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Depression and fitness: the Portuguese-Brazilian version of the evolutionary fitness scale

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ABSTRACT

The concept of fitness is crucial to the study of human behavior from an evolutionary perspective. A proposed causal link between fitness-related problems and depression has been suggested. Measuring fitness in humans requires exploring behavioral components, such as mating, parental investment, social capital, and health-oriented actions. This study navigates the relationship between depression and fitness, exploring the validity of the Evolutionary Fitness Scale in the Brazilian context. A sample of 804 Brazilian participants completed the EFS online. Exploratory Factor Analysis suggested a 4-factor model. Internal consistency was good (partner $\alpha = 0.87$; health $\alpha = 0.80$; social capital $\alpha = 0.85$; offspring $\alpha = 0.74$). The EFS differentiated between nondepressed and depressed individuals based on PHQ-9 scores, with a large effect size for health ($d = 0.93$) and social capital ($d = 0.89$) dimensions, and a medium effect for partner ($d = 0.40$). However, the offspring subscale did not discriminate between depressed and nondepressed. In summary, we demonstrated that the EFS represents an efficient, reliable, and valid measure for assessing self-reported data on human fitness.

Fitness is a crucial construct in evolutionary theory that involves traits aiding survival and reproduction. Evolutionary biology defines it as successful gene transmission (Brandon, 1978). Fitness can be direct (aiding offspring) or indirect (benefiting kin), shaping an individual's inclusive fitness (West et al., 2011). Cooperation and altruism from kin or others, such as mate support, alloparenting, social assistance, and knowledge sharing, contribute to overall fitness (Aktipis et al., 2018). Although assessing fitness in humans is not straightforward, behavioral factors such as (1) mating, (2) parental investment, (3) social capital, and (4) health-oriented behaviors are deemed primary components of fitness in humans (Livingstone, 1983; Vining, 1986).

Mating is an essential dimension of fitness, as it is critical for successful reproduction (Buss, 2015). A study has examined the relationship between inclusive fitness and the willingness to help individuals find a mate, demonstrating that people prefer to assist others in finding a long-term mate over a short-term one, and they prefer to suggest kin as a potential mate rather than nonkin (Jonason et al., 2007). In addition, long-term mating correlated positively with parental investment, offspring, and grandchildren numbers, while short-term mating was marginally related to multiple partners and reduced parental investment (Mededović, 2022).

However, merely having children does not guarantee reproductive success if offspring do not survive to reproduce (Kanazawa & Savage, 2009). Parental investment refers to any actions taken by parents that increase the likelihood of their offspring's survival and reproduction, at the cost of investment in their future offspring (Trivers, 1972). Paternal investment positively impacted breastfeeding, relationship quality, and infant development (Rempel et al., 2020). Not only do parents invest in their offspring. Related individuals can engage in alloparenting to indirectly increase reproductive success (Hamilton, 1964), as observed in Agta hunter-gatherers from the Philippines (Page et al., 2019).

Fitness contributions extend beyond kin (Aktipis et al., 2018). Social capital, defined as any resources intrinsic in interpersonal relationships, aids reproduction (Kanazawa & Savage, 2009). A positive correlation was found between offspring number and alloparenting by childless community religious members (Shaver et al., 2019). Given human social nature (Hawkley & Capitanio, 2015), traits such as cooperation, reciprocity, and social acceptance play a crucial role (Henrich & Muthukrishna, 2021). Evidence showed a 50 % increase in survival for people with strong social relationships (Holt-Lunstad et al., 2010).

Fitness is also linked to health. Good health, or the ability to maintain it, increases the chances of survival and the likelihood of

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reproduction (Gangestad & Scheyd, 2005; Yue et al., 2022). Additionally, proper nutrition, resembling our ancestral pattern with vegetables, fruits, lower saturated fat, and an active lifestyle significantly contributes to good health (Buss, 2015; Yin et al., 2021).

