Perceived Control Relates to Better Functional Health and Lower Cardio-Metabolic Risk: The Mediating Role of Physical Activity

Frank J. Infurna and Denis Gerstorf
Pennsylvania State University, German Institute for Economic Research (DIW Berlin), Berlin, Germany, and Humboldt University

Objective: The objective of the current study was to examine empirically associations between perceived control and indicators of functional health (grip strength) and cardio-metabolic risk (hemoglobin A1C, High Density Lipoprotein Cholesterol [HDL–C], Systolic Blood Pressure [SBP], Pulse Rate [PR], and Waist Circumference [WC]) and to explore the mediating role of physical activity. Method: Using cross-sectional data from the nation-wide Health and Retirement Study (N = 4,292; Mean age = 68, range 50–97; 59% women), we examined whether perceived control was predictive of the various health indicators over and above sociodemographic characteristics. We also used mediation models to test whether those direct associations were mediated by physical activity. Results: Findings indicated that perceiving more control related to better grip strength and lower cardio-metabolic risk. To illustrate, a 1 SD increase in control is associated with 2.5 fewer years of aging on grip strength, 10 fewer years of aging for hemoglobin A1C, 14.5 fewer years of aging for HDL–C, 3.7 fewer years of aging for pulse rate, and 5.75 fewer years of aging for waist circumference. We also found that physical activity mediated five of the six control–health associations. Conclusions: Our findings demonstrate the importance of perceived control as predictor of functional and physiological health and the role of physical exercise as a behavioral mediator of these associations. Our results suggest that control may serve as a facilitator of positive health outcomes, including functional health, cardio-metabolic risk, and physical activity. Findings provide impetus for future research to elucidate mechanisms underlying the health implications of perceived control.

Keywords: perceived control, physical activity, biomarkers, health and retirement study, adulthood and old age

Perceived control plays an important role in shaping physical health across adulthood and old age (Baltes & Baltes, 1986; Bandura, 1997; Lachman, 2006; Rodin, 1986). Empirical research suggests that perceiving more control is protective against declines in physical functioning (Caplan & Schooler, 2003; Lachman & Agirigororeai, 2010; Seeman, Unger, McAvay, & Mendes de Leon, 1999), cardiovascular disease incidence (Rosengren et al., 2004; Stürmer, Hasselbach, & Amelang, 2006), and mortality (Infurna, Gerstorf, Ram, Schupp, & Wagner, 2011a; Surtees, Wainwright, Luben, Khaw, & Day, 2006; Surtees et al., 2010). However, much less is known regarding the functional and physiological health indicators that underlie such associations and the behavioral factors that may play a mediating role in this context (Lachman, 2006; Rodin, 1986; Uchino, 2006). In the present report, we use cross-sectional data from the Health and Retirement Study (HRS) to examine how control links to several markers of functional and physiological health and explore the role of physical activity in mediating these associations.

Health Implications of Perceived Control

Because of the health demographics in the United States, the identification of risk and protective factors that contribute to key health outcomes of disability and disease in adulthood and old age has become a major theme of scientific inquiry (Miller, Chen, & Cole, 2009; Rozanski, Blumenthal, Davidson, Saab, & Kubzansky, 2005). For example, Seeman, Merkin, Crimmins, and Karlamangla (2010) reported that over 15% of older adults aged 60 and older typically report one functional limitation. Similarly, cardiovascular disease is the leading cause of death in the United States, accounting for over 600,000 deaths in 2007 (Xu, Kochanek, Murphy, & Tejada-Vera, 2010), and although its incidence rate has remained relatively stable, disease incidences of metabolic syndrome (e.g., diabetes) have increased in recent years (Crimmins & Beltrán-Sánchez, 2011; Grundy et al., 2005). Those statistics highlight the importance of identifying risk and protective factors for health outcomes so as to eventually help promote better health in adulthood and old age and mitigate accrued societal burdens arising...
from impaired health of large population segments (Olshansky, Goldman, Zheng, & Rowe, 2009; Rae et al., 2010).

