, or color–word reading, task, participants completed the manipulation-check questionnaire items followed by a second muscle-endurance performance trial identical to the first. On completion of the second muscle-endurance performance trial they were debriefed and thanked for their participation in the study.

**Data Analysis**

Statistical analysis of the data involved computing descriptive statistics for the four manipulation-check items and the two Brief Mood Introspection Scale subscale scores, which were then compared between groups using independent-groups ANOVA. Peak-force-generation (100% MVC) values were compared between groups and between trials using a 2 (group) × 2 (time) mixed ANOVA to ensure (or control for, if necessary) baseline group equivalence and consistency in MVC-force generation within the groups over the two trials. Raw change scores for the
muscle-endurance performance task were computed by subtracting the score (time in s) from Trial 1 from the muscle-endurance performance score (s) from Trial 2. The difference in raw change scores between the two groups was compared using one-way ANOVA. Based on past research (Bray et al., 2008; Tice, Baumeister, Shmueli, & Muraven, 2007) that has shown strong negative correlations between premanipulation muscle-endurance performance scores and between-trials change scores, residualized change scores were also computed by regressing the Trial 2 muscle-endurance performance scores on the Trial 1 muscle-endurance performance scores as recommended by Cohen, Cohen, West, and Aiken (2003). The difference between the mean residualized change scores from the two groups was assessed using one-way ANOVA.

Results

Summary descriptive statistics of the manipulation-check scores appear in Table 1. Participants in the depletion condition reported investing greater amounts of mental effort, \( F(1, 59) = 17.51, p < .001 \); greater frustration, \( F(1, 59) = 15.10, p < .01 \); and being more fatigued, \( F(1, 59) = 5.16, p = .03 \), immediately after the manipulation. These findings confirmed the intended effects of the cognitive-task manipulation in terms of requiring greater investment of self-regulatory effort or strength. The groups were not different in how pleasant they found the cognitive-manipulation task, \( F(1, 59) = 0.80, p = .38 \). Analysis of the Brief Mood Introspection Scale subscales (pleasant–unpleasant; arousal–calm) indicated that the two conditions did not differ in level of arousal–calm, \( F(1, 59) = 0.29, p = .59 \), but there was a trend, \( F(1, 59) = 3.41, p = .07 \), for lower scores for feeling pleasant–unpleasant in the depletion condition immediately after performing the Stroop task.

<table>
<thead>
<tr>
<th>Manipulation check</th>
<th>Depletion</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mental effort</td>
<td>4.91 (1.35)</td>
<td>3.18 (1.87)**</td>
</tr>
<tr>
<td>Fatigue</td>
<td>2.12 (1.02)</td>
<td>1.57 (0.84)*</td>
</tr>
<tr>
<td>Frustration</td>
<td>2.61 (1.58)</td>
<td>1.36 (0.68)**</td>
</tr>
<tr>
<td>Pleasantness</td>
<td>4.58 (1.25)</td>
<td>4.89 (1.52)</td>
</tr>
<tr>
<td>BMIS—mood</td>
<td>23.73 (16.15)</td>
<td>30.57 (12.09)†</td>
</tr>
<tr>
<td>BMIS—arousal</td>
<td>26.94 (7.83)</td>
<td>25.93 (6.63)</td>
</tr>
</tbody>
</table>

*p < .05. **p < .01. †p = .07.
MVC-Force Generation

Mean values for peak-force generation, which represents the MVC force from which the 50% MVC submaximal muscle-endurance performance task was derived, are presented by experimental condition in Table 2. The values ranged from 272.44 N ($SD = 108.75$) in the control group on Trial 1 to 278.47 N ($SD = 93.48$) in the depletion group on Trial 2. A $2 \times 2$ mixed ANOVA with repeated measures for trial and experimental condition as a between-subjects factor revealed no significant main or interaction effects ($p > .05$). Thus, average peak-force-generation scores, on which the submaximal (50%) criterion task was based, were comparable between and within groups across the two trials. These data indicate that the task demands associated with the muscle-endurance performance task were equivalent within and between groups.

Muscle-Endurance Performance

Mean values for the muscle-endurance performance task for both trials are also presented by experimental condition in Table 2. To examine differences between groups, changes in the amount of time participants were able to hold the isometric contraction on Trial 2 compared with Trial 1 were initially calculated as simple change scores ($M_{\Delta \text{depletion}} = –11.48 \pm 23.54$; $M_{\Delta \text{control}} = –6.08 \pm 36.41$). A one-way ANOVA comparison of these values showed a nonsignificant effect in the expected direction, $F(1, 59) = 1.68$, $p = .20$, Cohen’s $d = .18$. However, correlational analyses indicated that regardless of group assignment, the magnitude of the change score was strongly correlated with the muscle-endurance performance-task score on Trial 1, $r(61) = –.64$, $p < .001$. In other words, people who held their squeeze longer on the first trial showed larger drops in muscle-endurance performance from Trial 1.

