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A brief measure to predict exercise behavior: the Archer-Garcia Ratio

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Abstract

Background: Different forms of conscious and planned physical exercise and activity that individuals perform improve not only physical but also psychological health, well-being, and both physical and intellectual performance. Here we put forward and test the predictive validity of the Archer-Garcia Ratio, a brief measure for exercise frequency computed using participants' responses to two questions.

Method: The participants ($N = 158$) were recruited from a training facility in the south of Sweden. The Archer-Garcia Ratio was constructed by standardizing (i.e., z-scores) and then summarizing individuals' responses to two questions: "How often do you exercise?" (1 = *never*, 5 = *5 times/week or more*) and "Estimate the level of effort when you exercise" (1 = *none or very low*, 10 = *very high*). Participants responded also to the Godin Leisure-Time Exercise Questionnaire and allowed the collection of electronic data to track the number of times they had trained six months before and both six and twelve months after the survey.

Results: The Archer-Garcia Ratio predicted, moderately, how often individuals had trained during the six months before and both six months and twelve months after the survey.

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Conclusion: The Archer-Garcia Ratio is a brief and valid self-report measure that can be used to predict actual retrospective and prospective exercise behavior. It offers a simple and straightforward form to estimate adherence, compliance and propensities of peoples' exercise habits.

Keywords: Medicine, Clinical psychology, Psychology

1. Introduction

The estimation of physical exercise adherence, compliance, and propensity is measurable through various automated, non-automated, and self-report instruments (e.g., accelerometer-based activity performance adherence). These measures are used to assess the health-promoting effects of physical activity interventions (Evenson et al., 2015). This line of research has shown that individuals who adhere to different forms of conscious and planned physical exercise do not only improve their physical health and performance, but also psychological health, well-being, and intellectual performance (Archer and Garcia, 2014; Garcia et al., 2012). Among the elderly, for example, regular physical exercise with sufficient degree of physical effort and energy expenditure, serve as a proactive and prevention buffer against symptoms and biomarkers for several neurodegenerative and psychiatric disorders (Archer, 2012; Archer and Kostrzewa, 2015; Archer and Kostrzewa, 2016; Archer et al., 2014; Garcia and Archer, 2014).

There remains a lack of short, 'easy-to-apply', and valid self-rated measures of physical activity (Al Sayah et al., 2016; Dinh et al., 2016; Fitzgerald et al., 2015; Giggins et al., 2016; Kraal et al., 2014; Piotrowicz et al., 2015; Rathleff et al., 2015). We developed two questions, that combined we call the Archer-Garcia Ratio, to capture information pertaining to individuals' propensity, compliance, and persistence to maintain regular physical exercise, as well as effort level. These two simple items allow respondents to express an estimation of the frequency and intensity of their exercise or physical activity. These two questions have been shown to be related to the experience of high levels of positive affect, low levels of negative affect (e.g., Garcia and Archer, 2016) and high academic performance (e.g., Garcia et al., 2015). However, the validity of the Archer-Garcia Ratio's predictive value in relation to actual behaviour has not been tested. In previous studies, it has only been assumed that self-reported frequency and intensity of physical exercise is positivity related to actual exercise behaviour.

Hence, in the present study, we address the concurrent validity of the Archer-Garcia Ratio by comparing the Ratio's predictive value with those of another already well-established reliable and valid measure for exercise behaviour, namely, the Godin-Shepard Leisure-Time Physical Activity Questionnaire. This is an instrument that is often applied as a screening tool to provide estimations of weekly exercise exertion, it assesses strenuous intensity exercise involvement, and it has

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been shown to be strongly related to objective measures of physical activity and fitness in health studies (e.g., Motl et al., 2013). Hence, we found it as an appropriate and good standard measure to which we could compare the Archer-Garcia Ratio. In this study we investigated the concurrent validity (comparing to the Godin-Shepard Leisure-Time Physical Activity Questionnaire) and predictive validity (comparing to participants' gym attendance) of the Archer-Garcia Ratio.

2. Methods

2.1. Ethical statement

After consulting with the University of Gothenburg's Network for Empowerment and Well-Being's Review Board and according to law (2003: 460, section 2) concerning the ethical research involving humans we arrived at the conclusion that the design of the present study (e.g., all participants' data were anonymous and will not be used for commercial or other non-scientific purposes) required only verbal consent from participants.

2.2. Participants and data collection

The participants ($N = 158$) were recruited at a private training facility in the south of Sweden (an urban mid-sized city) and received a link to their email addresses that asked them to answer the survey online. The test survey was administered in Swedish. All participants received a cinema ticket for their collaboration. A total of 129 (42 males, 87 females) individuals answered all the questions (i.e., 82% response rate). Besides responding to a battery of self-reports, all participants were asked to provide their gym membership number in order to track their training frequency six months before (i.e., retrospective exercise frequency) and twelve months after (i.e., prospective exercise frequency) they answered the survey questions (111 participants provided this information). Participants were informed that their participation was voluntary and confidential.

