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Reproductive Motivation in the Context of the COVID-19 Epidemic: Is There Evidence for Accelerated Life History Dynamics?

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One of the key life history assumptions is that mortality rates are positively associated with fast life history dynamics. Since the COVID-19 pandemic has elevated mortality rates throughout the world, we tested this assumption using reproductive motivation (desired number of children and desired age of first reproduction) as a key output measure using a repeated cross-sectional design. We assessed reproductive motivation in Serbian young adults before the pandemic started (N = 362), during the pandemic-caused state of emergency (the peak of the epidemic's first wave: N = 389) and after the state of emergency (i.e., after the first wave: N = 430). Furthermore, in the third time-point we measured experiences during the state of emergency and additional measures of reproductive motivation (reasons for and against parenthood). Subsamples were matched by sex, education, and the sampling procedure. We found the between-group differences which are congruent with life history theory: the desired age of first reproduction was lowest after the state of emergency compared to the 2 previous time-points. However, there were no differences in the desired number of children. Furthermore, the analysis of the links between experiences during the epidemic and reproductive motivation yielded the results which are incongruent with life history theory - adverse experiences during the state of emergency were negatively related to the reproductive motivation. Since the findings were only partially in accordance with life history theory, we discuss possible reasons which may explain the heterogeneity of results.

Public Significance Statement
One of the key assumptions of life history theory is that elevated mortality rates should produce faster life history dynamics which should reflect in higher fertility. This hypothesis is important not only for understanding evolutionary processes in an ecological context but also for predicting demographic trends as well. This assumption was tested by examining the links between COVID-19 epidemic and reproductive motivation (desired number of children and desired age of first reproduction) in young adults. The results showed mixed support for the life history predictions and provide useful guidelines for future studies in this topic.

Keywords: life history theory, COVID-19 epidemic, reproductive motivation, adverse experiences

The key trait which is targeted by natural selection is fitness—the transmission of genes to the subsequent generation, operationalized most frequently by the lifetime number of offspring (Hunt & Hodgson, 2010). However, organisms cannot straightforwardly maximize fitness since fertility is related to various other characteristics and behaviors like somatic growth, health and longevity, mating, timing of reproduction, parenting, and others.

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Furthermore, some of the outcomes related to fitness tend to constrain each other, for example, fertility and longevity (Jasienska et al., 2017); mating and parenting (Gangestad & Simpson 2000) quantity and quality of offspring (Gillespie et al., 2008). These constraints in fitness components are called evolutionary tradeoffs—if an individual invests in certain components it must be at the expense of others. In fact, the investments in different fitness components are not equally adaptive in different ecological conditions. The evolutionary framework which analyzes the pathways of fitness optimization in different ecological contexts is labeled as life history evolution (Roff, 1992; Stearns, 1992) or life history theory.

There are two main ecological conditions which are related to evolutionary tradeoffs and fitness optimization - harshness and unpredictability (Brumbach et al., 2009). Harshness refers to the environments with low resources, elevated danger, and/or hostility; in these conditions natural selection should favor fitness maximization characterized by increased reproductive output—faster somatic growth, earlier start of sexual activity, earlier reproduction, higher number of offspring, with reduced parental investment. This pathway of fitness optimization is favored by selection because organisms cannot afford to delay reproduction if their survival is threatened or they might not reproduce at all. The described trajectory of fitness-related outcomes is labeled as fast life history trajectory (Del Giudice et al., 2015) or fast pace of life (Dammhahn et al., 2018). Conversely, beneficial environments should facilitate the opposite pattern—delaying reproduction, smaller number of offspring, and increased investment in parenting and longevity, that is, slow life history. Indeed, the empirical results showed that various aspects of environmental harshness like lower socioeconomic status (SES; Sheppard et al., 2016); violent intergroup conflicts (Međedović, 2019); the absence of a father (Webster et al., 2014); lack of maternal sensitivity (Dunkel et al., 2015); and troubled family relations (Chisholm et al., 2005), are related to fast life history dynamics in humans.