Table 2  Descriptive Statistics Contrasting Depletion- and Control-Group Scores of Older Adults on Peak-Force Generation and Muscle-Endurance Performance, $M$ ($SD$), $N = 61$

<table>
<thead>
<tr>
<th>Study Condition</th>
<th>Depletion</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trial 1 peak force (MVC), N</td>
<td>276.16 (105.67)</td>
<td>272.44 (108.75)</td>
</tr>
<tr>
<td>Trial 1 muscle-endurance performance, s</td>
<td>58.02 (31.61)</td>
<td>66.88 (32.77)</td>
</tr>
<tr>
<td>Trial 2 peak force (MVC), N</td>
<td>278.47 (93.48)</td>
<td>275.39 (94.83)</td>
</tr>
<tr>
<td>Trial 2 muscle-endurance performance, s</td>
<td>46.54 (21.25)$^{a,b}$</td>
<td>60.81 (27.47)</td>
</tr>
<tr>
<td>Trial 1 to Trial 2 simple change score</td>
<td>$–11.48$ (23.54)</td>
<td>$–6.08$ (36.41)</td>
</tr>
<tr>
<td>Trial 1 to Trial 2 residualized change score</td>
<td>$–6.05$ (15.85)$^{b}$</td>
<td>7.13 (22.12)</td>
</tr>
</tbody>
</table>

Note. MVC = maximal voluntary contraction.

$a$Significant ($p < .05$) difference within conditions. $b$Significant ($p < .05$) difference between conditions.
to Trial 2. To control for this confounding factor, residualized change scores were calculated by regressing the Trial 2 muscle-endurance performance score on the Trial 1 muscle-endurance performance score (Cohen et al., 2003). One-way ANOVA was computed to compare the unstandardized residual scores between the depletion and control conditions. Those results showed a highly significant difference between the scores ($M_{depletion} = -6.05 \pm 15.85; M_{control} = +7.13 \pm 22.12$), with a medium to large effect, $F(1, 59) = 7.31$, $p = .009$, Cohen’s $d = .69$.

**Discussion**

The main purpose of the current experiment was to examine the effects of a self-regulatory strength-depletion manipulation on a muscle-endurance performance task (isometric handgrip squeezing) in older adults. Consistent with our main hypothesis, older participants in the depletion condition had significantly poorer muscle-endurance performance than those in the control condition after the self-regulatory strength-depletion manipulation.

To the best of our knowledge, this is the first study to examine the effects of self-regulatory depletion on muscle-endurance performance using a self-regulatory strength-depletion paradigm in a sample of older adults. In previous investigations of the self-regulatory-strength model, consistent evidence was obtained showing that expenditure of self-regulatory strength in the performance of one task produces detrimental aftereffects on the performance of subsequent tasks requiring self-regulation (Hagger et al., 2010; Schmeichel & Baumeister, 2004). The current findings are consistent with those results and are comparable to studies that examined aftereffects of self-regulatory depletion on muscle-endurance performance tasks in samples of younger adults (Bray et al., 2008; Muraven & Shmueli, 2006; Muraven et al., 1998).

A considerable body of research has shown the cumulative effects of muscle fatigue resulting in performance impairments during repetitive trials requiring submaximal muscle endurance (Taylor & Gandevia, 2008). Muscle fatigue is hypothesized to manifest from a combination of peripheral fatigue that occurs in the muscles themselves and central fatigue that affects the descending neural drive to the muscle (Gandevia, 2001). Collectively, the current study and previous research (Bray et al., 2008; Muraven & Shmueli, 2006; Muraven et al., 1998) provide evidence that self-regulatory depletion brought on by cognitive and emotional tasks also results in performance impairments to muscle-endurance capabilities, with greater declines in performance occurring in depleted individuals than in controls. Because cognitive tasks such as the Stroop task used in the current study do not require muscle activation, our findings lead us to suggest that self-regulatory strength depletion contributes to perturbations in the central nervous system that can affect one’s muscle-endurance performance capabilities and, presumably, other capabilities that draw on central-nervous-system energy. Further examination of the interplay among self-regulatory strength-depletion processes and central-nervous-system fatigue should be undertaken.

The current findings are consistent with those observed among younger adults, with cognitively depleted participants showing poorer self-regulation of muscle-endurance performance than controls (Bray et al., 2008; Muraven & Shmueli, 2006; Muraven et al., 1998). However, given the age-related structural and neurochemical
degradations in the prefrontal cortex and impairments in executive functions such as working memory and planning that occur beyond the fifth and sixth decades of life (Dickstein et al., 2007; Pardo et al., 2007; West, 1996), we could have expected older adults to have been more susceptible than younger adults to self-regulatory strength-depletion effects. To explore this possibility, we compared the effect sizes observed in the current study with those of a methodologically similar study undertaken with younger adults (Bray et al., 2008). The effect size for the between-groups difference for younger adults in that study was \( d = .55 \), which is only slightly less than the effect size of \( d = .69 \) observed in the current data. Thus, our findings revealed that self-regulatory strength-depletion effects on muscle endurance were of medium size and somewhat comparable between older and younger adults.

