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Early-life exposure to economic stress and metabolic risks in young adulthood: the children of the reunification in East Germany

Lara Bister 1, Fanny Janssen,1,2 Tobias Vogt1,3

ABSTRACT

Background Research on the long-term health consequences of early-life exposure to economic crises is scarce. We examine for the first time the long-term effects of early-life exposure to an economic crisis on metabolic health risks. We study objective health measures, and exploit the quasi-experimental situation of the postreunification economic crisis in East Germany.

Methods Data were drawn from two waves of the longitudinal German Health Interview and Examination Survey for Children and Adolescents (2003–2006, 2014–2017). We compared 392 East Germans who were exposed to the economic crisis in utero and at ages 0–5 with 1123 of their West German counterparts using propensity score matching on individual and family characteristics. We assessed blood pressure, cholesterol, blood fat and body mass index (BMI); both combined as above-average metabolic health risks and individually at ages 19–30.

Results Early-life exposure to the economic crisis significantly increased the number of above-average metabolic health risks in young adulthood by 0.1482 (95% CI 0.0169 to 0.2796), which was 5.8% higher compared with no exposure. Among individuals exposed in utero, only females showed significant effects. Early-life exposure to the economic crisis was associated with increased systolic (0.9969, 95% CI −0.2806 to 2.2743) and diastolic blood pressure (0.6786, 95% CI −0.0802 to 1.4373), and with increased BMI (0.0245, 95% CI −0.6516 to 0.7001).

Conclusion The increased metabolic health risks found for women exposed to the postreunification economic crisis in utero are likely attributable to increased economic stress. While the observed differences are small, they may foreshadow the emergence of greater health disparities in older age.

INTRODUCTION

Economic crises pose a serious threat to population health. Children are particularly sensitive to extreme economic stress, which can occur during an economic crisis.1 Previous research has unambiguously shown that in utero and childhood exposure to chronic stress may trigger metabolic health responses, and that economic stress in particular can have negative short-term health effects.2–6 Moreover, there is evidence that early-life exposure to economic stress is associated with increased metabolic health risks in late adulthood and cardiovascular mortality later in life.2 This link can be explained using the critical period model within the life course approach, which hypothesises that development in the early and vulnerable life stages (eg, in utero or childhood) is sensitive to external stressors, and thus that exposure to such stressors can lead to long-term negative health outcomes.9

Research on the early adult health outcomes of individuals who experienced economic stress early in life is scarce. Metabolic health in particular is a health indicator that can be used to measure the long-term consequences of early-life exposure to economic stress. Negative metabolic health outcomes may result from increased exposure to financial and general distress and from

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Previous research has reported that exposure to economic stress has significant adverse effects on children and newborns. Moreover, while existing studies have found that economic crises can have short-term adverse effects on the metabolic health of children and adolescents, most of this research was focused solely on behavioural and subjective health measures. While early-life exposure to economic stress has been found to affect later-life cardiovascular mortality, adult metabolic health in the context of early-life exposure to an economic crisis remains understudied.

WHAT THIS STUDY ADDS

⇒ Exploiting the quasi-experimental situation of the economic crisis in postreunification East Germany, our findings reveal significant increases in metabolic health risks for young adults who were exposed to the economic crisis early in life, especially for females. We found that the blood pressure and body mass index of young adults were particularly affected, which could be linked to the long-term metabolic health consequences of early-life exposure to economic stress. Furthermore, we observed that in utero exposure to the economic crisis led to increased metabolic health risks among young adult females in particular, which might be attributable to females having a higher sensitivity to economic stress than males. The impact of early-life exposure to the economic crisis on metabolic health risks was up to five times larger than that of other adverse childhood experiences, such as parental separation.
Our findings suggest that individuals exposed to economic crisis early in their lives face a higher risk of physical dysregulation and cardiovascular health hazards later in life. This signals a possible delayed burden on the health system due to increased treatment requirements in the future. Subsequently, policy-makers should adopt measures to alleviate the economic stress of families during economic crises, and to promote compensating health behaviours among the affected individuals to help counteract the adverse long-term metabolic health consequences of early-life exposure to economic crises.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE AND/OR POLICY