Local Mortality as an Environmental Trigger for Fast Life History Trajectory

Many authors believe that the relations between a harsh environment and accelerated life history dynamics are mainly due to mortality rates (Belsky et al., 2012; Ellis et al., 2009)[1]. The available data shows that when the local mortality rates are higher (or conversely—with lower life expectancy) individuals tend to reproduce earlier in their lifetime—the findings are congruent both at the individual and population level (Bulley & Pepper, 2017; Low et al., 2013; Pink et al., 2020; Störmer & Lummaa, 2014). There are similar associations between mortality and fertility: individuals who experienced higher mortality rates tend to have a higher number of offspring (Bereczkei & Csanaky, 2001; Guégan et al., 2001; Zhang & Zhang, 2005). Both theory and data suggest that early-life experiences related to mortality are associated with accelerated life history pathways. However, it is interesting that individuals may react to the cues of elevated mortality as adults too. When young adults were exposed to mortality cues it affected their reproductive motivation by facilitating the desire to have their first child earlier in life; still, this effect was crucially dependent on their childhood environment—only the participants originating from poorer childhood conditions (i.e., low SES) had a desire for earlier reproduction when exposed to a mortality cue (Griskevicius et al., 2011). Hence, it seems that the link between elevated mortality and fast life history dynamics is well corroborated, both theoretically and empirically. Nevertheless, there are critiques of this hypothesis as well (Baldini, 2015). It is stated that higher mortality rates do not have to necessarily lead to accelerated life history—this link may be affected by various other ecological conditions and payoffs of life history trajectories in specific ecologies (André & Rousset, 2020).

Goals of the Present Research—Exploring the Link Between the COVID-19 Epidemic and Reproductive Motivation in the Life History Framework

The COVID-19 epidemic started in China at the end of 2019. It spread relatively quickly throughout the world and the World Health Organization declared an outbreak of a pandemic in the spring of 2020. COVID-19 is caused by coronavirus (SARS-

[1] More precisely, extrinsic mortality rates are thought to be the environmental trigger of fast life history—they refer to mortality which cannot be reduced by the individuals living in a certain environment. However, it is questionable if there is such a mortality—organisms usually can act in order to attempt to diminish risk to their health or safety (André & Rousset, 2020). Therefore, we use only the general term mortality in the present manuscript.

CoV-2) and it is expressed as a severe respiratory syndrome; it has fatal consequences in approximately 3.10% of infected individuals (calculated as a Case Fatality Rate: Zhao et al., 2020). The data in April 2021; showed nearly three million confirmed deaths of COVID-19 worldwide (World Health Organization, 2021). Hence, the pandemic elevated mortality rates throughout the globe (e.g., Fu et al., 2020; Hernández-Vásquez et al., 2020; Rivera et al., 2020; Vestergaard et al., 2020). Furthermore, due to extensive media coverage and high impact of the pandemic on everyday life, the awareness of elevated mortality is high as well. Therefore, it is plausible to assume that the pandemic may influence life history dynamics by creating an environment with elevated risk and mortality. The main goal of the present article is to analyze life history outcomes in the context of the pandemic in Serbia in order to evaluate if the epidemic accelerated life history dynamics in Serbia.

Since the COVID-19 pandemic is an ongoing ecological condition we could not measure fitness itself. We decided to measure motivation to reproduce—indicators like the desired number of children and desired age of first reproduction. The rationale for measuring these outcomes is relatively straightforward: modern humans have high conscious control over reproduction, at least in societies where contraceptive technology is easily available (Johnson-Hanks, 2008). The link between reproductive motivation and observed fertility is far from perfect but the former is a significant predictor of the latter: the desired age of first reproduction is significantly related to the actual timing of first reproduction (Nettle, 2011) and motives to reproduce are significantly related to the observed reproduction (Miller et al., 2010).