2.3. Measures

2.3.1. Exercise frequency

The number of times each participant was at the training facility for the six months before the survey and the coming six and twelve months was recorded by an electronic entry system. This information was linked to the participants' gym membership number.

2.3.2. The Archer-Garcia Ratio

The ratio was constructed by standardizing (i.e., *z-scores*) and then summarizing individuals' responses to two questions about exercise habits with regard to

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frequency ("How often do you exercise?"; Likert scale: 1 = *never*, 5 = *5 times/week or more*) and intensity ("Estimate the level of effort when you exercise"; Likert-type scale: 1 = *none or very low*, 10 = ve*ry high*).

2.3.3. The Godin-Shepard Leisure-time physical activity questionnaire (Godin and Shephard, 1985)

This questionnaire is one of the most popular for assessment of self-reported leisure-time physical activity. Participants are asked to report weekly frequencies of strenuous, moderate, and mild activities. The total weekly leisure activity score is computed by summing the products of the separate components, as shown in the following formula: Weekly leisure-time activity score = (9 × Strenuous) + (5 × Moderate) + (3 × Mild). As a separate question, participants are asked to estimate how often (1 = *often*, 3 = *never/barely*) in a 7-day period they engage in any regular activity long enough to work up a sweat (heart beats rapidly). For the analysis, participants' answers to this question were reversed for simplicity reasons.

2.4. Statistical analysis

A principal components analysis, with oblimin rotation (cf. Osborne and Costello, 2009), suggested that a single primary factor accounted for at least 70.94% of the variance in the Archer-Garcia Ratio; hence, supporting the calculation of the Ratio by standardizing the two questions (see Oneal et al., 2016). Spearman's rho correlation coefficient was calculated to evaluate the relationship between exercise frequency, the Archer-Garcia Ratio, the weekly leisure-time activity score, and the extra item in the Godin-Shepard Leisure-Time Questionnaire. In order to predict retrospective and prospective exercise frequency (cf. Motl et al., 2005), we conducted three linear regression analyses (one for retrospective six months, one for prospective six months, and one for prospective twelve months) using as independent variables the Archer-Garcia Ratio, the weekly leisure-time activity score and the extra item in the Godin-Shepard Leisure-Time Questionnaire (i.e., Considering a 7-day period, during your leisure-time, how often do you engage in any regular activity long enough to work up a sweat (heart beats rapidly)?).

3. Results

Table 1 shows that there was a moderate positive correlation among exercise frequency, the Archer-Garcia Ratio and the extra item of the Godin-Shepard Leisure-Time Questionnaire. No significant relationships were found between exercise frequency and the weekly leisure-time activity score. In other words, both the Archer-Garcia Ratio and the extra item of the Goding-Shepard Questionnaire

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Table 1. Correlation coefficient among the Archer-Garcia Ratio, the weekly leisure-time activity score, the extra item in the Godin-Shepard Leisure-Time Questionnaire, and both retrospective (six months before self-report) and prospective (six months and twelve months after self-report) objective training frequency.

	1	2	3	4	5	6
(1) The Archer-Garcia Ratio	-					
(2) Weekly Leisure-Time Activity Score	.23*	-				
(3) Extra Item in Godin-Shepard Leisure-Time	.45**	.38	-			
(4) Retrospective Six Months Exercise Frequency	.34***	.08	.29***	-		
(5) Prospective Six Months Exercise Frequency	.24**	.11	.26**	.75***	-	
(6) Prospective Twelve Months Exercise Frequency	.24**	.05	.23**	.78***	.93***	-
Means and standard deviations (±)	11.40 ± 1.60	42.13 ± 21.40	1.42 ± 0.58	31.99 ± 29.85	23.32 ± 22.98	45.59 ± 45.86

Note: $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$.

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offer effective measures of individuals' actual training propensity, compliance, and frequency (see Table 1).

The first regression showed that the model (i.e., Archer-Garcia Ratio, weekly leisure-time activity score, and the extra item of the Godin-Shepard Leisure-Time Questionnaire) predicted individuals' exercise frequency during the six months before they responded to the survey (i.e., retrospective exercise frequency): $F_{(3,109)} = 9.34$, $R_{adj}^2 = .18$, $p < .001$. Whereas the Archer-Garcia Ratio was a significant predictor ($\beta = .33$, $t = 3.31$, $p < .001$, 95% CI [2.23, 8.86]), neither the weekly leisure-time activity score ($\beta = .03$, $t = 0.33$, $p = .739$, 95% CI [-0.19, 0.27]) nor the extra item of the Godin-Shepard Questionnaire ($\beta = .17$, $t = 1.62$, $p = .109$, 95% CI [-19.03, 1.93]) were significant predictors of participants' six months retrospective exercise frequency.

