

INTRODUCTION

CrossFit, which has really become a major exercise trend in the West, claims to be based on an evolutionarily informed approach to movement and exercise (see Glassman, 2010; Platek et al., 2011). The basic rationale is essentially this: In modern, post-Agrarian conditions, people have the opportunities to exercise very little compared to the rates of exercise that would have necessarily characterized our pre-agrarian ancestors. In the Pleistocene, it was necessary for our ancestors to be physically active on a daily basis and the human body evolved in this context.

Modern humans in Westernized societies have developed various exercise regimens in an effort to compensate for the fact that our modern environments are highly mismatched from ancestral environments when it comes to required physical activity (see Platek et al., 2011; Geher, 2014). It is clear that at some point, people in Westernized societies came to figure out that a life without physical exercise is an unhealthy life (see Stapell, in press). This trend has substantial implications for human health, as high levels of exercise are famously associated with all kind of positive health outcomes (see Woodcock, 2011). For centuries now, humans in Westernized contexts have created planned, structured, and organized exercise regimens to address both cardiovascular and muscular-developmental issues.

Two Different Approaches to Fitness Workouts

The current research explores differences between a typical Gold's Gym work out compared with a typical CrossFit workout. These two classes of fitness regimens, which both seek to appeal to members of the general population, represent two different approaches to working out.

These two protocols differ from one another in terms of the basic equipment used as well as the amenities offered. Gold's Gym represents what might be considered a standard modern kind of workout, including various machine-based weight activities, cardiovascular equipment (e.g., the treadmill), and group fitness classes (see Andreasson & Johansson, 2014).

Relevant to the current project, the basic philosophy underlying Gold's has nothing to do with an evolutionary approach to health. In fact, this is not surprising – research into the world of healthcare has found generally that those in healthcare professions fully neglect the importance of evolution in designing healthcare practices in modern contexts (see Nesse & Williams, 1995). Nutritionists, medical doctors, dentists, etc., famously do their work without an evolutionarily informed approach. It only makes sense that many of those who design exercise regimens in modern contexts would similarly neglect evolutionary factors in their work.

With the advent of the modern field of evolutionary studies, which seeks to apply evolutionary principles broadly across domains of the human experience (see Wilson, Geher, Head, & Gallup, in press), there have been some major efforts to evolutionize the fields of nutrition and exercise (e.g., Wolf, 2010). CrossFit was developed with this kind of evolutionary thinking in mind. A CrossFit workout is designed in an effort to replicate the kinds of movements and activities that would have, hypothetically, been common among our pre-agrarian ancestors. Such activities, that are common in a CrossFit workout, include full-body bodyweight exercises (such as squats and pushups, which use one's bodyweight as a conditioning tool) as well as combinations of high-intensity sprints and lifting, in an effort to

replicate ancestral physical patterns. The basic philosophy of CrossFit, as well as the implementation, differ markedly from what is found with Gold's Gym.

The issue of whether CrossFit truly matches ancestral health regimens is a hotly contested issue (see Claudio et al., 2018). This question is, of course, important in its own right. This said, the current research does not get into the issue of whether CrossFit truly matches an ancestral approach to exercise. Rather, this work focuses more specifically on the psychological outcomes associated with CrossFit.

Psychological Factors Associated with Exercise

The psychology underlying exercise often focuses on motivational theories, with the primary such theory in this realm being Self-Determination Theory. This conception of human motivation may be helpful in understanding the predictions of this research and the proximate mechanisms for the success of CrossFit. Self-determination theory, originally conceptualized by Deci and Ryan (2002), has been increasingly utilized to understand motivation and persistence with regard to exercise programs (Thøgersen-Ntoumani & Ntoumanis, 2006). Self-determination theory proposes three variations of motivation: *amotivation*, *extrinsic motivation*, and *intrinsic motivation*. Each type of motivation varies by the degree of internalization of external goals. Amotivation refers to the individual holding no value in the outcome of the activity and not seeing a direct link in his or her behavior and the subsequent outcome. An individual would be considered to have extrinsic motivation if his or her behavior is propelled by outward goals such as body image, and intrinsically motivated if the link between behavior and outcome was guided by internal satisfaction such as feeling accomplished. It is possible that the source or type of motivation that the individual experiences may play a part in the initial choice in a fitness facility as well as ancillary decisions such as maintaining attendance and adhering to a training program. Thus, it may be that Gold's Gym members and CrossFit members choose these respective facilities based on different motivations.