Hence, in the context of the present research, faster life history dynamics is represented by a lower desired time of first reproduction and higher desired number of children. Two contrasting hypotheses (beside the null hypothesis) can be made regarding the link between pandemic and reproductive motivation. Based on the life history theory, pandemic may increase reproductive motivation: when confronted with elevated mortality rates individuals adapt by switching to fast life history trajectories. Conversely, elevated mortality rates induce fear; when frightened for their lives individuals may invest more in their health and thus redirect investment from reproduction to survival (Mobbs et al., 2015). Thus, the latter hypothesis would predict decreased reproductive motivation due to the pandemic. We tested these hypotheses on two levels - first, we analyzed the differences in reproductive motivation at three time points which cover different stages of the epidemic in Serbia: before the epidemic started, at the peak of the first wave (April 2020) and after the first wave (the end of May 2020). We did not expect the increase in reproductive motivation at the second-time point—the new experience characterized by fear of infection should not enhance the motives to become a parent; on the contrary, individuals invest their resources in preserving somatic health. Our main hypothesis is that reproductive motivation should be elevated in the third time-point (after the epidemic's first wave). Second, we analyzed the associations between the experiences and behavior during the epidemic and reproductive motivation. Our main hypothesis in this analysis is that epidemic-related experiences and reproductive motivation are positively associated. We took into account previous results that mortality cues lead to an earlier desired age of first reproduction only in individuals originating from lower SES environments (Griskevicius et al., 2011) by analyzing the characteristics of childhood environments as well (Gordon, 2021).

Method

Sample and Procedure

The COVID-19 epidemic in Serbia started on March 6th, 2020; when the first official case of the new virus was identified. Soon afterward (March 15th), a state of emergency was declared. It included several measures in order to reduce the incidence of infection which severely affected everyday life in the country. Some of these measures were: a curfew that prohibited movement between 5PM and 5AM the next day (the curfew was extended onto several whole weekends during the state of emergency, i.e., from 5PM on Friday to 5AM on Monday); senior citizens (over 65 years old) were completely prohibited from leaving their homes; social distancing was mandatory, public gatherings were banned, and working from home was advised by the Crisis Headquarters (the team of epidemiologists in charge of fighting the epidemic). The epidemic itself and imposed measures resulted in heightened levels of fear of infection followed by the feelings of worry and anxiety regarding the disease (Damnjanovic' et al., 2020). The state of emergency ended on May 6th; this was the end of the

Table 1
The Sample Characteristics in Three Time-Points

Descriptive statistics	Before epidemic	The peak of first wave	The end of first wave	χ^2/F
N	362	389	430	
Sex - female %	65.70%	59.40%	66.40%	4.93ns
$M_{age}(SD)$	25.05 (6.64)	25.97 (2.81)	24.63 (6.70)	5.76**
$M_{education}(SD)$	4.18 (0.67)	4.09 (1.03)	4.15 (0.64)	1.19ns

Note. ns = nonsignificant.
** $p < .01$.

first wave in Serbia. Importantly, most of the measures were not gradually reduced - they were suddenly revoked. This resulted in a fast return to normal life, even elevated activity, especially in the domain of social interaction which probably compensated for the social distancing and the lack of interpersonal contact during the state of emergency.

In order to analyze the relations between the COVID-19 epidemic in Serbia and reproductive motivation we measured the motives to have children and timing of reproduction using a repeated cross-sectional study. We sampled participants in three time-points: before the epidemic started (November 2019; three and a half months before the epidemic started in Serbia), during the state of emergency (April 2020), and after the state of emergency ended (June 2020)[2]. The data at all three time-points were collected via an online study (using the Google forms platform), participation in the study was voluntary and the first page of the survey contained the informed consent. No participants from one time-point were included in subsequent time-points. All subsamples were constructed in the same way - as a snowball sample where the initial pool of participants disseminated the survey throughout the web and found other participants mostly via social networks. The only criterion for inclusion in the study was that a participant does not have children, or is not expecting, at the time of data collection.