1. Depression and fitness

Depression, a prevalent emotional issue (World Health Organization [WHO], 2017), is explored from the evolutionary perspective as potentially adaptive for our ancestral fitness (Durisko et al., 2015; Hollon et al., 2021; Tavares et al., 2021). Human behavior revolves around fitness problems (Troisi & Mc Guire, 2014), such as finding sexual partners, helping allies and kin, health and nutrition, group affiliation, solving conflicts, and status (Buss, 2015; Gilbert & Bailey, 2014). Failing to meet such goals results in intense pain or subjective displeasure, leading to outcomes such as depression (Gilbert & Bailey, 2014).

Giosan et al. (2018) developed the Evolutionary Fitness Scale (EFS), a 58-item self-report measure evaluating fitness in humans. It comprises two dimensions: Factor 1, the perception of "personal adaptedness" (items 1–37; e.g., "I exercise at least four times a week"), and Factor 2, "partner and offspring fitness" (items 38–58; e.g., "My partner and I are very compatible sexually"). Scores range from 1 (strongly disagree) to 5 (strongly agree). Higher scores indicate greater fitness. The original English version was tested on American undergraduates ($n = 146$) with a reliability of 0.92 for the total scale. It was applied in a controlled clinical trial that tested the effectiveness of cognitive evolutionary therapy (CET) to treat depression (Giosan et al., 2020). EFS was used to identify fitness-problems conceptualized as distal mechanisms contributing to depression. The problems identified with the scale were addressed during sessions.

The EFS was adapted into Persian. The reliability for Factor 1 was 0.96, 0.81 for Factor 2, and 0.97 for the overall scale. Test-retest reliability resulted in 0.81 for Factor 1, 0.80 for Factor 2, and 0.83 for the overall scale. There was a positive correlation between EFS subscales and self-esteem, and a negative correlation between EFS subscales and depression, anxiety, and stress (Ghazanfari et al., 2022).

Although fitness is traditionally measured as the number of children, the EFS was designed as a self-report instrument. In psychology, a traditional approach to investigating behavior involves the development of psychometric instruments designed to measure them. These tools are constructed through standardization procedures, facilitating the comparison of individuals based on their scores (Coaley, 2014).

2. Current study

In the present study, we aimed to adapt the Evolutionary Fitness Scale (EFS) for the Brazilian population and establish its validity evidence. We tested two hypotheses: (1) a negative correlation exists between depression and fitness; (2) given the association of maximizing fitness with social and health dimensions, we expected a positive correlation between fitness and measurements of quality of life and social adjustment.

3. Methods

3.1. Translation and cultural adaptation

The adaptation process was developed according to The International Test Commission guidelines (ITC, 2017). Translation and back-translation of the EFS into Portuguese were performed by a team of proficient researchers who were native Brazilian Portuguese speakers and fluent in English. Preliminary testing with a group of twelve adult volunteers - two of whom were seeking treatment for depression - was conducted to evaluate content and linguistic adequacy. No modifications were suggested during this phase. Subsequently, the final Brazilian Portuguese version of the scale was administered to a larger sample.

3.2. Sample and survey procedure

Participants were recruited through online invitations sent to the academic community of a Brazilian Federal University by its Information Technology Department. This sample characteristic was similar to the original paper, which minimizes result disparities arising from variations in sample profiles (ITC, 2017). A total of 1399 people accessed the survey hosted on LimeSurvey. However, 590 (42.1 %) were excluded for not completing the questionnaire, and 5 (0.35 %) for providing incorrect answers to control questions. The final sample was 804 adults (57.46 %) aged 18 and over. This study was approved by the Research Ethics Committee of the Federal University of Espírito Santo (CAAE: 46264520.0.0000.5542).

3.3. Measures

3.3.1. Demographic information

Questions were included to obtain data on the participant's sex, ethnicity, age, and marital status.