Another basic set of psychological attributes relevant to exercise is found in basic personality traits. Among these, the "Big Five" traits (openness, extraversion, emotional stability, agreeableness, and conscientiousness) have all been explored in terms of their roles in exercise regimens. In a large-scale meta-analysis on this relationship, based on more than 100,000 participants, Sutin et al. (2016) found consistent effects of emotional stability, conscientiousness, extraversion and openness – each of which was found to be positively related to the amount of exercise that someone gets. In our study, we included a measure of these traits to see if we could replicate this general finding to add to a more comprehensive portrait of the psychology surrounding exercise. We also use our measures of these traits to see if any differences in basic personality traits were found between Gold's Gym and CrossFit users.

Past Research on Psychological Outcomes Associated with CrossFit

Like many exercise regimens, CrossFit seeks to develop people in a holistic manner, trying to cultivate both physical and psychological health. In a recent meta-analysis on the benefits of CrossFit, Claudio et al. (2018) found mixed results regarding the overall efficacy of CrossFit, particularly in regard to physical outcomes. This said, Claudio et al. (2018) do acknowledge that several individual studies have found various psychological benefits of CrossFit.

Among the findings on this topic, are studies showing that CrossFit helps to facilitate strong motivation and adherence among participants (Heinrich et al., 2014; Partridge et al., 2014;

Fisher et al., 2016). Further, several studies have shown small but significant effects for improved emotional functioning in certain populations. For instance, Heinrich et al. (2015) found evidence for improved emotional functioning in cancer survivors while Eather et al. (2016) found evidence for improved mental health functioning in troubled teens resulting from the CrossFit experience. Further, several studies have found that CrossFit succeeds in facilitating a strong perceived sense of community (e.g., Pickett et al., 2016; Whiteman et al. (2016).

It must be noted, however, that some studies have failed to find positive psychological effects for CrossFit. For instance, a study by Koteles et al. (2016) found no positive effects of CrossFit on such outcomes as body self-esteem. Also, Lichtenstein et al. (2016) actually found evidence showing that CrossFit often leads to unhealthy patterns of exercise addiction coupled with relatively negative attitudes toward exercise.

Predictions

The primary goal of this study was to quantitatively compare those participants who attend an evolutionarily informed facility with those who attend a mainstream facility (specifically CrossFit and Gold's Gym respectively). This investigation aimed to address the following predictions:

1. CrossFit participants were predicted to show relatively strong regimen adherence
2. CrossFit participants were predicted to show higher levels of intrinsic motivation
3. CrossFit participants were predicted to demonstrate report relatively positively on features of their physical and mental health.

In short, this study examined if the CrossFit experience, theoretically rooted in an evolutionary approach to exercise, truly leads to stronger outcomes across the board compared with the more typical and traditional Gold's Gym experience.

METHOD

Study Design

This study had two basic goals. First, we sought to investigate the potential differences in motivation between people who select either Gold's or CrossFit. Second, we sought to investigate the perceived health-related and psychological differences that exist between Gold's and CrossFit members.

This study was cross-sectional (between-groups) in nature. Participants across the two groups were compared in terms of age, gender, income, and length of gym membership. After ensuring that the samples were equivalent in terms of these variables, this study measured the degree to which demographics, personality traits, and source of motivation for a physical exercise program were predicted by the type of gym someone attends. The questions and established measures used for this study were specifically chosen for appropriateness to explore participants' considerations for choosing a fitness program, motivations/feelings about exercise, types of activities engaged in, dietary choices, lifestyle habits, and body image.

Participants

One hundred eighty eight participants: 76 male, 112 female; 69 Gold's Gym members, and 119 CrossFit members completed the online survey. All subjects met the following criteria in

order to participate: They were 18 years of age or older, understood English, and were current members of either Gold's Gym or CrossFit.