The key demographic characteristics of every subsample are shown in Table 1. We can see that the participants in all three subsamples were young adults, dominantly females with higher education levels than the Serbian average. Education was measured in the same way for all three time-points. A five-point scale was used where the numbers denoted: 1 - did not finish elementary school; 2 - finished elementary school; 3 - finished high school; 4 - currently studying college; 5 - finished college. The between-group comparisons on key demographic variables showed that the subsamples did not significantly differ in the participants' sex ($\chi^2[2] = 4.93$; $p > .05$) and education ($F[2, 1179] = 1.19$; $p > .05$). However, significant differences in the participants' age were detected ($F[2, 1179] = 5.76$; $p < .001$); the group of participants sampled in the second time-point had a higher mean age compared to the first (*M* Difference = .92; $p < .05$) and third time-point (*M* Difference = 1.34; $p < .01$).

Measures

The key measures which were administered in all three-time points are Desired age of first reproduction ("How old would you like to be to have your first child?") and Desired number of children ("In total, how many children would you like to have?").

The following measures were collected only in the third time-point:

In order to more precisely assess reproductive motivation, we measured Reasons for and against parenthood (Langdridge et al., 2005). Reasons for parenthood ($M = 3.53$; $SD = .84$; $\alpha = .92$) were measured via 20 items which represent positive motives for parenthood: for example, "It would give me something to strive for" or "My family would be pleased if I had a child." Conversely, Reasons against parenthood ($M = 2.44$; $SD = .88$; $\alpha = .90$) were measured via 15 items which assess negative motivations regarding parenthood: for example, "Having a child would interfere with my career" or "I do not like children." The response scale was a 5 point Likert-type scale where 1 denoted "does not influence me to want a child" (or "does not influence me not to want a child" in the case of Reasons against reproduction) and 5 denoted "very strongly influences me to want a child" (or "very strongly influences

[2] The data collected in first and second time-point were a part of our other research projects; only the data from the third time-point were intentionally collected in order to test the hypotheses of the present research.

me not to want a child" in the case of Reasons against reproduction).

We assessed individual differences in experiences during the state of emergency as well. We used four measures of experiences during the state of emergency. The first was Containment-related behavior. We asked the participants which of the following behaviors they performed during the state of emergency (the response scale was binary - YES and NO): (a) Purchased face masks; (b) Acquired disinfectants; (c) Canceled one or more trips; (d) Restricted movement outside the house only to necessary ones; (e) Washed their hands more often than usual; (f) Obtained information about the symptoms of the virus; (g) Followed the news about the recommendations of the authorities; (h) Wrote down the phone number published by the Ministry of Health which should be called in case of COVID-19 symptoms. The responses to these 8 items were summed up and averaged into a single measure ($M = .87$; $SD = .20$; $\alpha = .71$).

Second, we measured epidemic-related distress. We asked the participants how much they were aware of the daily published number of deaths due to coronavirus (Death awareness: $M = 2.36$; $SD = 1.08$). Additionally, we asked the participants how much they feared for their own health during the state of emergency (Health concerns: $M = 2.19$; $SD = 1.12$). Both items had the same 5-point Likert-type response scale where 1 stands for "not at all" while 5 stands for "very much."

Participants were asked if some of the people they personally know (irrelevant if they were kin or non-kin) was infected by the coronavirus; participants answered with YES or NO (43.7% of participants positively responded). This was the fourth measure of harsh experiences during the state of emergency and it was labeled as Familiar individuals infected.

Finally, we measured the SES in childhood using a single item: "Please rate on a scale of 1 to 10 the financial situation in your family while you were growing up" (1 - "very poor"; 10 - "very good"). This variable was labeled as Childhood SES ($M = 6.46$; $SD = 1.96$).

