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Special Issue Article

Cognitive control beliefs and cognitive functioning in mid- to late-life

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Objectives. Older adults experience age-related cognitive declines and often feel as if the severity of these declines is out of their control. Recent research suggests, though, that control beliefs may be related to less age-related declines. The aim of the current study was to investigate cognitive domain-specific control beliefs and the link between those cognitive control beliefs and cognitive functioning among a nationwide sample of adults ($N = 3{,}670$), as well as to explore whether cognitive control beliefs moderated the relationship between age and cognitive functioning.

Method. The aims were addressed using data from the national Midlife in the United States study (MIDUS II). Cognitive functioning was assessed using the Brief Test of Adult Cognition by Telephone (BTACT), and cognitive control beliefs were assessed with the Personality in Intellectual Aging Contexts (PIC) Inventory Control Scales.

Results. Regression analyses revealed that adults with higher control beliefs demonstrated better cognitive functioning. Moderation analyses indicated cognitive control beliefs moderated the relationship between age and executive functioning, but not the association between age and episodic memory.

Conclusion. Results suggested that the relationship between age and executive functioning was weaker at high levels of cognitive control beliefs. Future research should establish the directionality of the effect between cognitive control beliefs and cognition and investigate the association between control beliefs and cognition in samples at higher risk for substantial cognitive decline, including the oldest-old.

Statement of contribution

What is already known on this subject?

- Literature indicates a positive relationship between broadly defined control beliefs and cognition.
- Greater memory deficits have been reported in older adults with low control beliefs.

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What does this study add?

- Cognitive control beliefs, specifically, are predictive of executive functioning and episodic memory above and beyond age and other demographic variables.
- A significant interaction between age and cognitive control beliefs on executive functioning was found.

Background

Control beliefs are defined as one's perception of control over their ability to bring about positive outcomes, particularly within the context of ageing and age-related changes (Lachman, 2006). From a broad perspective, feelings of being in control of one's life outcomes confer benefits for health and well-being (Lachman & Weaver, 1998). Unfortunately, as people age, there is an increase in externality, such that for older adults, events are perceived to be more out of one's control (Perrig-Chiello, Perrig, & Stähelin, 1999). From a cognitive domain perspective, this increase in externality may be especially concerning. In fact, older adults are more likely to believe their cognitive abilities are more affected by external factors, than factors that are within their control (Hultsch, MacDonald, & Dixon, 2002). Therefore, across the lifespan, cognitive abilities are perceived to be more and more out of our control.

Much research has reported on age-related cognitive declines in older adults, including declines in verbal skills (Kemper, Greiner, Marquis, Prenovost, & Mitzner, 2001), verbal memory (Lamar, Resnick, & Zonderman, 2003), and overall cognitive abilities (Karlamangla et al., 2009). However, some cognitive skills tend to decline more quickly and sooner than others. Cognitive tests of speed and reaction time have been shown to be the first to begin to decline in one's 40 s, whereas delayed recall abilities indicated declines a decade later (Hughes, Agrigoroaei, Jeon, Bruzzese, & Lachman, 2018). It is important to note that some changes in control beliefs over time may partially be due to an actual loss of control, such that even if there are some things in one's control, some inevitable changes cannot be prevented. However, the magnification of these changes may contribute to poorer health and well-being.

While some of these declines in cognitive abilities are to be expected as individuals age, prior research indicates that older adults have fundamentally different perceptions about problems in cognitive abilities than do younger adults, and this may further compound actual age-related cognitive declines. For example, in comparison with young adults, older adults perceive lapses in memory as an irreversible part of ageing rather than a passing issue or a fluke (Ponds, Commissaris, & Jolles, 1997). When you forget where you placed your car keys when you are 25 years old, you may choose to laugh it off as you being temporarily forgetful. However, when you find yourself in this same situation at 70 years old, you are more likely to blame your age and declining cognition for the memory lapse. Furthermore, older adults who anticipate extensive age-related cognitive declines may not persist as long on cognitive tasks (Miller & West, 2010). Similarly, in healthy older adults, memory strategy use partially mediates the relationship between control beliefs and memory outcomes (Hutchens et al., 2013). In effect, belief in having little control over one's cognitive abilities in later life may potentially set the stage for a self-fulfilling prophecy whereby cognition declines even further due to lack of appropriate efforts, strategies, or cognitive engagement.