3.3.1.1. Patient Health Questionnaire (PHQ-9). Depression was assessed through the PHQ-9, consisting of nine items rated from 0 – not at all to 3 = nearly every day). The cut-off >10 is used for the diagnosis of depression (Spitzer et al., 1999). Validation for the Brazilian population was conducted by Santos et al. (2013).

3.3.1.2. The World Health Organization Quality of Life-BREF. The WHOQOL-BREF (World Health Organization, [WHO], 1996), is a 26-item measure of the quality of life with four domains: (1) physical health, (2) psychological, (3) social relation, and (4) environment. Lower scores indicate a lower quality of life. The Brazilian version (Fleck et al., 2000) demonstrated good internal consistency (Domain 1 $\alpha =$ 0.84, Domain 2 $\alpha = 0.79$, Domain 3 $\alpha = 0.69$, Domain 4 $\alpha = 0.71$).

3.3.1.3. Social Adjustment Scale- Self-report (SAS-SR). The SAS-SR (Weissman & Bothwell, 1976) assess daily functioning across six major dimensions: (1) work (as a worker, housewife, or student); (2) social and leisure activities; (3) relationships with extended family; (4) role as a spouse; (5) parent; and (6) member of the family unit. Higher scores indicate greater functional impairment. The reliability of the Brazilian version of SAS was 0.85 (Gorenstein et al., 2002).

3.4. Data analyses

Demographic variables were summarized using descriptive statistics. To verify the EFS structure of the Brazilian version an Exploratory Factor Analysis (EFA) was conducted (Orçan, 2018). The decision on the number of factors to be retained was made using parallel analysis with a polychoric matrix and the Robust Diagonally Weighted Least Squares (RDWLS) extraction method, along with the Robust Promin rotation. The adequacy of the model was assessed using Kaiser-Meyer-Olkin (KMO) (> 0.70) (Hutcheson & Sofroniou, 1999) and Bartlett's test of sphericity ($p < 0,05$) (Tabachnick & Fidell, 2007).

The stability of factors was assessed using the H index. High H values (>80) suggest a well-defined latent variable (Ferrando & Lorenzo-Seva, 2017). Convergent validity was assessed between EFS, SAS-SR, and WHOQOL-BREF using Spearman's product-moment correlation, with an expected moderate correlation (0.40–0.69) (Schober et al., 2018). To evaluate the scale's ability to discriminate between different populations we conduct a *t*-test. The effect size was evaluated according to the parameters: small (d = 0.20–0.30), medium (d = 0.40–0.70), and large (d $\geq$ 0.80) (Cohen, 1992). Internal consistency was assessed using Cronbach's alpha (α), and composite reliability, which determines the

variation in the factor loadings of the items (Valentini & Damásio, 2016). Data were analyzed using IBM SPSS Statistics for Windows, version 26. Exploratory Factor Analysis was performed in FACTOR 12.01.02 (Ferrando & Lorenzo-Seva, 2017). The composite reliability was performed using The Composite Reliability Calculator.

4. Results

4.1. Participants' demographic characteristics

The study included 804 adult participants from 18 to 78 years old (mean ± SD 31.9 ± 13.49). Most of the participants self-identified as White (52.7 %, $n = 424$), followed by Mixed race (*pardo*) (33.7 %, $n = 271$), Black (11.6 %, $n = 93$), Asian (1.5 %, $n = 12$), and Indigenous (0.5 %, n = 4). The sample was predominantly female (66.4 %, $n = 534$) and single (66.4 %, n = 534), with 28.4 % ($n = 228$) being married, 4.6 % ($n = 37$) divorced, and 0.6 % (n = 5) widowed. Regarding education, 40.5 % ($n = 326$) held undergraduate degrees, 30.1 % ($n = 242$) graduate degrees, 16.7 % ($n = 134$) high school, 4.9 % ($n = 39$) certificates, and 7.8 % ($n = 63$) postgraduate degrees. Only 26.74 % ($n = 215$) of the participants had children. Based upon the scores of PHQ-9 using a cut-off >10, 48.2 % ($n = 388$) of the participants were classified as a clinical sample.