Statistical Analyses

Current research has two parts: the first is based on the between-groups analysis where we compare the mean levels of Desired age of first reproduction and Desired number of children before the epidemic started, in the peak of the first wave, and after the first wave in Serbia. We do this by conducting ANOVA to estimate the raw effect of the epidemic on the reproductive motivation but also by conducting MANCOVA - the subsequent analysis controls for possible effect of covariates (sex, age, and education) but also controls for the correlation between the two criterion measures because negative correlation is expected between desired timing of first reproduction and desired number of offspring. The second part of the research is based on the individual differences analysis where we analyze the relations between pandemic-related experiences and reproductive motivation in the third time-point. Bivariate correlations (Pearson's correlation coefficients are calculated for all bivariate analyses except for the variable Familiar individuals infected; Point-biserial correlation coefficients are obtained for this measure since it is a binary variable) and the multivariate linear regression models are used for this estimation—four models are estimated because two additional criterions (Reasons for and against reproduction) are assessed in this time point beside Desired age of first reproduction and Desired number of children. Finally, since previous research suggested that childhood environmental conditions may moderate the link between mortality rates and reproductive motivation (Griskevicius et al., 2011); we calculated interactions between SES in childhood and the measures of epidemic-related experiences and tested them in the regression models as well.

Results

Between-Group Differences in Reproductive Motivation

We did not find significant differences in the Desired number of children between the groups *($M = 2.49$; $SD = .78$ for the first time-point; $M = 2.52$; $SD = .77$ for the second time-point; $M = 2.54$; $SD = .87$ for the third time-point; $F[2; 1178] = .41$; $p > .05$)*. However, we detected significant differences in the Desired age of first reproduction ($F[2; 1178] = 23.12$; $p < .001$). Desired timing of first reproduction was lower in the third time-point ($M = 28.87$; $SD = 3.99$) compared to the first ($M = 29.77$; $SD = 3.46$) and second one ($M = 30.68$; $SD = 3.97$): the mean differences were $-.91$; $p < .01$ and -1.82; $p < .001$, respectively. Furthermore, the average Desired age of first reproduction was higher in the second, compared to the first time-point (*M* difference = .91; $p < .01$). Hence, the lowest Desired age of first reproduction was after the end of the state of emergency compared to the measurements during the state of emergency and before the start of the epidemic; the highest Desired age of first reproduction was during the state of emergency, compared to both other groups. This finding was confirmed in MANCOVA as well ($F[2] = 19.86$; $p < .001$), where we controlled for the shared variation between the two measures of reproductive motivation ($r = -.19$; $p < .001$), together with the participants' sex, age, and education.

Bivariate Associations Between the Experiences in Epidemic and Reproductive Motivation

In the third time-point (after the state of emergency in Serbia) we assessed the measures of adverse experiences during the state of emergency and additional measures of reproductive motivations as well. Bivariate associations between the examined measures are shown in Table 2. We can see in that adverse experiences during the state of emergency are mostly negatively associated with the reproductive motivation: the harsher environment during the epidemic is negatively related to the Desired number of children and Reasons for parenthood, while it is positively associated with the Reasons against parenthood.

Regression Models for the Prediction of Reproductive Motivation

We set four regression models for the prediction of reproductive motivation measures - participants' sex, age, and education were controlled in the regressions as well. The regression functions are shown in Table 3. Although all four regression models were statistically significant, the experience during the state of emergency had an independent role for the prediction of only two criteria measures. Death awareness during the epidemic had a negative contribution to the prediction of Reasons for parenthood and positive contribution to the prediction of Reasons against parenthood. Health concerns had a positive contribution in the regression model with Reasons for parenthood as a criterion measure; however, note that there is a suppression effect here since this predictor had negative zero-order correlation with the Reasons for parenthood. Childhood SES also showed a positive relationship with Reasons for parenthood and negative association with the Desired age of first reproduction.

Interactions Between Childhood SES and Epidemic-Related Experiences

Finally, we calculated the interactions between the SES in childhood and the measures of epidemic-related experiences; therefore, there were four interactions per every criteria measure. Interactions were calculated as the products of centered variables and added to the next level in the hierarchical linear regression. Only one interaction turned out to be statistically significant: individuals with lesser awareness of the coronavirus-related deaths originating from poorer socioeconomic conditions had a higher Desired number of children ($\beta = .12$; $p < .05$; $\Delta F = 6.22$; $p < .05$; $\Delta R^2 = .01$). This interaction is shown in Figure 1.