Indeed, the literature consistently indicates a positive relationship between higher control beliefs and increased cognitive abilities (Neupert & Allaire, 2012; West & Yassuda, 2004). Across multiple trials of increasingly difficult cognitive tasks, adults with increased and stable control beliefs displayed enhanced performance, as well as reduced anxiety and distraction (Agrigoroaei, Neupert, & Lachman, 2013). Similarly, on a recall task, it was found that although older adults performed worse than young adults, older adults with low sense of control displayed the greatest performance deficits (Amrhein, Bond, & Hamilton, 1999). Though correlational, these initial results may suggest that cognitive control beliefs play an integral role in understanding psychosocial aspects of cognitive outcomes in ageing adults. Control beliefs have also been found to be related to subjective memory complaints, such that greater control beliefs predicted better subjective memory outcomes (Lee, 2016), and higher sense of memory control has been found to be associated with reduced self-reported forgetfulness (Scheibner & Leathem, 2012). Lachman (2006) reviews evidence of the importance of control beliefs for a variety of ageing-related outcomes, and given that by the year 2040, the number of persons over the age of 65 will rise significantly, constituting 21.7% of the total US population (Administration on Aging, 2016), it is necessary to explore avenues to promote healthy cognition in older adults. Indeed, the Centers for Disease control have identified subjective cognitive decline as a growing public health issue with an emphasis on identifying these concerns early (Centers for Disease Control and Prevention, 2019).

Previous research on age-related cognitive changes supports the presence of two main cognitive domains: executive functioning and episodic memory (Goh et al., 2011), and both have been shown to decline with age (Kinugawa et al., 2013; Goh et al., 2011; Robinson and Lachman, 2018). Yet, it is critical to distinguish between these two facets of cognition, because as noted earlier, cognitive decline is not a uniform process. Rather, some cognitive abilities may decline sooner in life or display sharper declines, while others may begin declining significantly later in life or have more subtle rates of decline. Executive functioning has often been challenging to operationalize, and different studies have taken various approaches to studying executive functioning, which has made it difficult to compare results (Albinet, Boucard, Bouquet, & Audiffren, 2012). However, broadly conceptualized, executive functioning can be understood as those cognitive processes which allow individuals to better adapt to novel or complex situations. These may include processes such as working memory, mental flexibility, and the ability to formulate and implement goals (Albinet et al., 2012). Episodic memory, on the other hand, is concerned with one's memory of events, which may include the ability to remember the day's events, or the name of someone you have just met (Goh et al., 2011). Therefore, the current study aimed to shed some light on the role of cognitive control beliefs for both executive functioning and episodic memory.

Control beliefs have been broadly investigated, with a plethora of research supporting the positive relationships between one's sense of control over general aspects of their life, and health and well-being outcomes. However, there is still much to be learned regarding domain-specific cognitive control beliefs. That is, how might our specific beliefs about control over age-related changes in cognition be related to our actual cognitive abilities? Previous work has investigated this relation, with some links found between cognitive control beliefs and cognitive functioning (Bielak et al., 2007; Cherry et al., 2019; Parisi, Gross, Marsiske, Willis, & Rebok, 2017). However, previous studies have been limited by sample size (Bielak et al., 2007) and sample geographic restrictions (Cherry et al., 2019). A 10-year longitudinal study found that cognitive performance at baseline predicted changes in control beliefs over the course of the study; however, control beliefs did not

predict cognitive functioning over the course of the study (Parisi et al., 2017). It must be noted that in order to be eligible for the longitudinal trial conducted by Parisi et al. (2017), participants were required to be over the age of 65 at baseline. It is possible that this age restriction resulted in a failure to capture levels of control beliefs in young- or middle-adulthood that may predict cognitive functioning. That is, this age restriction may have also resulted in a range restriction of scores on control beliefs.

Therefore, the goal of the current study was to investigate the relationship between cognitive control beliefs and cognitive functioning among a large, nationwide sample of adults at varying ages across the lifespan. This study also aimed to investigate whether cognitive control beliefs moderate the relationship between age and cognitive functioning. We hypothesized that, (1) cognitive control beliefs would significantly predict both executive functioning and episodic memory, and (2) higher cognitive control beliefs would be associated with a weaker relationship between age and cognitive functioning.