Measures

Background questions addressed the participants' current geographical location (country and/or state in which they live) and location of the gym at which they are currently a member. The first grouping variable in this study was the classification of "novice" (≤ 6 months), "intermediate" (> 6 months but ≤ 12 months), or "advanced" (> 12 months). Note that these durations are based on the amount of time that participants have been enrolled in their current fitness program. A second grouping variable was the type of gym the participant attends. The outcome/dependent variables measured included frequency of gym attendance, current training (workout) programs, perceptions of health and fitness, dietary choices, and achievement of fitness-related goals, along with objective markers of fitness such as BMI and number of sick days. Other scales included the Exercise Regulations Questionnaire (BREQ-2) (Markland, 2000), Exercise Motivation Inventory (EMI-2) (Markland, 1997), Exercise Feelings Questionnaire (GOEM) (Markland, n.d.), and Gosling's Ten Item Personality Inventory (TIPI) for measuring personality (Gosling, Rentfrow & Swann Jr., 2003).

The Exercise Regulations Questionnaire (BREQ-2) (Markland, 2000), is a 19-item measure of individuals underlying decisions to engage, or not engage in exercise. This scale specifically addresses source of motivation. The BREQ-2 is a Likert-type scale from 0 to 4, where 0 = not true for me, 2 = sometimes true for me, and 4 = very true for me. Examples of questions on the BREQ-2 are "I feel ashamed when I miss an exercise session", and "I take part in exercise because my friends/family/partner say I should." The Cronbach Alpha coefficients have been determined to be in the range of .53-.90 (Markland & Tobin, 2004).

The Exercise Motivation Inventory (EMI-2) (Markland, 1997), is a 51-item measure that addresses degree of intrinsic or extrinsic motivation specifically as it is related to beginning and continuing an exercise regimen. This is a Likert-type scale with anchors from 0 to 5, where 0 = not at all true for me and 5 = very true for me. Examples of questions on the EMI are "personally, I exercise (or might exercise) to look more attractive," and "personally, I exercise (or might exercise) to give me personal challenges to face." Cronbach Alpha coefficients for the subscales have been determined to be in the range of .59-.88 (Markland & Hardy, 1993).

The Exercise Feelings questionnaire (GOEM) (Markland, n.d.), is a ten-item measure examining respondent's feelings regarding the outcomes of his or her physical activity/exercise, and how those feelings relate to how the participant views him/herself as compared to others. Responses are given on a Likert-type scale of 1 to 5 where 1 = strongly disagree and 5 = strongly agree. Examples of questions on the GOEM are "I achieve the exercise goal I set for myself," and "I know that I am more capable than other exercisers." Cronbach Alpha coefficients for the subscales have been determined to be in the range of .61-.86 (see Petherick & Markland, 2008).

The Ten-Item Personality Inventory (TIPI) (Gosling, Rentfrow, & Swann, 2003) is used to assess an individual's personality. It measures the Big 5 personality traits (openness, conscientiousness, extrovertedness, agreeableness, and neuroticism). This scale consists of a 7-point Likert-type scale where 1 = disagree strongly and 7 = agree strongly. Sample items include "I see myself as conventional, uncreative" and "I see myself as anxious, easily upset." The Cronbach alpha levels for the TIPI are 0.68, 0.40, 0.50, 0.73, and 0.45 for extroversion,

agreeableness, conscientiousness, emotional stability, and openness to experience scales respectively.

Procedures

Participants accessed the survey, containing quantitative scales in one session, on the website Qualtrics (Qualtrics.com). Participants were recruited via and directly to members of Gold's Gym and CrossFit. A link to the survey was also posted on health and fitness- related blogs and it was disseminated to various groups via Facebook. This survey took about 30 minutes to complete.

RESULTS

The analyses fundamentally addressed the issues of (a) demographic features of CrossFit versus Gold's members (to address the matched-samples concept), (b) differences in psychological variables between the two groups, (c) differences in physical health-related variables between the two groups, and (d) differences in gym-related behavior. Importantly, as many statistical tests were included herein, to account for Type-I Error using the Bonferonni correction, we only are reporting results that are significant at the $p < .001$ level.