Our outcome measure was metabolic health measured at ages 19–30. We used four cardiometabolic risk factors: (1) blood pressure (systole-diastole ratio, mm Hg), (2) body mass index (BMI) in kg/m², (3) cholesterol levels (high-density lipoprotein (HDL) in blood, mg/dL) and (4) body fat levels (triglyceride in blood, mg/dL). We analysed the measures individually and combined as a composite measure indicating the number of above-average metabolic health risks for each metabolic health measure, that is, a count variable ranging from zero (no above-average metabolic risks) to four (four above-average metabolic risks).

Our outcome measure was early-life exposure to the postreunification economic crisis in East Germany, which was based on whether each respondent’s place of residence in the first KiGGS wave (2003–2006) was in East Germany instead of in West Germany. Because East and West Berlin were not differentiated in the data, we excluded Berlin. We obtained the average treatment effect (ATE) of exposure to the postreunification economic crisis in East Germany by applying propensity score matching, which reduced bias from confounding by ensuring that the exposed sample and the unexposed sample were balanced in terms of their characteristics (online supplemental table S4). We matched the East German (treatment group) with the West German sample (control group) using the following uncorrelated variables as confounders: age at childbirth (continuous), mother’s age at childbirth (continuous) and parental education (continuous). See online supplemental tables S1–S3 for the variable descriptions and the descriptive statistics for outcome, treatment and control measures.

RESULTS

The overall number of above-average metabolic risks was higher for the exposed group (= East Germans), with an average of 2.70, than for the unexposed group (= West Germans), with an average of 2.57. This difference was statistically significant (p<0.05) (table 1). There was no statistically significant difference in the individual metabolic health measures of the exposed group and the unexposed group. However, the systolic and diastolic blood pressure was higher for the exposed group than for the unexposed group (123.65/73.45 mm Hg vs 122.66/72.85 mm Hg). The metabolic health outcomes for males were also not significantly different. For females, however, we found significantly higher average metabolic health risks in the composite measure (2.49 vs 2.24, p<0.05) and the systolic and diastolic blood pressure (119.77/72.96 mm Hg vs 117.74/71.70 mm Hg, p<0.05).

The effect on the composite metabolic health measure for the exposed group was, at 0.1482 (p<0.05) (table 2), 5.8% higher than the number of above-average metabolic health risks for the
unexposed group. While the effect on the composite measure was not statistically significant in males, it was in females, at 0.236 (p<0.05). For the individual metabolic health measures, the estimates of systolic and diastolic blood pressure and BMI were increased in the total exposed sample, although only the effect for diastolic blood pressure was statistically significant. Conversely, the positive HDL and negative triglyceride estimates indicate that the control group were in worse health, although these values were not statistically significant. The single estimates show no significant effect in males. However, systolic blood pressure was, at 2.136 mmHg (p<0.05), significantly higher in the exposed females than in the unexposed females. While the outcomes for the remaining metabolic health measures seem to be worse in the exposed females than in the unexposed females, the differences were not significant.

Figure 1 plots the ATE of early-life exposure to economic stress on metabolic health risks (composite measure) in young adulthood, assessed separately for the cohorts born between 1986 and 1994 and stratified by gender. We found no effect among males (left panel). Among females (right panel), we observed statistically significant effects of 0.821 for the 1992 birth cohort (28.7%, p<0.05) on the number of above-average metabolic health risks in young adulthood, assessed separately for the cohorts born between 1986 and 1994 and stratified by gender. We found no effect for the exposed with the unexposed group. These birth cohorts were exposed to the economic crisis in utero. We found no effect for the exposed females than in the unexposed females. While the effect on the composite measure was not statistically significant in males, it was in females, at 0.236 (p<0.05). For the individual metabolic health measures, the estimates of systolic and diastolic blood pressure and BMI were increased in the total exposed sample, although only the effect for diastolic blood pressure was statistically significant. Conversely, the positive HDL and negative triglyceride estimates indicate that the control group were in worse health, although these values were not statistically significant. The single estimates show no significant effect in males. However, systolic blood pressure was, at 2.136 mmHg (p<0.05), significantly higher in the exposed females than in the unexposed females. While the outcomes for the remaining metabolic health measures seem to be worse in the exposed females than in the unexposed females, the differences were not significant.