Method

Participants

Data included 3,670 participants from the second wave of data collection for the longitudinal and national Midlife in the United States study (MIDUS II; Brim, Ryff, & Kessler, 2004). Only participants who had completed the measure of cognitive control beliefs and the cognitive battery assessment were included in the present study. MIDUS II involved a 30-min phone interview and two self-administered questionnaires assessing demographic, psychosocial, and physical health variables. Participants also completed a 15-min phone assessment of cognitive ability.

Materials

Cognitive control Beliefs

The Personality in Intellectual Aging Contexts (PIC) Inventory Control Scales (Lachman, Baltes, Nesselroade, & Willis, 1982) was used to evaluate older adults' beliefs about their cognitive and intellectual abilities. The 9-item version of the PIC was administered in MIDUS II and evaluated older adults' beliefs regarding their intellectual and cognitive capabilities as they age. Sample items include, 'As long as I exercise my mind I will always be on top of things' (reverse-scored), and 'It's evitable that my intellectual functioning will decline as I get older'. Participants were asked to indicate their agreement with each statement along a 7-point Likert scale with 1 = *Strongly Agree* to 7 = *Strongly Disagree*. Two of the nine items were reverse-coded prior to calculating total score. The total score was then calculated by computing the mean for all items, with higher scores indicating greater cognitive control beliefs. The PIC demonstrated acceptable internal consistency in this sample (α = .69).

Cognition

Cognition was assessed using the Brief Test of Adult Cognition by Telephone (BTACT; Tun & Lachman, 2006). The BTACT includes seven subtests that measure a variety of cognitive areas: (1) immediate word list recall (episodic verbal memory), (2) digit backward span (working memory), (3) category fluency (verbal ability and speed), (4) Stop and Go Switch Task (SGST; executive function-inhibitory control), (5) number series (fluid intelligence/

reasoning), (6) backward counting (speed of processing), and (7) delayed word list recall (episodic verbal memory/forgetting). Together, these subtests create two factors as specified by Lachman, Agrigoroaei, Tun, and Weaver (2014): episodic memory and executive functioning. Episodic memory included measures of immediate and delayed word list recall. Executive functioning scores comprised all remaining measures: backward digit span, category fluency, SGST, number series, and backward counting. For both episodic memory and executive functioning, higher scores were indicative of higher cognitive abilities. For a full description of the BTACT and its psychometric properties, see Lachman et al. (2014).

Data analysis

To test whether cognitive control beliefs moderated the relationship between age and cognition, two separate moderation analyses using PROCESS macro for SPSS (Hayes, 2018) were conducted controlling for age, gender, level of education, and self-rated physical health. Previous research suggests it is particularly important to control for physical health status, as BTACT performance has been found to be highly sensitive to one's current physical health (Lachman et al., 2014). For both moderation analyses, age was entered as the independent variable, cognitive control beliefs were entered as the moderator, and gender, level of education, and self-rated physical health were entered as covariates.

Results

Descriptives

The final sample included in analyses ranged in age from 32 to 84 years (M = 56.43, SD = 12.32), 44.6% male, 55.4% female, and 92.3% White, and 3.3% Black or African American. The majority of the sample had at least a high school degree or GED equivalent (94.3%), and 38.6% of the sample had earned a 4-year degree or graduate degree. Mean self-rated health was 2.44 (SD = 1.01), and mean level of cognitive control beliefs was 4.91 (SD = 0.978).

Moderation results

To test whether cognitive control beliefs moderated the relationship between age and cognition, two moderation analyses using PROCESS macro for SPSS were conducted with the IV and moderator centred (Hayes, 2018). Table 1 contains model statistics and parameters from the moderation analyses. The first model tested whether control beliefs moderated the relationship between age and episodic memory. The overall model significantly predicted episodic memory, $F(6, 3663) = 165.72$, $p < .001$, $R^2 = .21$. After controlling for gender, education, and self-reported physical health, the interaction between age and control beliefs did not significantly predict episodic memory, $\Delta R^2 = .001$, $\Delta F = 2.78$, $p = .096$, $\beta = .024$, 95% CI [−0.004, 0.05]. All other predictors in the model significantly predicted episodic memory, p's $< .001$.