Perceived control can be construed as representing one key protective factor with major health implications. Perceptions of control refer to beliefs about one’s capability to exert influence over and shape one’s life circumstances (Skinner, 1996). Both conceptual work and empirical reports suggest that individuals who report higher levels of control tend to view their health as controllable, making it more likely for them to engage in healthy behaviors and adequately manage their health (Bandura, 2004; Lachman et al., 1997). As a consequence, perceiving greater control has been linked to lower risk of declines in physical functioning, cardiovascular disease incidence, and mortality (Cawley, 2003; Gerstorf, Röcke, & Lachman, 2011; Infurna et al., 2011a; Infurna, Gerstorf, & Zarit, 2011b; Rosengren et al., 2004; Surtees et al., 2006, 2010). Underlying the health salutary effects of perceived control are presumably functional and physiological factors (Lachman, 2006; Rodin, 1986; Uchino, 2006). In particular, several studies reported that control relates to better functional health, neuroendocrine functioning, and cardio-metabolic health (Bollini, Walker, Hamann, & Kestler, 2004; Brach et al., 2003; Roepke & Grant, 2011). Such associations between control and various indicators of functional and physiological health may be carried by behavioral factors. For example, individuals who perceive more control can be expected to adopt and maintain health-promoting behaviors including exercise, preventive care, and proper diet, which in the long run help sustaining good health (McAuley, 1993; White, Wójcicki, & McAuley, 2012).

Perceived Control and Indicators of Functional Health and Cardio-Metabolic Risk

Conceptual models of control delineate that control is linked to health outcomes of disability, disease incidence, and mortality through behavioral resources, as well as indicators of functional health and cardio-metabolic risk (Lachman, 2006; Uchino, 2006). To begin with, functional health represents one’s state of general muscle strength, subclinical disease, and general vitality that results in good functional ability (Anstey, Luszcz, Giles, & Andrews, 2001; Rantanen et al., 1999). Limitations in functional health or grip strength represent often-used proxies for the presence of chronic disease, lack of resistance to external stressors, and cumulative biological burdens that are established markers of disability, disease incidence, and mortality (McEwen, 1998; Rantanen et al., 2003). Studies across the life span have linked perceptions of control to functional health indices. For example, participants in childhood and young adulthood who reported higher levels of control were more likely to exhibit better functional health, as indexed by forced expiratory volume and functional status (Gale, Batty, & Deary, 2008; Griffin & Chen, 2006). In adulthood and old age, perceiving control may facilitate and motivate participating in leisure and restorative activities, which in turn promote muscle strength and functional abilities (Pressman et al., 2009; Rozanski et al., 2005).

Cardio-metabolic risk is a constellation of interrelated risk factors of metabolic origin that promote the development of cardiovascular disease and Type 2 diabetes mellitus (Grundy et al., 2005). Poor management of one’s cardio-metabolic health can contribute to atherogenesis, protein glycation of vessel walls, and induce release of inflammatory cytokines that are linked to increased risk for cardiovascular disease incidence, metabolic syndrome, and mortality (Després et al., 2008; Khaw & Wareham, 2006). Links between perceived control and cardio-metabolic risk have been reported from population studies using different age groups as well as high-risk groups such as caregivers and people with chronic illnesses. For example, in children with diabetes and in adult samples, perceived control was linked to lower hemoglobin A1C, higher High Density Lipoprotein–Cholesterol (HDL–C), and lower waist circumference (Nabors, McGrady, & Kichler, 2010; Paquet, Dubé, Gauvin, Kestens, & Daniel, 2010; Tsenkova, Love, Singer, & Ryff, 2008). For caregivers and people with metabolic diseases and diabetes, perceiving more control serves as a psychological resource that protects against increasing cardio-metabolic risk (Roepke & Grant, 2011). In sum, there is reason to believe that functional health and cardio-metabolic risk underlie the well-documented associations between perceived control and disease incidence/mortality and that behavioral (physical activity) pathways may provide the means for control to facilitate better functional health and lower cardio-metabolic risk.