Demographic Variables

Of the 188 participants, 69 were Gold's Gym members and 119 were CrossFit members. Overall, there were 76 males and 112 females. t-tests were performed to determine whether the participants in both the Gold's Gym group and the CrossFit group were equivalent in terms of certain demographic variables. The results show that the groups were equivalent in terms of age (Gold's Gym $M = 34$ years, CrossFit $M = 33$ years), gender (36% male, 64% female and 43% male, 57% female for Gold's Gym and CrossFit respectively), and income (Gold's Gym median range = \$70,000-\$79,999, CrossFit median range = \$80,000-\$89,999). Participants were also asked to report their length of membership at either CrossFit or Gold's Gym in months. The groups were matched in this domain as well (Gold's Gym $M = 24.27$, $SD = 34.11$, CrossFit $M = 18.00$, $SD = 15.18$). No significant differences were found between the two groups on any of these critical background variables. These findings imply that the Gold's Gym and CrossFit groups are reasonably well matched to one another.

Dispositional Differences across Groups

Between-groups t-tests performed showed no differences between Gold's Gym and CrossFit members on the Big Five personality scores, suggesting that the kinds of people across the two gym types were generally similar in terms of basic personality dimensions.

Additional between-group t-tests were also performed for the remaining psychological measurements (with the grouping variable being gym membership). When analyzing the BREQ-2, EMI-2, and GOEM scales, several differences in psychological variables across these groups emerged. These are summarized in Table 1.

Table 1: Means and Standard Deviations between the Two Groups across Various Psychological Variables

Gym Type			<i>t</i>	<i>df</i>
	Gold's	CrossFit		

Openness (TIPI)	10.64 (2.34)	11.16 (2.22)	1.43	168
Conscientiousness (TIPI)	11.62 (2.26)	11.51 (2.34)	0.30	168
Extroversion (TIPI)	9.64 (2.86)	9.25 (3.43)	0.22	168
Agreeableness (TIPI)	10.00 (2.21)	9.95 (2.37)	0.12	168
Emotional Stability (TIPI)	9.62 (3.36)	10.00 (2.63)	0.83	168
Amotivation (EMI-2)	3.29 (1.07)	3.16 (0.57)	1.00	157
External Regulation (EMI-2)	5.02 (2.23)	5.02 (1.84)	0.01	157
Introjected Regulation (BREQ-2)	8.93 (3.82)	8.91 (3.65)	0.03	157
Identified Regulation (BREQ-2)	17.63 (2.63)	18.81 (1.65)	3.05	157
Intrinsic Regulation (BREQ-2)	17.79 (3.15)	18.85 (2.03)	2.27	157

Table 1: Means between the Two Groups across Various Psychological Variables

Relative Autonomy Index (RAI) (EMI-2)	59.79 (17.39)	65.73 (12.76)	2.25	157
Stress Management (EMI-2)	3.90 (1.78)	4.00 (0.88)	0.55	151
Revitalization (EMI-2)	4.37 (0.77)	4.44 (0.65)	0.60	151
Enjoyment (GOEM)	4.28 (0.97)	4.57 (0.66)	1.94	151
Challenge (GOEM)	3.62 (1.11)	4.16 (0.71)	3.21	151
Social Recognition (GOEM)	2.30 (1.31)	3.00 (1.10)	3.42	150
Affiliation (GOEM)	2.60 (1.35)	3.60 (1.02)	4.63***	150
Competition (GOEM)	2.83 (1.41)	3.62 (1.23)	3.59***	150
Health Pressures (EMI-2)	2.42 (1.23)	2.30 (0.91)	0.61	149
Ill-Health Avoidance (EMI-2)	4.16 (0.94)	4.01 (0.85)	0.95	150
Positive Health (EMI-2)	4.63 (0.62)	4.65 (0.62)	0.16	151
Weight Management (EMI-2)	4.03 (1.06)	3.64 (1.67)	2.06	151

Table 1: Means between the Two Groups across Various Psychological Variables

Appearance (EMI-2)	3.96	3.97	0.01	151
--------------------	------	------	------	-----