The second moderation model tested whether control beliefs moderated the relationship between age and executive functioning. The overall model containing all predictors significantly predicted executive functioning, $F(6, 3663) = 344.39$, $p < .001$, $R^2 = .36$. All predictors significantly predicted executive functioning, p's $< .001$.

Table 1. Model statistics and predictor estimates for episodic memory and executive functioning (N = 3,670)

	β	*SE*	95% CI
Episodic memory			
Age	−.29***	.02	(−0.32, −0.26)
Gender	.49***	.03	(0.43, 0.54)
Education	.06***	.006	(0.05, 0.07)
Self-reported physical health	−.07***	.02	(−0.10, −0.03)
Control beliefs	.10***	.02	(0.07, 0.13)
Age x control beliefs	.024	.015	(−0.004, 0.053)
Executive functioning			
Age	−.34***	.01	(−0.37, −0.32)
Gender	−.14***	.027	(−0.20, −0.09)
Education	.12***	.006	(0.10, 0.13)
Self-reported physical health	−.13***	.01	(−0.16, −0.10)
Control beliefs	.13***	.01	(0.10, 0.15)
Age x control beliefs	−.028*	.01	(0.002, 0.05)

Note. Control beliefs measured with the Personality in Intellectual Aging Contexts.
***$p < .001$; *$p < .05$.

Moreover, the control beliefs significantly moderated the relationship between age and executive functioning, $\Delta R^2 = .001, \Delta F = 4.48, p = .034, \beta = .028$, 95% CI [0.002, 0.053]. Figure 1 contains a visual depiction of the significant, small moderation effect. The results suggest that the association between age and executive functioning becomes slightly weaker as the level of control beliefs increases. In other words, executive functioning decreases more slowly among adults at older ages when they have high rather than lower cognitive control beliefs. The Johnson–Neyman technique was used to probe the conditional effect of the predictor at values of the moderator. The findings indicated that moderation was significant at all values of control beliefs total score. Age had a slightly stronger association with executive functioning at low cognitive beliefs (lowest score of 1), $p < .001$, $\beta = -.44$, 95% CI [−0.53, −0.35], than moderate control beliefs (middle score of 4), $p < .001$, $\beta = -.37$, 95% CI [−0.40, −0.34]. Similarly, moderate control beliefs had a slightly stronger association with executive functioning at high control beliefs (highest score of 7), $p < .001$, $\beta = -.29$, 95% CI [−0.35, −0.22].

Discussion

This study aimed to understand the role of cognitive control beliefs on cognitive functioning. Hypotheses were partially supported. As predicted, analyses indicated that cognitive control beliefs are significantly predictive of executive functioning and episodic memory, even when controlling for age, and other demographic variables. This suggests that cognitive control beliefs are predictive of declines in cognition above and beyond any normal, age-related declines. Although our current study is not designed to determine any direction of effect, such results may indicate that lower cognitive control beliefs precede cognitive declines, an idea that future research should investigate.

Moderation analyses did not reveal a significant interaction between cognitive control beliefs and age for episodic memory, but we did find a significant (albeit small) interaction

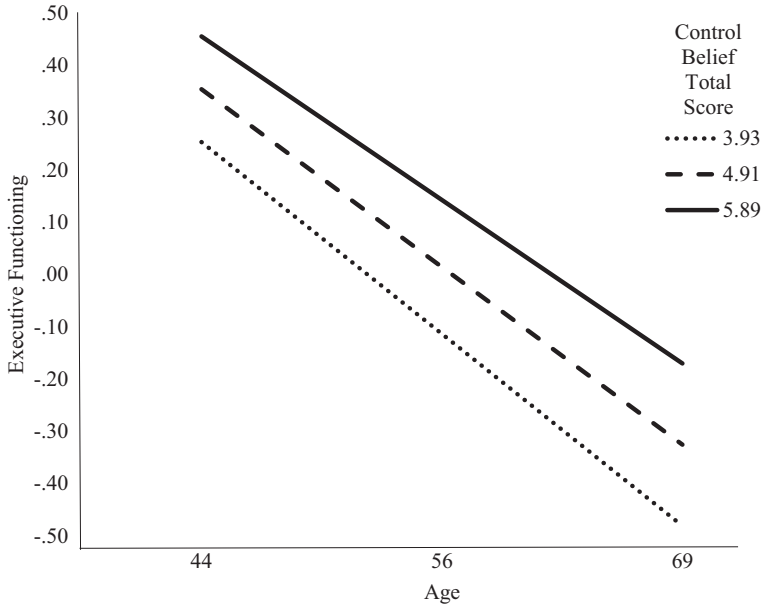

Figure 1. Graph of significant interaction between age and cognitive control beliefs on executive functioning. *Note.* Control beliefs scores at depicted at one standard deviation below the mean, the mean, and one standard deviation above the mean.