Although older and younger adults do not seem to differ in their susceptibility to self-regulatory strength depletion, there is evidence (not without debate) suggesting that older adults are more resilient to skeletal-muscle fatigue than younger adults (Allman & Rice, 2002; Hunter, Critchlow, & Enoka, 2004; Kent-Braun, 2009). Explanations for an age advantage in fatigue resistance highlight physiological mechanisms in the muscle, such as variations in adenosine triphosphate (ATP) production pathways and \( \text{H}_2\text{PO}_4 \) accumulation that favor older muscle (Kent-Braun, 2009). Thus, age-related differences in self-regulatory strength depletion’s effects on muscle-endurance self-regulation may have been somewhat obscured by age-related adaptations in muscle metabolism that favor older adults.

Despite possible age-related adaptations in muscle efficiency that may have benefitted older adults in this study, it should be stressed that self-regulatory depletion effects were found regardless of what might be considered age-related compensatory factors. Future research on self-regulatory strength’s effects and aging should explore other tasks requiring self-regulation strength for which older and younger adults are equal or for which older adults may have a disadvantage. We noted earlier that compared with younger adults, older adults show marked deficits in their abilities to suppress socially inappropriate verbal outbursts and other problematic attitudes and behaviors such as racial prejudice and gambling (von Hippel, 2007). Research investigating self-regulatory strength-depletion effects on such behaviors in older and younger samples would be interesting to compare with the current findings. In addition, older adults are susceptible to failures in self-regulation of health-related behaviors such as diet, medication, and exercise adherence (e.g., Culos-Reed et al., 2000; Shephard, 1994; U.S. Department of Health and Human Services, 1996). Thus, an important implication of the current findings is that older adults and practitioners who work with older adults should be cognizant of the self-regulatory depletion demands of executive-control tasks and their carryover effects. For example, older individuals may wish to plan some rest and recovery time after performing cognitively demanding tasks to replenish their self-regulatory strength to perform effortful physical exercise. Future work in applied settings could provide further insights into effective management strategies for tasks that deplete self-regulatory strength.

The current findings contribute to theory and raise a number of issues regarding the healthy functioning of older adults; however, they are limited in some respects. One limitation relates to the controlled laboratory tasks involved in the study and the relative simplicity of the isometric endurance task. Future studies should explore
self-regulatory strength-depletion effects using more ecologically valid or complex tasks that older adults may encounter or perhaps take measures to avoid in daily life. Despite its relative simplicity, however, the isometric endurance task represents an advancement in assessing physical self-regulation; that is, previous studies (Martijn, Tenbült, Merckelbach, Dreezens, & de Vries, 2002; Muraven & Shmueli, 2006; Muraven et al., 1998) have used a commercially available spring-loaded handgrip exercise device to determine muscle-endurance performance, requiring participants to squeeze the handles hard enough to hold a wad of paper in place between them. The use of uncalibrated equipment with a standard force-load requirement is likely to increase random error (i.e., instruments have unproven reliability), as well as systematic error, because the relative force generation required by a person with a smaller (cross-sectional area) muscle is much greater than that required by an individual with a larger muscle.

In our study, digitally calibrated force-recording equipment ensured a high degree of reliability. Furthermore, the force determined for the muscle-endurance performance task (50% of MVC) was gauged on participants’ independently determined maximum-force values before each trial, which controlled for interindividual variations in strength. Controlling for interindividual differences in strength is an important consideration in aging research, in which participants may be frail or have high between-persons variability in muscle volume or fiber composition because of aging (Hunter, Todd, Butler, Gandevia, & Taylor, 2008; Kent-Braun, 2009). Nonetheless, future research should build on these initial findings employing physical tasks and self-regulatory manipulations that better resemble real-world phenomena.

In summary, the current study has provided evidence that self-regulatory depletion caused by a cognitively demanding task imparts debilitating aftereffects on muscle-endurance performance in a sample of older adults. These findings support and extend basic research that has tested the tenets of the limited-strength model among younger adults (Baumeister & Heatherton, 1996; Baumeister et al., 1994; Baumeister et al., 2007; Hagger et al., 2010; Muraven & Baumeister, 2000). Self-regulatory strength-depletion effects on muscle-endurance performance among older adults were not different than those observed in a similar study of younger adults; however, age-related resiliency to muscle fatigue may play a protective role against regulatory-depletion effects for activities of this sort. Given the importance of self-regulation to older adults’ physical and psychological well-being (Wrosch et al., 2006), future research should examine mechanisms governing self-regulatory depletion (e.g., central-nervous-system fatigue) and investigate the validity and application of the limited-strength model to the self-regulatory demands and challenges that affect older adults in everyday life.

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References