Table 2
Correlations Between Adverse Experiences in the Epidemic and Reproductive Motivation

Variables	1	2	3	4	5	6	7	8
1. Childhood SES								
2. Containment-related behavior	.07							
3. Death awareness	−.01	.32**						
4. Health concerns	.03	.30**	.57**					
5. Familiar individuals infected	.05	.15**	.08	.03				
6. Desired age of first reproduction	−.25**	.02	.08	.05	.01			
7. Desired number of children	−.05	−.13**	−.12*	−.11*	−.08	−.22**		
8. Reasons for parenthood	.16**	.00	−.13**	−.01	.01	−.31**	.15**	
9. Reasons against parenthood	−.05	.03	.21**	.10*	−.03	.21**	−.23**	−.41**

* $p < .05$. ** $p < .01$.

Table 3
Results of Regression Models for Reproductive Motivation

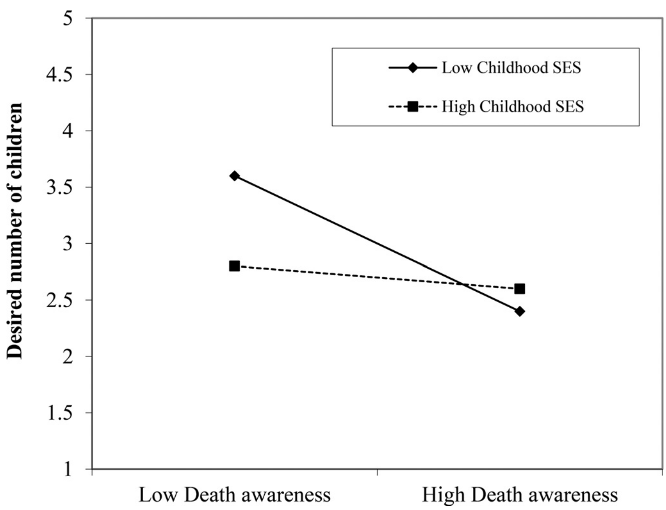
Predictors	Desired age of first reproduction β(*SE*)	Desired number of children β(*SE*)	Reasons for parenthood β(*SE*)	Reasons against parenthood β(*SE*)
Sex	−.11 (.40)*	−.16 (.10)**	−.15 (.09)**	.15 (.10)**
Age	.46 (.03)**	−.21 (.01)**	−.28 (.00)**	.09 (.01)
Education	.05 (.28)	.02 (.07)	−.05 (.06)	.08 (.07)
Childhood SES	−.10 (.08)*	−.06 (.02)	.10 (.02)*	−.04 (.02)
Containment-related behavior	−.01 (.89)	−.08 (.23)	.04 (.21)	−.04 (.23)
Death awareness	.09 (.18)	−.07 (.04)	−.18 (.04)**	.22 (.04)**
Health concerns	.00 (.17)	−.01 (.04)	.12 (.04)*	−.05 (.04)
Familiar individuals infected	−.03 (.33)	−.04 (.08)	.04 (.07)	−.05 (.08)
F	25.59**	3.47**	6.77**	4.44**
R^2	.33	.25	.34	.28

Note. β = standardized regression coefficient; *SE* = standard error; *F* = ANOVA test for the regression models; R^2 = coefficient of determination.
* $p < .05$. ** $p < .01$.

Discussion

The COVID-19 pandemic represents a global-scale event with various consequences for the functioning of individuals and societies. It has elevated mortality rates throughout the world and made our environment riskier and harsher by introducing the possibility of infection with possible severe health consequences. Hence, the pandemic represents an ecological change which may affect the ways organisms adapt in a biological sense as well, that is, the ways individuals maximize their fitness. Life history theory predicts that such environmental conditions facilitate the development of fast life history trajectory - earlier reproduction followed by a higher number of offspring. In the present research we tested this prediction in two ways: first, we compared reproductive motivation in Serbian young adults before the epidemic started, at the peak of the epidemic's first wave (in the middle of the state of emergency), and after the first wave ended (after the state of emergency); second, we analyzed the relations between adverse experiences during the epidemic and reproductive motivation in the third time-point. Interestingly, the effects obtained in the former analysis were in line with the life history

Figure 1
Interaction Between Childhood SES and Death Awareness in the Prediction of Desired Number of Children



theory predictions; however, the findings from the latter analysis are opposite to the theory's predictions. We discuss the findings and their heterogeneity in the following text.