between age and cognitive control beliefs on the outcome of executive functioning. This suggests that the association between age and executive functioning depends to some degree on the level of cognitive control beliefs. Although older adults had lower executive functioning scores than middle-aged adults regardless of level of control beliefs, our data indicate that older adults with higher cognitive control beliefs had better executive functioning than older adults with low cognitive control beliefs.

Though the current study is not able to draw conclusions about the direction of this effect, our results may suggest that one's individual cognitive control beliefs play a role in normal, age-related declines in cognitive abilities. Moreover, given that cognitive control beliefs are related to executive functions, this begs the question as to the potential mechanisms involved that connect cognitive control to executive functions, but not episodic memory. Similar work has shown that relationship between cognitive control and memory performance is present for middle-aged and older adults, but not younger adults, indicating age may be an important theoretical consideration (Lachman & Andreoletti, 2006). Additionally, previous work has suggested that performance on episodic memory can be inhibited by poor executive abilities (Craik, Eftekhari, Bialystok, & Anderson, 2018; Troyer, Graves, & Cullum, 1994). Our findings suggested that cognitive control may be strongly related to executive functions that are less intimately involved in episodic memory performance. However, additional research is needed to confirm this and examine to what extent functions, such as inductive reasoning and inhibitory control, are associated with episodic memory processes. Recent evidence suggests that this may

be a complex answer since the executive functions involved in episodic memory processes differ according to the information being retrieved and other age-related impairments (Craik et al., 2018).

A potential link between cognitive control beliefs and executive functioning may be that older adults who hold greater cognitive control beliefs are more likely to consistently engage in strategies that strengthen the components of executive functioning, including working memory span, verbal fluency, accuracy and reaction time, inductive reasoning, and speed of processing. Previous research lends support to this idea, as older adults higher in executive functioning have displayed greater internal memory strategies (e.g., mnemonics), potentially due to their beliefs about their cognitive abilities being modifiable and, thus, taking deliberate action to 'practice' cognitive strategies (Bouazzaoui et al., 2010). Research on control beliefs has found that higher control beliefs are also associated with more positive behaviours, including greater engagement in a reading task, suggesting that control beliefs may foster persistence on a task (Miller & West, 2010). Additionally, when provided the opportunity to interact with chosen stimuli, older adults with higher control beliefs chose to interact with fewer negative stimuli in comparison with those with low control beliefs (Rovenpor, Skogsberg, & Isaacowitz, 2012). Further research has found that enhanced cognition is associated with greater control beliefs, possibly due to more effective strategy use (Lachman & Andreoletti, 2006). These studies suggest that older adults with greater control beliefs are finding strategies to successfully compensate for normal age-related declines in cognition.

Yet, if cognitive control beliefs are related to executive functioning due to improved strategy use and practice, it is curious that our results did not also find a significant interaction between cognitive control beliefs and age for episodic memory. It would be expected that if cognitive control beliefs can result in greater internal strategy usage, that this would also be beneficial for episodic memory outcomes. However, this lack of a significant finding in regard to episodic memory may be due to episodic memory being very sensitive to age-related declines in cognition (Pause et al., 2013). This possibility is supported by Lachman et al. (2014) who investigated age patterns for the two factors of the BTACT and found evidence within the MIDUS sample that the trendline for episodic memory declined more steeply with age than the trendline for executive functioning. In other words, perhaps any positive role that cognitive control beliefs may play in cognitive outcomes is too weak to have any effect on age-related declines in episodic memory.