4.2. Analyzing the structure

Due to a high number of missing data on items 46 to 58, which were answered only by participants who had children, we conducted two separate analyses. The first included items 1 to 45 for the whole sample ($n = 804$) and the second included items 46 to 58 for the parent's sample (n = 215). After conducting a parallel analysis, and excluding items with low factor loadings (<0.400) (Guadagnoli & Velicer, 1988), a 4-factor solution with 35 items was identified: partner (7 items), health (7 items), social capital (11 items), and offspring (10 items). Mean scores were calculated for each dimension. Items 54, 56, and 57 in the offspring factor were reverse-coded. Higher scores indicate higher fitness as the original version. Table 1 provides information on the factor loadings and parameters.

4.3. Validity

The EFS dimensions were positively correlated with quality of life and social adjustment as follows: (a) partner with SAS-SR marital; (b) health with WHOQOL health, WHOQOL psychological, and WHOQOL environment; (c) Social capital with SAS-SR social leisure, WHOQOL social relations, and WHOQOL environment; (d) Offspring with SAS-SR parent (Table 2). The EFS was negatively correlated with PHQ-9, except Offspring factor. Moreover, the Fisher's r-to-z transformation test demonstrated that health ($r = 0.48$, $p > 0{,}01$) and social capital ($r = 0.46$, $p > 0{,}05$) ($z = -0{,}759$; $p > 0{,}05$) were equally associated with PHQ-9.

To conduct *t*-test analyses, we incorporated bootstrap standard errors to compensate the lack of normal distribution of EFS subscales partner (S-W(804) = 0.962, $p < 0.001$), health (S-W(804) = 0.987, $p < 0.001$), and social capital (S-W(804) = 0.985, $p < 0.001$) (Haukoos & Lewis, 2005). The offspring subscale presented normal distribution (S-W(728) = 0.984, $p > 0.005$). Nondepressed participants scored significantly higher than depressed participants in perceiving fitness on partner, health, and social capital dimensions (Table 3).

4.4. Discussion

We have demonstrated that EFS is an efficient, reliable, and valid instrument for assessing self-reported data on fitness in four dimensions: partner, health, social capital, and offspring. The difference between our results and those of the original version (Giosan et al., 2018) may be due

Table 1
Factor loadings and parameters of the EFS- Brazilian version. The highest loading for each item is given in bold.