The Mediating Role of Physical Activity

We aim to substantiate control—health associations by targeting whether control is directly associated with functional health and cardio-metabolic risk. However, the factors underlying associations between control with functional health and cardio-metabolic risk are not well understood. Physical activity can be assumed to play a key role in linking perceptions of control to indicators of functional health and cardio-metabolic risk. Physical activity refers to one’s involvement with and engagement in vigorous (e.g., running or gym workout), moderate (e.g., gardening or walking), and mild (e.g., vacuuming) activities (Levine, Eberhardt, & Jensen, 1999; McAuley, 1993). Perceived control is often instrumental in facilitating and regulating physical activity and strenuous exercise, which are in turn linked to better functional health and lower cardio-metabolic risk (Arsenault et al., 2010; Lakka et al., 2003). As a functional health implication, physical activity is known to increase muscle strength (Brach et al., 2003). Also, partaking in strenuous exercise and physical activity promotes vitality and vigor that helps maintain functional abilities (Pressman et al., 2009; Rozanski et al., 2005). As cardio-metabolic implications, engaging in physical activities often suppresses endogenous glucose production and promotes antioxidant functions (Selvin et al., 2010). In a similar vein, exercise helps lowering cardio-metabolic risk by reducing adipose tissue and body mass or fat, as well as increasing HDL–C production and reverse cholesterol transport (Penedo & Dahn, 2005; Thompson et al., 2003). Taken together, empirical evidence suggests that perceived control facilitates positive health through fostering and motivating physical activity.

The Present Study

Taken together, recent empirical research shows that the health implications of perceived control range from being protective against disability and declines in physical functioning to having a decreased risk of cardiovascular disease incidence and mortality.
Our goal in this study is to elucidate how control relates to several indicators of control in the long-run may contribute to the predictive effects of control for major health outcomes such as mortality. We are particularly interested in whether perceived control is associated with indicators of functional health and cardio-metabolic risk because each of these factors is linked to health outcomes of disability, disease incidence, and mortality. Previous research testing the functional and physiological indicators that underlie these associations has largely been done focusing on single, primarily stress-related indicators in experimental settings and convenience samples. In the present report, we aim to extend previous research by targeting many indicators jointly in one study. We utilize data from the nation-wide Health and Retirement Study (HRS) that consists of individuals in late adulthood and old age (ages 50+) and first examine whether perceived control is associated with functional health (grip strength) and cardio-metabolic risk (hemoglobin $A_{1c}$, High Density Lipoprotein Cholesterol [HDL–C], Systolic Blood Pressure [SBP], Pulse Rate [PR], and Waist Circumference [WC]), net of the effects of sociodemographic characteristics. We note that utilizing data from the nation-wide HRS allows for our findings to be generalized to the larger adult population in the US. Based on previous findings, we expect that higher levels of perceived control are linked to better functional health and lower cardio-metabolic risk. Second, our mediation analyses evaluate the role of physical activity in how perceived control relates to functional health and cardio-metabolic risk (MacKinnon & Luecken, 2008). We expect that much of the health salutary effects of perceived control for the targeted functional and physiological indicators are mediated by physical activity.

Method

Participants

The HRS is a nationally representative probability sample of households in the contiguous United States of noninstitutionalized adults aged 50 years and older that now has in total surveyed more than 30,000 individuals (McArdle, Fisher, & Kadlec, 2007; Soldo, Hurd, Rodgers, & Wallace, 1997). The measures assessed cover a wide range of economic, sociological, psychological, mental, and physical health information.