COVID-19 Epidemic and Reproductive Motivation

Our analysis showed that the desired age of first reproduction was lowest after the end of the state of emergency, compared to the period when the incidence of infection was at its peak and the period before the epidemic. Hence, when the first epidemic-induced crisis ended, individuals wanted to have their first child sooner than during the state of emergency and before the epidemic. This finding is in line with numerous data (e.g., Chisholm et al., 2005; Dunkel et al., 2015; Međedović, 2019; Sheppard et al., 2016; Webster et al., 2014); showing that a harsher, riskier, and more depriving environment is related to fast life history dynamics, marked by enhanced reproductive output, earlier reproduction, and higher number of children. Furthermore, the result is congruent with the hypothesis and empirical findings that mortality rates are the key environmental characteristics which trigger a fast life history pathway (Belsky et al., 2012; Bereczkei & Csanaky, 2001; Bulley & Pepper, 2017; Ellis et al., 2009; Guégan et al., 2001; Low et al., 2013; Pink et al., 2020; Störmer & Lummaa, 2014; Zhang & Zhang, 2005). Hence, the motivation to have the first child earlier in life could be an adaptive response to the ecology characterized by elevated mortality rates - delaying reproduction could be highly costly to fitness in a harsh environment since individuals may die before leaving descendants.

On the other hand, analyzing individual differences in the third time-point yielded the opposite results: adverse experiences during the epidemic had negative associations with reproduction motivation. This was particularly true for individuals who were highly aware of epidemic-induced mortality: they had less positive reasons and more negative reasons to become parents and there were some indications (significant bivariate correlations) that they wanted less children in general. Other indicators of a harsh environment (Containment-related behavior and Health concerns) also showed negative bivariate associations with reproduction motivation; however, they did not independently contribute to the explanation of criteria variation in the regression models. This can be explained by the fact that these two variables positively correlate with the awareness of corona virus-related deaths; hence, the awareness of mortality was the most powerful predictor of reproductive motivation.

We paid special attention to the interaction between experiences in the epidemic and childhood SES because previous research showed that only individuals from poorer childhood environments were motivated to have their first child earlier when exposed to mortality cues (Griskevicius et al., 2011). However, we did not replicate these findings. The interaction we detected showed that individuals who originated from low-SES environments wanted to have their first child earlier but only if they had low pandemic-related death awareness, that is, the ones affected by elevated mortality to a lesser extent. The discrepancies between the present and former study can be attributed to the context in which elevated mortality rates were introduced to the participants. In the study of Griskevicius and colleagues (2011) participants read a fake newspaper article which contained information about increased mortality; in the present case the threat was real. Hence, the mere magnitude of induced fear by elevated mortality could lead to decreased reproductive motivation in the present study. Note that this assumption can be interpreted in the evolutionary context as well. If individuals perceive that the threat is still present and imminent, they may invest in survival instead of reproduction (Mobbs et al., 2015): fear of infection is one of the most important predictors of containment-related behavior, compliance with public health measures, and other preventive behaviors (Harper et al., 2020; Pakpour & Griffiths, 2020). Thus, fear of elevated mortality may lead to greater care for one's own health; it represents a form of somatic investment aimed at securing survival. By investing in survival individuals redirect investment from reproduction which is in accordance with one of the major evolutionary tradeoffs - the fertility-longevity tradeoff (Jasienska et al., 2017; Roff, 1992; Williams, 1966).