EFS item	Factor loading			
	1	2	3	4
Factor 1: Partner				
9. I am generally satisfied with my sex life.	**0.70**	0.19	0.05	
39. I am satisfied with my sex life with my partner.	**0.89**	0.09	−0.05	
40. My partner and I are very compatible sexually.	**0.84**	−0.06	0.02	
41. I believe my partner is faithful to me.	**0.85**	−0.10	−0.01	
42. My partner enjoys good health.	**0.72**	−0.02	0.01	
43. I have a harmonious, conflict-free, relationship with my partner.	**0.81**	−0.03	−0.01	
45. If I wanted to, my partner would have a child with me.	**0.45**	−0.10	0.06	
Factor 2: Health				
4. I eat very healthy.	0.4	**0.79**	−0.06	
13. I often get the chance to spend time outside.	−0.09	**0.42**	0.17	
15. I am an active outdoors person.	−0.02	**0.71**	0.08	
18. I eat at least three servings of vegetables or fruits per day.	0.07	**0.73**	−0.09	
19. I eat nuts frequently.	0.02	**0.57**	0.01	
23. I exercise at least four times a week	−0.08	**0.77**	−0.04	
24. I am in better physical shape than most people my age.	0.02	**0.69**	−0.04	
Factor 3: Social Capital				
1. I have at least one best friend.	0.04	0.09	**0.61**	
3. I have many friends ready to help me in case of need.	0.02	0.08	**0.66**	
28. I frequently go out with my friends.	−0.04	0.12	**0.54**	
29. I fit well with my coworkers or schoolmates.	0.01	−0.06	**0.57**	
30. The circumstances in which I find myself now are a good match with my personal goals and aspirations.	0.09	0.16	**0.44**	
32. My family members brag about me.	0.00	−0.03	**0.69**	
33. I am admired by my friends.	−0.04	−0.00	**0.78**	
34. I help many people.	0.00	−0.03	**0.46**	
35. I am important to people other than my family.	0.09	−0.10	**0.83**	
36. My friends contact me often.	−0.09	−0.03	**0.89**	
37. My family contacts me often.	0.02	−0.05	**0.57**	
Factor4: Offspring				
46. My relatives would take care of my children, in case of need.				**0.45**
48. My children are in the top 10 % at school.				**0.42**
50. My children rarely get sick.				**0.45**
51. People say my children are very cute.				**0.53**
53. I have a close relationship with my children.				**0.72**
54. My children's ideas often irritate me.				**−0.67**
55. My children confide in me.				**0.67**
56. I get into frequent arguments with my children.				**−0.50**
57. I don't like my children's friends.				**−0.41**
58. My children trust and follow my advice.				**0.68**
Composite reliability	0.90	0.85	0.88	0.82
H-latent	0.93	0.88	0.92	0.84
H-observed	0.94	0.91	0.94	0.83
KMO	0.85	–	–	0.76
Bartlett's test of sphericity	9139.3, $df = 300$, $p < 0{,}001$		585.2, $df = 45$, $p < 0{,}001$	
Cronbach's Alpha	0.87	0.80	0.85	0.74

Table 2
Correlations between EFS, PHQ-9, SAS-SR and WHOQOL.

	1	2	3	4	5	6	7	8	9	10	11	12
1. EFS partner	1	0.22*	0.26*	0.28*	−0.28*	−0.57*	−0.20*	−0.25*	0.28*	0.34*	0.54**	0.24*
2. EFS health		1	0.39*	0.08	−0.48*	−0.31*	−0.18*	−0.36*	0.51*	0.53*	0.36**	0.43*
3. EFS social capital			1	0.40*	−0.46*	−0.29*	−0.29*	−0.62*	0.44*	0.58*	0.59**	0.47*
4. EFS offspring				1	−0.05	−0.07	−0.43*	−0.20*	0.19*	0.22*	0.18**	0.24*
5. PHQ-9					1	0.46*	0.36*	0.58*	−0.73*	−0.80*	−0.54**	−0.45*
6. SAS-SR marital						1	0.37*	0.45*	−0.43*	−0.53*	−0.60**	−0.31*
7. SAS-SR parent							1	0.22*	−0.35*	−0.37*	−0.29**	−0.27*
8. SAS-SR social leisure								1	−0.50*	−0.60*	−0.57*	−0.42*
9. WHOQOL health									1	0.72*	0.51*	0.55*
10. WHOQOL psychological										1	0.63*	0.52*
11. WHOQOL social relations											1	0.44*
12. WHOQOL environment												1

* Correlation significative at level 0.01.

Table 3
Depressed x nondepressed *t*-test.

	Groups	*N*	*M*	*SD*	*t*	*df*	*P*	Cohen's *d*
EFS partner	Nondepressed	416	3.5254	0.76700	5.690	802	0.000	0.40
	Depressed	388	3.2128	0.79054				
EFS health	Nondepressed	416	3.2734	0.79514	13.166	802	0.000	0.93
	Depressed	388	2.5545	0.74985				
EFS social capital	Nondepressed	416	3.7926	0.54377	12.527	802	0.000	0.89
	Depressed	388	3.2737	0.62997				
EFS offspring	Nondepressed	141	4.0326	0.48634	289	213	0.773	0.04
	Depressed	74	4.0135	0.44633				

to different analysis procedures. While they employed principal component estimation and oblique rotation for the EFA without excluding poorly loaded items, we followed statistical guidelines and removed them.