	(0.89)	(0.93)		
Strength Endurance (EMI-2)	4.48	4.63	1.46	151
	(0.67)	(0.58)		
Nimbleness (EMI-2)	3.96	4.14	1.12	151
	(1.08)	(0.83)		
Task Orientation (BREQ-2)	4.38	4.58	1.99	146
	(0.63)	(0.46)		
Ego Orientation (GOEM)	1.94	2.15	1.12	146
	(0.98)	(1.09)		

Note: *** $p < .001$

Differences in Gym-Related Behaviors

Chi-squared tests were performed to determine likelihood of each group to consider certain factors when choosing a gym or fitness facility. The results show that CrossFitters were less likely to be concerned with the cost of membership as a factor in choosing a gym as compared to Gold's Gym members $X^2(1, N=188) = 22.75, p < .001$. Likewise, Gold's members were less likely to consider philosophy of the gym when joining, $X^2(1, N=188) = 62.55, p < .001$ as compared to CrossFit members. In both of these cases, the Chi Square test was a goodness-of-fit test.

It was found (via a marginal, $p < .01$, level of significance) that Gold's Gym members spent more time on cardiovascular endurance activities being greater for Gold's Gym members than for CrossFit members, ($M = 43.45, SD = 25.84$ and $M = 31.67, SD = 20.07, t(142) = 2.79, p < .01$). The CrossFitters, thus, exercise about 34% longer than do the members of Gold's. Between-group t-tests were performed to determine specifically what activities each group spent time on while in the gym. Next, several between-group t-tests were conducted to examine differences in time spent in particular modes of exercise. Table 2 shows that CrossFit members are more likely to spend time on plyometric exercises, interval training, weightlifting, and sport-specific training. The means correspond to the ratio (as continuous variables) of their workout dedicated to each particular mode of exercise.

Table 2: Means & Standard Deviations of Activities Engaged in while at the Gym

Gym Type			<i>t</i>	<i>df</i>
	Gold's	CrossFit		
Plyometric Exercises	0.21 (0.41)	0.59 (0.49)	5.70***	185
Interval Training	0.37 (0.49)	0.67 (0.47)	4.20***	185
Weightlifting	0.57 (0.50)	0.85 (0.36)	4.00***	185
Sport-specific Training	0.12 (0.33)	0.23 (0.42)	1.98	185

Notes: *** $p < .001$. Each scale here is based on the participant checking either "1" indicating that he or she engages in the activity, or "0" indicating that he or she does not engage in this activity. A higher mean thus corresponds to more participants engaging in that activity, on a scale of 0-1.

Further tests were performed to determine specific types of equipment used by members of each group while at the gym. Overall, the results show that Gold's Gym members were more likely to use modern fitness machines, while CrossFit members were more likely to use strength equipment. Significant results are summarized in Table 3.

Table 3: Means & Standard Deviations of Equipment Used while at the Gym

Gym Type			<i>t</i>	<i>df</i>
	Gold's	CrossFit		
Rower/Erg	0.12 (.45)	0.72 (0.33)	10.62***	185
Treadmill	0.67 (0.48)	0.08 (0.28)	9.14***	185
Stairmaster	0.34 (0.48)	0.03 (0.16)	5.25***	185
Step-Machine	0.24 (0.48)	0.03 (0.18)	3.71***	185
Stationary Bike	0.43 (0.50)	0.08 (0.27)	5.39***	185
Barbell	0.60 (0.49)	0.87 (0.34)	3.86***	182
Resistance Machine	0.28 (0.45)	0.02 (0.13)	4.55***	182
Pulley-Based Machine	0.48 (0.50)	0.03 (0.16)	7.05***	182
Smith Machine	0.22 (0.41)	0.00 (0.00)	4.19***	182
Kettlebells	0.22 (0.41)	0.80 (0.40)	9.29***	182
Strongman Equipment	0.03 (0.17)	0.40 (0.49)	7.44***	182

Notes: *** $p < .001$. Each scale here is based on the participant checking either "1" indicating that he or she engages in the activity, or "0" indicating that he or she does not engage in this

activity. A higher mean thus corresponds to more participants engaging in that activity, on a scale of 0-1.