Our results may also speak to a highly relevant area of concern for the ageing population: ageism. In contrast to many other types of bias, age-related biases are socially acceptable, deeply institutionalized in the United States, and will be experienced by everyone who lives long enough (Allen, 2016). Based on the 'weathering hypothesis', Allen (2016) hypothesizes that stress brought about by exposure to age-related prejudice and discrimination can lead to negative health outcomes. Results from this study may inform our understanding of the negative effects of ageism on cognition. Individuals with higher cognitive control beliefs may be less susceptible to cognitive deficits related to stereotype threat. Similar research indicates that manipulating subjective age reduces the influence of age-related stereotypes, suggesting that some self-perceptions about the ageing process may be to some extent malleable and beneficial for the promotion of positive ageing processes (Eibach, Mock, & Courtney, 2010).

This malleability is an important aspect to note when considering any beneficial role of cognitive control beliefs on cognition. According to Lachman's (2006) proposed model, control beliefs are theorized to arise both from one's actual performance as well as perceptions of mastery, perceived constraints, and attributions. Although there is

currently limited evidence to suggest the efficacy of addressing cognitive control beliefs specifically, there is evidence that other related beliefs systems can be at least temporarily, experimentally manipulated. For example, Lachman (2006) reviewed research indicating that cognitive-restructuring strategies were able to successfully change control beliefs regarding age-related physical abilities. Specifically, an eight-session intervention was able to reframe older adults' maladaptive beliefs about their susceptibility to falling, and researchers found that changing these beliefs resulted in increased physical activity levels (Tennstedt et al., 1998). Another study reported that locus of control (e.g., the degree to which one feels personally in control of life's outcomes) can be experimentally manipulated by changing perceptions of the environment as being controllable and predictable (Johnson, Rosen, Chang, & Lin, 2015). Galvin, Randel, Collins, and Johnson (2018) reviewed the literature on locus of control, noting that, 'Whereas self-esteem and generalized self-efficacy are internal, direct appraisals of one's overall worth and capabilities, respectively, locus of control involves an assessment of the environment and external rewards' (p. 823). Thus, perceptions of control may be to some degree, modifiable. However, the extent of these changes in beliefs and their durability are unclear and may be opportunities for additional investigation.

However, we must note again that a major limitation of the current study is that the cross-sectional nature of this research makes it difficult to draw conclusions about directions of the effect. Whether control beliefs help improve cognition, or if improved cognition enhances one's sense of control, remains to be determined. Previous research on physical health in older adults does support that despite decreases in health over time, those with heightened general control beliefs had attenuated cognitive declines (Lachman & Agrigoroaei, 2010). Additionally, the majority of the current sample was white, with <10% of the sample identifying as minority, and research indicates that race moderates the relationship between cognitive control beliefs and cognitive functioning (Kennedy, Allaire, Gamaldo, & Whitfield, 2012). Nonetheless, a strength of the MIDUS II sample is its extensive sample size, and the inclusion of individuals from varied regions of the United States.

Finally, we recognize that the significant interaction we found for age by control beliefs on executive functioning only accounted for 0.1% of the variance, which is a very small effect. However, small effect sizes can still carry significant practical meaning, especially within the field of psychology in which many variables are at play in understanding any one specific outcome. Therefore, no single predictor variable is likely to account for any significant portion of the variance. We should also note that the presence of a small effect size is considered to still carry weight in situations in which we would not anticipate the independent variable to have a significant effect on the outcome (Prentice & Miller, 1992). Although the current study was not experimental and we cannot make statements on directions of the effect, we would still not reasonably expect that cognitive control beliefs would have any *profound* effect on measured cognition had the study been designed to test directional effects.

Future research should expand upon these findings by longitudinally examining the association between cognitive control beliefs and cognition over time among older adults, particularly the oldest-old. Given the previously reviewed evidence of age-related cognitive declines which become more pronounced with age, improved cognitive control beliefs may be particularly relevant for understanding and potentially limiting cognitive decline in this age group. Moreover, future work should consider the potential benefit of exercises designed to reduce negative self-perceptions about ageing. Such

exercises could benefit adults in middle-age to prepare them for exposure to future ageist stereotypes and potentially reduce the likelihood of negative effects from ageist beliefs.

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Conflicts of interest

All authors declare no conflict of interest.

Author contributions

T.R. conducted the analysis and interpretation of the data and contributed to the drafting of the manuscript. E.P. conducted revised analyses and contributed to substantial manuscript revisions. E.K. contributed to manuscript revisions. J.D. assisted in the drafting of the manuscript and subsequent critical revisions.

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