Other Explanations for the Opposite Results

Despite the fact that we measured the relations between experiences in the epidemic and reproductive motivation after the first wave of the epidemic in Serbia, the infection-related threat happened only several weeks before the data collection. Hence, it is plausible that the participants who were highly aware of the elevated mortality were still preoccupied by their physical health and not reproduction. Therefore, it may take more time in order for individuals to shift their investment into reproductive output. It would be fruitful to measure reproductive motivation after the pandemic itself is officially over in order to test this hypothesis. However, this assumption has a crucial condition - it assumes that human life histories are highly plastic. Most of the research in this area was focused on the childhood environment because it is believed that environmental cues shape life history dynamics in the early stages of ontogeny (e.g., Belsky et al., 2012; Ellis et al., 2009). In the present research we measured reproduction motivation in young adults, and it is questionable if life history trajectories can be changed in this developmental phase. However, previous research (Griskevicius et al., 2011) provided indications that they indeed can, probably due to high phenotypic plasticity in modern humans which emerges as a consequence of frequent environmental changes (Galipaud & Kokko, 2020). Furthermore, it may be relevant that corona-virus has higher probability to cause lethal consequences mostly to older individuals and the ones with other risk-factors (e.g., chronic illnesses). Our participants were mostly young and more educated adults and they could be less affected by mortality rates which were mostly increased in elderly population. If the virus (or some other selection pressure) affected younger age groups than its influence on life history dynamics may be more straightforward.

Certainly, there is the question if elevated mortality rates and harsh environments in general necessarily lead to fast life history dynamics in the first place, because there are critiques to this hypothesis (Baldini, 2015). Recent criticisms claim that harsh environments are not directly related to accelerated life history (André & Rousset, 2020). High mortality rates decrease competition in a population: both fast and slow life history pathways may be adaptive in the conditions of decreased competition and various other ecological factors can affect which life history trajectory would lead to higher fitness. Therefore, this criticism advises researchers to search for moderating factors that affect the link between harsh environments and life history dynamics.

Limitations and Future Directions

Several limitations of the present research were already mentioned when we discussed the reasons for the opposite findings. One of them is the fact that the infection-induced threat was still quite present in the participants' memory affecting the results. This possibility could be tested if we included an additional variable, that is, if we asked the participants if they are still afraid of the coronavirus infection. Since the risk of infection would be still present, even when a vaccine is developed, this variable should be fruitful to measure in future studies on this topic. One instead of On of the major limitations of the present research is the study design itself - longitudinal studies would be better in estimating the effect of epidemic on reproductive motivation because the same participants would be assessed in different time-points. However, since the majority of our research is cross-sectional and the identity of participants in confidential, this was the only way to test the study predictions. Furthermore, the samples we collected the data from were not representative - they were composed of highly educated young adults. Some demographic variables were controlled in the analyses (sex, age, and education) but other potential confounding factors like current SES were not accounted for and they could affect the results. The sample originates from a WEIRD country (western, educated, industrialized, rich and democratic; although the two latter adjectives can be applied only to a certain extent for Serbia) which further limits the generalization of the findings (Henrich et al., 2010). In order to analyze how individuals and populations adjust their life history pathways as a response to the COVID-19 pandemic it would be beneficial to have more heterogeneous samples. Future research can use objective measures of mortality instead of the subjective assessments, however it is certainly plausible that psychological processes (e.g., fear) are the mediators in the link between environmental characteristics and reproductive decisions; hence, measuring both may be the optimal strategy.

Concluding Remarks

In the present research we tested the predictions derived from life history theory regarding the reproductive motivation in the real-life context of the COVID-19 epidemic in Serbia. The pandemic facilitated numerous scientific research on various topics relevant to the complex new condition human populations have found themselves in. This study may provide us with some insight into adaptive evolutionary mechanisms, individuals and populations can generate in order to respond to the ecological conditions they are faced with. The results of the present study are heterogeneous - some are in line with life history theory and others contradict it. This may not surprise us given the fact that the relations between harsh environments and life history dynamics may not be straightforward but complex in nature. The present study certainly showed the fruitfulness of applying the evolutionary framework in the analysis of reproductive motivation in the context of risks in our biotic environment. It may serve as a basis for the future studies in this area which will certainly proliferate due to the importance of the pandemic itself and its effect on human societies.

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