As a whole, based on a between-groups t-test, there was no significant difference between Gold's Gym and CrossFit members in how often, in days per week, they attend the gym ($M = 4.95, SD = 1.61$ and $M = 5.41, SD = 1.50, t(160) = 1.832, p = .07$) respectively. Next, the groups were filtered by the following longevity classifications: novice (six months or less of membership), intermediate (greater than six, but less than or equal to 12 months of membership), and advanced (Greater than 12 months of membership). After grouping for longevity of membership, additional t-tests were run to determine if there were any differences in days per week of attendance at each level of longevity. The results show no difference. Results for the overall attendance and each level of longevity are summarized in Table 4.

Table 4: Means & Standard Deviations of Days per Week Attendance

Gym Type			<i>t</i>	<i>df</i>
	Gold's	CrossFit		
Overall (no longevity filter)	4.95 (1.61)	5.41 (1.49)	1.83	160
Novice (≤ 6 months)	4.53 (1.84)	5.26 (1.54)	1.37	38
Intermediate (>6 but <12 months)	4.14 (1.07)	5.70 (1.66)	2.35	35
Advanced (12 months+)	5.33 (1.49)	5.41 (1.15)	.27	82

To address the question of whether Gold's Gym and CrossFit members vary in days per week attendance over time within their respective groups, planned contrasts were performed. No significant results were found, suggesting that members in both groups tended to maintain a relative frequency of attendance across time, despite slight changes in mean days per week attendance.

Finally, chi-square analyses revealed differences in physical health-related exercise goals between the groups. Specifically, CrossFit members were more likely strive for increased sports performance, $X^2(1, N=188) = 16.05, p < .001$, as compared to Gold's members (via a Goodness-of-Fit test).

DISCUSSION

The study described here examines the differential psychological outcomes associated with a typical/traditional (Gold's Gym) exercise regimen compared with a regimen that claims to be evolutionarily informed (CrossFit). The samples across the two gym types were, interestingly, quite similar in terms of such important factors as socioeconomic status, age, and basic personality structure. This matched-groups approach allowed for an examination of whether the members of the two different kinds of gyms differed from one another for reasons that were disconnected from demographics and from basic personality dimensions.

In fact, consistent with the hypotheses, several important differences between the groups were obtained. In terms of motivation, CrossFitters were more likely than were those who attend Gold's Gym to demonstrate higher levels of identified regulation, suggesting that they see their exercise regimen as a strong part of their individual identities. They also are more likely to be motivated to experience challenge and to seek social recognition and affiliation connected with exercise. These findings make sense in light of the small-group context that surrounds the CrossFit experience.

The CrossFit experience is qualitatively different from the Gold's Gym experience in various important ways. The CrossFit experience is designed to try to map onto ancestral kinds of physical activities in a small-group social setting. This mindset, which corresponds to a general approach in the modern field of Darwinian medicine (see Nesse & Williams, 1995), seems to have, at the very least, helped motivate the CrossFitters in the current research using intrinsic rewards. Perhaps this is a key to the success of CrossFit.

In sum, the differences that did emerge between the two groups suggest that CrossFit is associated with more intrinsic motivation along with a focus on the social connections associated with working out.

Limitations

One conceptual problem with the current work is somewhat entrenched in all modern scholarship that focuses on evolutionary mismatch (see Zuk, 2013). On this point, conclusions from the current data need to be extrapolated to questions of the evolutionary relevance of CrossFit cautiously.

Further, this research utilized a quasi-experimental design. While we took strong steps to demonstrate that our samples were matched along several relevant demographic and dispositional dimensions, at the end of the day, this research did not include a true experimental manipulation and, as such, the full internal validity of this work is necessarily called into question. As such, we are not able to infer whether the differences in motivation levels across the groups were the result of being in the different fitness regimens or if they were, instead, the result of a priori differences among the people who chose one regiment or the other. Future research would benefit from utilizing an approach that includes random assignment to the different gyms.