In the present study, we utilize data from 4,292 participants who (a) participated in the 2006 enhanced face-to-face interview, (b) were aged 50 years and older at the time of assessment (so as to reduce menopausal effects on blood measurements among women; 144 participants below age 50 were excluded, 118 or 82% were women), and (c) provided data on all of our measures of interest. Table 1 shows descriptive statistics for our sample. Participants were, on average, 68 years of age ($SD = 9.74$), attained 13 years of education ($SD = 3.03$), 59% were women, 86% were White, and 70% were married or partnered. Relative to those participants who participated in the enhanced face-to-face interview, but were not included in our analyses because of missing data ($n = 4,303$), our subsample did not differ in age ($M = 67.56, SD = 9.74$ vs. $M = 67.36, SD = 11.82$; $F[1, 8595] = 0.71, p > .05$), gender ($59\%$ vs. $58\%$; $X^2[1, 8595] = 2.36, p > .05$), grip strength ($M = 30.92, SD = 10.86$ vs. $M = 30.93, SD = 11.43$; $F[1, 7403] = 0.00, p > .05$), HDL–C ($M = 57.27, SD = 14.32$ vs. $M = 57.27, SD = 16.62$; $F[1, 5039] = 0.08, p > .05$), and pulse ($M = 70.40, SD = 11.20$ vs. $M = 70.93, SD = 11.79$; $F[1, 7358] = 3.79, p > .05$), but attained slightly more years of education ($M = 12.73, SD = 3.05$ vs. $M = 12.28, SD = 3.32$; $F[1, 8582] = 42.05, p < .05$), were more likely to be white ($86\%$ vs. $79\%$; $X^2[1, 8591] = 73.68, p < .05$), married or partnered ($70\%$ vs. $66\%$; $X^2[1, 8591] = 16.49, p < .05$), reported more perceived control ($M = 4.79, SD = 0.95$ vs. $M = 4.70, SD = 1.00$; $F[1, 7622] = 15.50, p < .05$), were more physically active ($M = 2.95, SD = 0.89$ vs. $M = 2.73, SD = 0.98$; $F[1, 8594] = 113.04, p < .05$), had lower hemoglobin $A_{1c}$ ($M = 5.82, SD = 0.82$ vs. $M = 5.88, SD = 0.94$; $F[1, 6505] = 8.68, p < .05$), higher SBP ($M = 131.91, SD = 20.39$ vs. $M = 130.83, SD = 21.20$; $F[1, 7359] = 4.94, p < .05$), and higher WC ($M = 70.79, SD = 6.03$ vs. $M = 39.41, SD = 6.07$; $F[1, 7355] = 6.94, p < .05$). Although there are differences in education, race, marital status, perceived control, physical activity, hemoglobin $A_{1c}$, SBP, and WC, the relatively small differences in substantive terms ($\eta^2 < .01$ for all comparisons) suggest that the study sample is generalizable.
is comparable to the study population from which they were drawn.

Procedure

In 2006, approximately 50% of the longitudinal HRS sample completed an enhanced face-to-face interview. Selected respondents received a self-report questionnaire and were asked to complete and mail (for details, see Clarke, Fisher, House, Smith, & Weir, 2008), and were also given the opportunity to contribute biomarker and physical health marker measurements (for details, see Crimmins et al., 2008, 2009). The HRS was conducted under Institutional Review Board approval by the relevant committees at the University of Michigan and the National Institute on Aging, the primary sponsor of HRS. Interviewers were trained to properly administer the physical and biomarker measurements and prior to describing the individual measures, a consent form was administered by the interviewer, where the participants were asked to read and sign the form. Participants who did not sign the consent form were not asked to complete the physical and biomarker measures.

Measures

Outcomes. The target outcome variables were six indicators that represent functional health and cardio-metabolic risk (see Table 1). Grip strength was measured using a Smedley spring-type hand dynamometer (Anstey et al., 2001; Crimmins et al., 2008). The dynamometer was fit to the participant’s hand, and the person was instructed to stand and squeeze the meter as hard as they were able to for a couple of seconds and then let go. Participants completed two measurements with each hand, alternating hands, while standing or if a participant was unable to stand, the measurement was completed with the participant seated. The participants’ maximum score out of their total measurement trials was selected ($M = 30.92$ kg, $SD = 10.86$).

Blood acquisition and determination was performed using instructions and kits from Biosafe Laboratories, Chicago, IL (for details, see Crimmins et al., 2009). Blood was taken by pricking the participant’s finger with a sterile lancet after cleansing the finger with an alcohol swab and analyzed for concentrations of hemoglobin $A_{1c}$ and HDL–C. Droplets of blood were directly placed on specially treated filter paper and then placed in special foil envelopes with a desiccant packet and then within mailing containers, and shipped to Biosafe Labs (for details, see Crimmins et al., 2009). Repeated measures within a specific laboratory run showed a coefficient of variation of less than 3.5% for HDL–C and less than 7% between runs (Crimmins et al., 2009). Hemoglobin $A_{1c}$ is a summary measure of blood glucose metabolism that covers the preceding 3 months.

Participants’ systolic blood pressure and pulse rate were measured using an Omron HEM-780 Intellisense Automated blood pressure monitor with ComFit cuff (see Crimmins et al., 2008). Respondents were instructed to sit down with both feet on the floor and their left arm comfortably support with the palm facing up. The cuff was adjusted to the respondent’s arm; the bottom of the cuff was approximately half an inch above the elbow and the air tube ran down the middle of the respondent’s arm. Three measurements were taken, 45 seconds apart, on the respondent’s left arm. We used the average of three measurements for SBP ($M = 131.91$, $SD = 20.39$) and PR ($M = 70.40$ beats per minute, $SD = 11.20$).