The second regression showed that the model predicted individuals' exercise frequency during the six months after they responded to the survey (i.e., prospective exercise frequency): $F_{(3,108)} = 7.06$, *Adjusted* $r^2 = .14$, $p < .001$. While the Archer-Garcia Ratio was a significant predictor ($\beta = .26$, $t = 2.52$, $p < .05$, 95% CI [0.81, 6.83]), neither the weekly leisure-time activity score ($\beta = .09$, $t = 0.91$, $p = .363$, 95% CI [-0.11, 0.31]) nor the extra item of the Godin-Shepard Questionnaire ($\beta = .17$, $t = 1.56$, $p = .122$, 95% CI [-17.05, 2.04]) were significant predictors of participants' six months prospective exercise frequency.

The third regression showed that the model predicted individuals' exercise frequency during the twelve months after they responded to the survey (i.e., prospective exercise frequency): $F_{(3,108)} = 5.93$, $R_{adj}^2 = .12$, $p < .001$. While the Archer-Garcia Ratio was a significant predictor ($\beta = .23$, $t = 2.23$, $p < .05$, 95% CI [0.74, 12.51]), neither the weekly leisure-time activity score ($\beta = .04$, $t = 0.38$, $p = .705$, 95% CI [-0.33, 0.49]) nor the extra item of the Godin-Shepard Questionnaire ($\beta = .19$, $t = 1.68$, $p = .098$, 95% CI [-34.35, 2.96]) were significant predictors of participants' twelve months prospective exercise frequency.

4. Discussion

The persistent requirement for physical exercise, which provides a unique non-pharmacologic, non-invasive intervention that incorporates different regimes, whether dynamic or static, endurance, or resistance, cannot be overstated. In an earlier study (Garcia and Archer, 2014), performed on a combined adolescent and adult population, we found that the propensity and compliance for exercise, measured as the Archer-Garcia Ratio, predicted high levels of positive affect; this result was a further indication that regular and intensive exercise was associated with indicators of well-being. Nevertheless, the Archer-Garcia Ratio has until today only been assumed to measure actual physical exercise behaviour. The aim of the present study was to investigate concurrent validity (comparing to the

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Godin-Shepard Leisure-Time Physical Activity Questionnaire) and predictive validity (comparing to participants' gym attendance) of the Archer-Garcia Ratio. Although more studies need to be conducted, the Archer-Garcia Ratio seems to offer a brief, easily-to-apply, and valid self-report measure that renders concurrent and predictive validity for the prediction of actual retrospective and prospective exercise behavior. The results are indeed encouraging, but it ought to be noted that the predictive/retrospective effects are quite limited (correlations between .24 and .34).

4.1. Limitations and future research

Even if we had a longitudinal design expanding to 18 months of data (six months before self-report and 12 months after self-report), it is important to point out that we had a relatively small sample size and with an overrepresentation of females. Also, we measured gym attendance, which is not the same as actual exercise behaviour. In addition, the two questions used to construct the Archer-Garcia Ratio need to be scrutinized in different samples, especially different cultures and languages (e.g., Garcia et al., 2012). For instance, these two items were developed with different scales (5-point and 10-point). Although we standardized the answers before constructing the Archer-Garcia Ratio, the rationale behind using different scales for the items needs further development and discussion.

5. Conclusion

Despite its reliance upon only two self-report items within a health background questionnaire, the Archer-Garcia Ratio presented a moderately strong prediction of individuals' exercise frequency. In short, the Archer-Garcia ratio presents a relatively simple and straightforward instrument for estimating individuals' adherence, compliance, and propensities to exercise.

"Give me a lever long enough and a fulcrum on which to place it,

and I shall move the world."

Archimedes

Declarations

Author contribution statement

Danilo Garcia: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Wrote the paper.

Thiago Medeiros da Costa Daniele: Analyzed and interpreted the data; Wrote the paper.

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Trevor Archer: Wrote the paper.

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Competing interest statement

The authors declare the following conflicts of interest: Danilo Garcia is the Director of the Blekinge Center of Competence, which is the Blekinge County Council's research and development unit. The Center works on innovations in public health and practice through interdisciplinary scientific research, person-centered methods, community projects, and the dissemination of knowledge in order to increase the quality of life of the habitants of the county of Blekinge, Sweden. He is also an Associate Professor at the University of Gothenburg and together with Professor Trevor Archer and Associate Professor Max Rapp Ricciardi, the leading researcher of the Network for Empowerment and Well-Being. Mr. Thiago Medeiros da Costa Daniele is a researcher and member of the Network for Empowerment and Well-Being.

Additional information

The raw data is available upon request to the Network for Empowerment and Well-Being, lead researcher Danilo Garcia: http://ltblekinge.se/Forskning-och-utveckling/Blekinge-kompetenscentrum/Summary-in-English/

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