The *t*-test results indicated discrimination between depressed and nondepressed individuals in three of the four fitness dimensions. The effect size demonstrates the strength of this difference, emphasizing the EFS's accuracy in distinguishing them. These results support the primary purpose for which the scale was created: the relationship between fitness and depression.

The moderate correlation between EFS social capital and health dimensions, along with their equal association with PHQ-9, underscores the importance of social capital and health in human fitness and their correlation with depression. Researchers demonstrated that social isolation has the greatest impact on the health and well-being of adults (Cordier et al., 2018), while social support is protective for maintaining good health (Coughlin, 2019).

Furthermore, we expected a negative correlation between EFS offspring and depression; however, no such correlation was observed. Among our sample, most of the participants who reported having children were married (70.23 %, $n = 151$), which can act as a protective factor against depression (Kislev, 2022). These results along with results from research, may indicate that the level of support received by parents is a more direct trigger for depression than the perceived offspring fitness (Park & Lee, 2022). Nevertheless, further research should investigate the characteristics of the children (e.g., number of children, age), to explore it.

Additionally, we observed a moderate correlation between social capital and offspring, consistent with the literature that underscores the importance of social support for humans, not just for survival but also for reproduction (Holt-Lunstad et al., 2010). While parental investment significantly impacts offspring fitness, it is worth noting that alloparenting can also positively affect offspring fitness (Nitsch et al., 2014), and social support provided by either family or friends facilitates parental investment (Wang et al., 2022).

Lastly, we found a moderate correlation between EFS subscales and social adjustment and quality of life, as expected. Social adjustment increases the chance of individuals forming alliances, which can increase their access to resources and improve their chances of survival (Henrich & Muthukrishna, 2021). Quality of life concerns an individual's level of satisfaction and appreciation for their living conditions, personal income security, access to healthcare, safety, and education (WHO, 1996). Therefore, quality of life leads to better health outcomes and consequently to a better self-evaluation of fitness. Nevertheless, the moderate correlations between the dimensions of EFS and depression, quality of life, and social adjustment indicate that these are distinct constructs (Schober et al., 2018).

4.5. Limitations

Our study has several limitations. As we collected data within the academic community, the majority of our participants have higher education (78.4 %, $n = 631$), representing only 21 % of the Brazilian population. Our clinical sample was based on the self-reported PHQ-9 due to data collected during the COVID-19 pandemic. Although its effectiveness has been demonstrated in prior studies (Beard et al., 2016), we suggest that these findings need replication in populations with a broader range of medical conditions, and educational backgrounds. Lastly, our study should not be taken as a contribution to the assertion of causality between fitness and depression, given that our analysis was mainly correlational.

4.6. Conclusion

The present study provided support for the validity evidence of a fitness measure in humans, although we did not measure fitness per se, but rather dimensions of fitness. Indeed, humans are not inherently motivated to maximize reproductive success; instead, they focus on behaviors that will lead to it (Gilbert & Bailey, 2014). As a result of our process of transcultural adaptation, we found a multifactorial scale with four dimensions, instead of the two domains originally proposed (Giosan et al., 2018). EFS items demonstrated a high degree of internal consistency and exhibited a good correlation between the subscales and external variables. In summary, we have demonstrated that EFS is an

efficient, reliable, and valid instrument for assessing self-reported data on fitness. This psychometric tool can be applied in clinical settings and various research fields to explore how fitness impacts human emotions, well-being, and behaviors.

CRediT authorship contribution statement

Andreza Conceição de Souza Tavares: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Writing – original draft, Writing – review & editing. **Cezar Giosan:** Supervision. **Rosana Suemi Tokumaru:** Conceptualization, Formal analysis, Project administration, Supervision, Validation, Writing – review & editing.

Declaration of competing interest

The authors have no conflict of interest to declare. This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brazil (CAPES) - Finance Code 001. The funder had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Data availability

Data will be made available on request.

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