Waist circumference was measured at the level of the respondents’ maximal score out of their total measurement trials was completed with the participant seated. The respondent was instructed to inhale and slowly exhale, and waist circumference was measured while holding the exhale ($M = 39.79$ in., $SD = 6.03$; see Crimmins et al., 2008).

Perceived control. We used a unit-weighted composite of 10 items that assessed one’s feelings of control over life circumstances to index perceived control (see Clarke et al., 2008; Lachman & Weaver, 1998). Our measure of perceived control consisted of two dimensions, personal mastery and perceived constraints that were assessed with five items each and combined (for discussion, see Lachman & Weaver, 1998) and are consistent with Skinner’s (1996) twofold conceptualization of control as comprised of competence and contingency. Participants were asked to indicate the extent to which they agree with each of the items, using a 6-point scale (1 = strongly disagree to 6 = strongly agree; e.g., “I can do just about anything I really set my mind to”). Negatively valenced items were reverse coded, so that higher scores reflected perceiving more control ($M = 4.79$, $SD = 0.95$; Cronbach’s alpha = .87).

Physical activity. Physical activity was measured using a unit-weighted composite of three items assessing how often participants partake in vigorous activity (e.g., jogging, swimming, or gym workout), moderate activity (e.g., gardening or walking at a moderate pace), and mild activity (e.g., vacuuming or laundry). Participants rated each item using a 5-point scale (1 = every day to 5 = hardly ever or never). The items were reverse coded and averaged, with higher scores indicating more physical activity ($M = 2.95$, $SD = 0.89$; Cronbach’s alpha = .54). Substantively similar findings were observed when we first weighted the three items (vigorous activity .9, moderate activity .5, and light activity .3) and then averaged them (see McAuley, 1993).

Statistical Analyses

To test our research questions, two regression models were estimated. In a first step, each physiological indicator was regressed onto perceived control and sociodemographics (age, gender, and education). In a second step, we tested a mediation model where physical activity was regressed onto perceived control and each indicator was regressed onto physical activity. A nonparametric resampling or bootstrapping procedure was applied using Mplus (Muthén & Muthén, 1998–2007) to test whether the indirect effect of perceived control through the hypothesized mediator (physical activity) and whether the targeted indicator were each reliably different from zero. To acknowledge the possible skew of the distribution of the indirect effect, our models did not impose normality assumptions (see Preacher & Hayes, 2008). We set the statistical significance level at $p < .05$.

Results

Perceived Control and Indicators of Functional Health and Cardio-Metabolic Risk

Table 1 shows descriptive statistics and correlations for the measures of interest and Table 2 shows results from our regression
Table 2

<table>
<thead>
<tr>
<th>Model 1</th>
<th>Grip strength</th>
<th>Hemoglobin A1c</th>
<th>HDL–C</th>
<th>SBP</th>
<th>WC</th>
<th>PR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outcome</td>
<td>Estimate (SE)</td>
<td>Estimate (SE)</td>
<td>Estimate (SE)</td>
<td>Estimate (SE)</td>
<td>Estimate (SE)</td>
<td>Estimate (SE)</td>
</tr>
<tr>
<td>Intercept</td>
<td>29.97 (0.10)</td>
<td>13.38 (0.21)</td>
<td>0.35 (0.02)</td>
<td>0.16 (0.02)</td>
<td>15.91 (0.21)</td>
<td>0.34 (0.01)</td>
</tr>
<tr>
<td>Perceived control</td>
<td>0.95* (0.12)</td>
<td>0.80* (0.01)</td>
<td>0.10 (0.09)</td>
<td>0.17 (0.01)</td>
<td>0.36* (0.01)</td>
<td>0.10 (0.03)</td>
</tr>
<tr>
<td>Gender</td>
<td>0.37* (0.01)</td>
<td>0.74* (0.01)</td>
<td>0.22* (0.06)</td>
<td>0.24* (0.03)</td>
<td>0.11</td>
<td>0.06</td>
</tr>
<tr>
<td>Age</td>
<td>0.34* (0.01)</td>
<td>0.72* (0.01)</td>
<td>0.03 (0.01)</td>
<td>0.02 (0.01)</td>
<td>0.14</td>
<td>0.05</td>
</tr>
</tbody>
</table>