Summary

The burgeoning interdisciplinary field of evolutionary studies (see Wilson et al., in press) has famously shown how an evolutionarily informed approach can help shed lights on a broad array of human issues (e.g., education, politics, warfare, mental health, art, and more). The current work takes a step toward advancing our understanding of how an evolutionarily informed approach to exercise may have key benefits over more traditional exercise regimens. While there are clearly some issues with construct validity vis a vis our use of CrossFit as a marker of an evolutionary approach to exercise, this research did uncover several apparent benefits associated with the use of CrossFit compared with Gold's Gym. We hope that this study serves as a significant early step in our understanding of the psychological, social, and physical outcomes associated with approaches to exercise that are framed in terms of evolutionary relevance.

References

- Andreasson, J., & Johansson, T. (2014). The Fitness Revolution: Historical Transformations in the Global Gym and Fitness Culture. *Sport Science Review, XXIII(3-4)*: 91-112.
- Claudino, J. G., Gabbett, T. J., Bourgeois, F., de Sa Souza, H., Miranda, R. C., Mezencio, B., Soncin, R., Filho, C. A. C., Bottaro, M., Hernandez, A. J., Amadio, A. C., & Sarrao, J. C. (2018). CrossFit Overview: Systematic Review and Meta-Analysis. *Sports Medicine – Open*. 4:11.
- Clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults: BMI Chart. *National Heart, Lung and Blood Institute*. Retrieved January 9, 2013 from <http://www.nhlbi.nih.gov/guidelines/obesity/>
- Deci, E. L., & Ryan, R. M. (2002). *Handbook of self-determination research*. Rochester, NY: University of Rochester Press.
- Eaton, S. B., & Eaton, S. (2003). An evolutionary perspective on human physical activity: implications for health. *Comparative Biochemistry and Physiology, 136 Part A*, 153-159.
- Eather N, Morgan PJ, Lubans DR. (2016). Effects of exercise on mental health outcomes in adolescents: findings from the CrossFit teens randomized controlled trial. *Psychol Sport Exerc*. 26:14.

- Fisher, J, Sales, A, Carlson, L, & Steele, J. (2016). A comparison of the motivational factors between CrossFit participants and other resistance exercise modalities: a pilot study. *J Sports Med Phys Fitness*. 9:1227
- Geher, G. (2014). *Evolutionary Psychology 101*. New York: Springer.
- Glassman G. (2010) What is CrossFit? CrossFit Level 1 Training Guide. *The CrossFit Journal*, 24.
- Gold's Gym: About. (n.d.) Retrieved January 9, 2013 from goldsgym.com.
- Gosling, S., Rentfrow, P., Swann Jr., W. (2003). A very brief measure of the big-five personality domains. *Journal of Research in Personality*, 37, 504-528
- Hardy, L., & Markland, D. (1993). The exercise motivations inventory: Preliminary development and validity of a measure of individuals' reasons for participation in regular physical exercise. *Personality and Individual Differences*, 15(3), 289-296.
- Heinrich KM, Patel PM, O'Neal, JL, & Heinrich, BS. (2014). High-intensity compared to moderate-intensity training for exercise initiation, enjoyment, adherence, and intentions: an intervention study. *BMC Public Health*. 14:789.
- Heinrich, KM, Becker, C, Carlisle, T, Gilmore, K, Hauser, J, Frye J, et al.(2015) High- intensity functional training improves functional movement and body composition among cancer survivors: a pilot study. *Eur J Cancer Care*. 24:812.
- How much physical activity do adults need? (n.d.). Retrieved November 30, 2012 from the CDC website: <http://www.cdc.gov/physicalactivity/everyone/guidelines/adults.html>
- Kötele, F, Kollsete, M, Kollsete, H, Köteles, F, Kollsete, M, Kollsete, H, et al.(2016). Psychological concomitants of CrossFit training: does more exercise really make your everyday psychological functioning better? *Kinesiology*.48:39.