Table 2: Unstandardized and Standardized Estimates From Regression Models Predicting Indicators of Functional Health and Cardio-Metabolic Risk

The Mediating Role of Physical Activity

In our second model, we included physical activity as a mediator to examine whether physical activity mediates associations between perceived control and each indicator. To begin with, we observed that perceiving more control was linked to participating in more frequent physical activity (see bottom of Table 2). Also, reporting more physical activity was associated with better grip strength, lower hemoglobin A1C, higher HDL–C, lower SBP, lower PR, and lower WC. Most importantly for our research question, we found that for grip strength, HDL–C, SBP, and PR the direct effect of perceived control was reduced, but remained reliably different from zero, whereas for hemoglobin A1C and WC the inclusion of physical activity attenuated the direct effect of control to the null. The nonparametric bootstrapping technique allowed us to quantify whether the indirect effect of control through physical activity was reliably different from zero for each outcome. Analyses revealed that physical activity reliably mediated the relationship between perceived control and grip strength, hemoglobin A1C, HDL–C, PR, and WC, but not SBP (indirect effect). Our results suggest that the direct effect of perceived control onto functional health and cardio-metabolic risk is (partly) attributable to physical activity. Following procedures outlined by Preacher and Kelley (2011), we quantified the observed effect size for the indirect effect of perceived control through physical activity, which was .01, .03, .01, and .03 for grip strength, hemoglobin A1C, HDL–C, PR, and WC, respectively. The effect size metric discussed by Preacher and Kelley (2011) follows the same distribution as Cohen’s $d$ (.01 = small, .05 = medium, .21 = large). The observed effects are in the small range of effect sizes.

Discussion

The objective was to examine whether and how perceived control relates to a variety of different physiological indicators and to explore the mediating role of physical activity for such links. In a first step, we found that, independent of sociodemographics, perceived control was linked to prime indicators of functional health (better grip strength) and cardio-metabolic risk (lower hemoglobin A1C, higher HDL–C, higher SBP, lower PR, and lower WC). In a second step, we further elucidated this association by conducting mediation analyses targeting the role of physical activity. These analyses revealed that physical activity mediated associations of perceived control with grip strength, hemoglobin A1C, HDL–C, PR, and WC, but not SBP. Our results suggest that
the effect of perceived control onto functional health and cardio-metabolic risk was (partly) attributable to physical activity. Although this is a cross-sectional study, our study contributes to a deeper understanding of control-health associations by showing the importance of perceived control as being predictive of functional and physiological health, emphasizing the impact of physical exercise as a behavioral mediator of these associations. Our discussion focuses on the health implications of perceived control and how control facilitates positive health outcomes through behavioral (physical activity) and physiological functioning. We also highlight the need for future research to pinpoint the specific mechanisms that underlie control-health associations.

**Perceived Control and Indicators of Functional Health and Cardio-Metabolic Risk**

Our study is among the first to demonstrate empirically in a conjoint manner that perceived control is indeed associated with key markers of functional health and cardio-metabolic risk. In line with Roepke and Grant’s (2011) review, our findings strengthen notions that perceived control facilitates positive health through systems or processes that represent functional health and cardio-metabolic health. Our findings obtained from a nation-wide sample of older adults are similar to and extend previous research on earlier phases of the life span, on caregivers, patient populations, and convenience samples that found control was associated with better functional health and protective against cardio-metabolic risk (Gale et al., 2008; Nabors et al., 2010; Roepke et al., 2011). In our view, the effect size of such associations is not negligible, but striking. For example, results from Model 1 in Table 2 indicate that a 1 SD increase in control is associated with 2.5 fewer years of aging on grip strength, 10 fewer years of aging for hemoglobin A1C, 14.5 fewer years of aging for HDL-C, 3.7 fewer years of aging for pulse rate, and 5.75 fewer years of aging for waist circumference. In a similar vein, Al Snih, Markides, Ray, Ostir, and Goodwin (2002) reported that a 1 kg increase in grip strength reduces the risk of mortality by 3%. In our study, a one-unit increase in perceived control on a scale from 1 to 6 was associated with a 0.95 kg increase in grip strength. Following those numbers, this increase in perceived control translates via grip strength into a reduction of mortality risk by almost 3%. We also note that our findings extend the previous literature through utilization of the nation-wide HRS that permits our results to be generalized to the larger adult population in the US. Additionally, we did not solely focus on one indicator, but in the case of cardio-metabolic risk included a total of five key factors to index this multidimensional physiological component.

Our findings complement studies done in experimental settings and panel surveys focusing on immune and endocrine systems. Specifically, we corroborate laboratory- or experimentally-based findings linking facets of control to markers of stress (Bollini et al., 2004) using a nation-wide sample. In a similar vein, earlier studies have primarily linked aspects of well-being or certain coping strategies to various interrelated physiological systems or processes (Friedman, Hayney, & Love, 2007; Steptoe, Wardle, & Marmot, 2005). With perceived control, we have linked yet another psychosocial indicator to pivotal markers of functional health and cardio-metabolic risk. Of note is that those psychosocial indicators are often modifiable. For example, community health and intervention programs with a joint focus on modifying perceptions of control, acquiring new skills and behaviors, and setting realistic expectations are shown to be effective for improving health profiles (Lachman et al., 1997).

**The Mediating Role of Physical Activity**

Our second set of analyses revealed that the above associations between perceived control and functional and physiological indicators were largely mediated through physical activity. Perceived control appears to operate by mobilizing individuals to be more physically active, perform strenuous exercise, and be involved with leisure activities, subsequently resulting in better maintained functional health and lower cardio-metabolic risk (Lachman, 2006; Rodin, 1986). Perceptions of control provide individuals with motivations and means to engage in more health salutary behaviors, as well as with attitudes and beliefs of contingency that behaviors will lead to desired outcomes (Bandura, 2004; Lachman et al., 1997). Similar to above, from our mediation analyses (Model 2 in Table 2), we can quantify the indirect effect of physical activity. For example, every 1 SD increase in control is
accounted for indirectly through physical activity for .59 fewer years of aging on grip strength (or 24% of 2.5 years), 9.5 fewer years of aging for hemoglobin A1C (or 95% of 10 years), 8.8 fewer years of aging for HDL-C (or 61% of 14.5 years), .81 fewer years of aging for pulse rate (or 22% of 3.7 years), and 5.6 fewer years of aging for waist circumference (97% of 5.75 years). As delineated in the seminal work by Bandura (1997), health and other central outcomes are predicated by social–cognitive and behavior processes. For example, if one acknowledges that physical activity will most likely lead to a positive health profile (outcome expectations), but one does not believe to be personally capable of engaging in such behaviors (efficacy expectations), his or her efforts for a healthy profile would not be fruitful. Additionally, if people believe that their health is largely fixed rather than dynamic and modifiable, they are unlikely to have the motivational resources to engage in health-promoting behaviors, such as physical activity or eating a balanced diet, resulting in a poorer health profile.

Several pathways may underlie the supposed salutary effects of physical activity on functional health and cardio-metabolic risk. First, regularly exercising or partaking in moderate activities increases muscle strength and provides for intrinsic vitality and better functional health (Brach et al., 2003; Rantanen et al., 1999). Second, physical activity and exercise are known to suppress glucose production and promote antioxidant functioning (Selvin et al., 2010). Lastly, a byproduct of physical activity is a reduction in adipose tissue and body mass or fat, which promotes pre HDL production and reverse cholesterol transport (resulting in higher HDL–C levels) and protects against atherogenesis (Penedo & Dahn, 2005; Thompson et al., 2003). In sum, our findings are consistent with notions suggesting that perceived control facilitates positive health through physical activity and physiological indicators that more broadly represent functional health and cardio-metabolic risk. As a consequence, lower perceived control alters one’s behavioral and physiological functioning, probably leading to increased vulnerability to disability, diseases, and subsequent mortality. We also observed that control was linked to higher SBP and this effect was not mediated through physical activity. One possible reason may be that resting state (as opposed to more dynamic assessments) may be a suboptimal operational definition to examine control-SBP associations. For example, control is shown to buffer increases in SBP during times of acute stress, such as in experimental settings or in people who experience chronic stress, such as caregivers (Roepke & Grant, 2011).