- Markland, D. (1997, 2000). Exercise motivation measurement. http://pages.bangor.ac.uk/~pes004/exercise_motivation/scales.htm
- Markland, D., & Tobin, V. (2004). A modification to the Behavioural Regulation in Exercise Questionnaire to include an assessment of amotivation. *Journal of Sport and Exercise Psychology, 26*, 191-196.
- Markland, D., & Hardy, L. (n.d.). The exercise motivations inventory: Preliminary development and validity of a measure of individuals' reasons for participation in regular physical exercise. *Personality and Individual Differences, 15*(3), 289-296.
- Markland, D., & Tobin, V. (2004). A modification to the behavioural regulation in exercise questionnaire to include an assessment of amotivation. *Journal of Sport and Exercise Psychology, 26*, 191-196.
- Mullen, S., & Whaley, D. (2010). Age, gender, and fitness club membership: Factors related to initial involvement and sustained participation. *International Journal of Sport and Exercise Psychology, 8*(1), 24-35.
- Nesse, R. M., & Williams, G. C. (1995). *Why We Get Sick: The New Science of Darwinian Medicine*. New York: Times Books.
- Partridge, JA, Knapp, BA, & Massengale BD. (2014). An investigation of motivational variables in CrossFit facilities. *J Strength Cond Res. 28*:1714.
- Petherick, C., & Markland, D. (2008). The development of a goal orientation in exercise measure (GOEM). *Measurement in Physical Education and Exercise Science, 12*(2), 55-71.
- Pickett, AC, Goldsmith, A, Damon, Z, & Walker, M. (2016). The influence of sense of community on the perceived value of physical activity: a cross-context analysis. *Leis Sci. 38*:199.

- Platek, S. (2010). Moved to mate? *CrossFit Journal*. 1-6.
- Platek, S., Geher, G., Heywood, L., Stapell, H., Porter, J. R., & Walters, T. (2011). Walking the walk to teach the talk: implementing ancestral lifestyle strategies as the newest tool in evolutionary studies. *Evolution, Education, & Outreach*, 4, 41-51.
- Ryan, R., Frederick, C., Lepas, D., Rubio, N., & Sheldon, K. (1997). Intrinsic motivation and exercise adherence. *International Journal of Sport Psychology*, 28, 335-354.
- Sherwood, N., & Jeffery, R. (2000). The behavioral determinants of exercise: Implications for physical activity interventions. *Annual Reviews*, 20(21), 21-44.
- Stapell, H. M. (in press). Evolution and Human Health in Historical Context. In (Wilson, D. S., Geher, G., Head, H., & Gallup, A., Eds.) *Darwin's Roadmap to the Curriculum: Evolutionary Studies in Higher Education*. New York: Oxford University Press.
- Sutin, A. R., Stephan, Y., Luchetti, M., Artese, A., Oshio, A., & Terracciano, A. (2016). The Five-Factor Model of Personality and Physical Inactivity: A Meta-Analysis of 16 Samples. *Journal of Research in Personality*, 63, 22-28.
<http://doi.org/10.1016/j.jrp.2016.05.001>
- Thogersen-Ntoumani, C., & Ntoumanis, N. (2006). The role of self-determined motivation in the understanding of exercise-related behaviours, cognitions and physical self-evaluations. *Journal of Sports Sciences*, 24(4), 393-404.
- Wells, D. Adaption: period, persistence, and prioritization. (2010). Retrieved January 17, 2014 from the Starting Strength website:
http://startingstrength.com/index.php/site/article/adaptation_period_persistence_and_prioritization/P2#.Uw1NJIXEfbN

- Whiteman-Sandland J, Hawkins J, & Clayton D. (2016). The role of social capital and community belongingness for exercise adherence: an exploratory study of the CrossFit gym model. *J Health Psychol.* 1:1359105316664132.
- Wilson, D. S., Geher, G., Gallup, A. G., & Head, H. (in press). *Darwin's Roadmap to the Curriculum: Evolutionary Studies in Higher Education*. New York: Oxford University Press.
- Wolff, R. (2010). *The Paleo Solution*. Las Vegas, NV. Victory Belt Publishing.
- Woodcock, J., O.H. Franco, N. Orsini, & I. Roberts (2011). Non-vigorous physical activity and all-cause mortality: Systematic review and meta-analysis of cohort studies. *International Journal of Epidemiology*, 40, 121–38.
- Zuk, M. (2013). *Paleofantasy: What Evolution Really Tells us about Sex, Diet, and How we Live*. New York: Norton.