Health Implications of Perceived Control

The health demographics of the United States bespeak to further understanding the risk and protective factors, along with the underlying mechanisms implicated in disability, disease, and mortality processes. Our objective was to examine how control is directly and indirectly associated with some of the functional and physiological health indicators that may accumulate and in the long-run contribute to key health outcomes. Perceived control represents a protective factor for health outcomes because it represents a health-promoting, modifiable factor that can be subjected to targeted intervention and infrastructure programs (Bandura, 2004; Lachman & Agrigoroaei, 2010). Programs that focus on one’s attitudes, beliefs, and motivations regarding life circumstances can help individuals to feel competent and motivated to engage in physical activity aimed at improving physiological and overall health profiles (Bandura, 2004; Estabrooks et al., 2011; Lachman et al., 1997). At a more general level, programs that are aimed at strengthening control (or mental capital) have the possibility to reduce accrued societal, family, and individual burdens (Beddington et al., 2008; Rae et al., 2010). To inform the design and implementation of effective intervention programs, future research is needed to more thoroughly examine possible moderators of control-health associations (e.g., potential for control; Heckhausen, Wrosch, & Schulz, 2010). For example, perceiving high control in situations where control potential is low often results in negative outcomes (e.g., poorer subjective well-being, increased likelihood of mortality), whereas low perceived control in a low control potential situation can have positive effects (Hall, Chipperfield, Heckhausen, & Perry, 2010).

Limitations and Conclusion

In closing, we highlight several limitations of our study. First, our study is cross-sectional making it impossible to draw inferences regarding directionality (for discussion, see Lindenberger, von Oertzen, Ghisletta, & Hertzog, 2011). As opposed to the direction examined here, more physical activity and better physiological functioning may in turn improve one’s ability to complete everyday activities thereby enhancing and enlarging people’s perceived control. If longitudinal data were available, future studies may be able to employ latent change score models (Ferrer & McArdle, 2010; Gerstorf, Lövdén, Röcke, Smith, & Lindenberger, 2007) and examine multidirectional dynamics between control, physical activity, and physiological functioning. Second, our measure of physical activity was broad, and we were unable to directly test the frequency of specific activities individuals participated in (Levine et al., 1999; McAuley, 1993). It will be instructive to incorporate more specific indices of physical activity that assess both duration and calories burned to enable more direct specification of the types of physical activities that are most beneficial. Third, effect sizes observed in our study were small, probably reflecting the fact that our measures of physiological indicators were objective and performance-based, resulting in smaller shared variance than what is typically observed between two self-rated indices (Spiro & Brady, 2008). We note, however, that calculating an effect size metric in mediation analyses has been a recent endeavor, and more work is clearly needed to better understand the properties of the approach applied here (Preacher & Kelley, 2011). Finally, conceptual frameworks of control and empirical research indicate that perceived control facilitates positive health through various pathways. Indicators that should be targeted in future studies as mechanisms that underlie associations between control and health include emotion regulation (Kiecolt-Glaser, McGuire, Robles, & Glaser, 2002), stress-buffering properties (Hay & Diehl, 2010; Neupert, Almeida, & Charles, 2007), and direct modulation of immune and neuroendocrine functioning (Bosch, Fischer, & Fischer, 2009; Roepke et al., 2011). As of now, it is an open question whether high perceived control serves as a protective factor against poor physiological functioning, whether reduced perceived control may act as a risk factor for impaired physiological functioning, or whether both mechanisms are operating at the same time.
Taken together, our study examined how perceived control relates to markers of functional and physiological health that may underlie control-health associations. Our results underscore the importance and facilitative nature of perceived control for better health in adulthood and old age. We found that perceiving more control is associated with better functional health and lower cardio-metabolic risk, and one way control relates to these systems is via physical activity. Our findings provide empirical evidence for conceptual frameworks of control that detail how behavioral and physiological functioning underlie control-health associations (Bandura, 1997; Lachman, 2006; Rodin, 1986; Uchino, 2006). We take our results to provide impetus for future studies to examine biomarkers as pathways linking psychosocial indicators to health outcomes (Steptoe, 2011), which will allow for thoroughly examining processes involved in linking psychosocial indicators to key health outcomes in adulthood and old age.

References


CONTROL. FUNCTIONAL HEALTH, AND CARDIO-METABOLIC RISK


Received October 10, 2011
Revision received May 23, 2012
Accepted June 15, 2012