**CONCLUSION**

**Summary of results**

Early-life exposure to the economic crisis significantly increased the number of above-average metabolic health risks in young adulthood by 0.1482 (95% CI 0.0169 to 0.2796), which was 5.8% higher compared with no exposure. Significant effects were found only for females exposed in utero. Early-life exposure to the economic crisis was associated with increased systolic (0.9969, 95% CI −0.2806 to 2.2743) and diastolic blood pressure (0.6786, 95% CI −0.0802 to 1.4373) and with increased BMI (0.0245, 95% CI: −0.6516 to 0.7001).

**Evaluation of data and methods**

Our study has some data-related limitations.

First, because the KiGGS only provided information on the region of residence—that is, our exposure measure—for the first wave (2003–2006), we had to consider the possibility that our results were affected by unobserved migration between German reunification in 1990 and the first KiGGS wave. However, our sensitivity analysis, in which we considered the impact of East-West migration among a subsample for whom the reunification occurrence was known, showed that migration did not affect our results (online supplemental table S7).

Second, because the KiGGS did not provide information on the respondents’ exposure to economic stress, but only allowed for a linkage with contextual information on the post reunification economic crisis through geographical

**Table 1** Comparison of the young adult (ages 19–30) mean metabolic health outcomes between the exposed (East German) and the unexposed (West German) matched samples, 2014–2017 (N=1515)

<table>
<thead>
<tr>
<th>Metabolic health outcome</th>
<th>Total (n=1515)</th>
<th>Males (n=791)</th>
<th>Females (n=724)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Exposed†</td>
<td>Unexposed‡</td>
<td>Exposed†</td>
</tr>
<tr>
<td>Composite measure (0–4)</td>
<td>2.70*</td>
<td>2.57*</td>
<td>2.88</td>
</tr>
<tr>
<td>Systolic blood pressure§</td>
<td>123.65</td>
<td>122.67</td>
<td>126.69</td>
</tr>
<tr>
<td>Diastolic blood pressure§</td>
<td>73.47</td>
<td>72.85</td>
<td>73.97</td>
</tr>
<tr>
<td>Body mass index¶</td>
<td>24.25</td>
<td>24.39</td>
<td>24.32</td>
</tr>
<tr>
<td>High-density lipoprotein**††</td>
<td>26.51</td>
<td>26.40</td>
<td>23.73</td>
</tr>
<tr>
<td>Triglyceride**</td>
<td>24.09</td>
<td>24.20</td>
<td>25.18</td>
</tr>
</tbody>
</table>

Bold values indicate significant coefficients.

Significance levels (t-test results): ***p<0.001, **p<0.01, *p<0.05.

Interpretation of measures: †mmHg; ‡kg/square metre; §mg/dL in blood; ¶lower high-density lipoprotein means higher cholesterol levels.

**Table 2** Effect of early-life exposure to the post reunification economic crisis in East Germany (comparing East and West German samples) on combined and individual metabolic health outcomes at young adulthood (ages 19–30), 2014–2017 (N=1515)

<table>
<thead>
<tr>
<th>Metabolic health outcome</th>
<th>Total (N=1515)</th>
<th>Males (N=791)</th>
<th>Females (N=724)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ATE</td>
<td>95% Conf. Int.</td>
<td>ATE</td>
</tr>
<tr>
<td>Composite measure (0–4)</td>
<td>0.148*</td>
<td>−0.026 to 0.270</td>
<td>0.004</td>
</tr>
<tr>
<td>Systolic blood pressure†</td>
<td>0.997</td>
<td>−0.229 to 2.223</td>
<td>−0.976</td>
</tr>
<tr>
<td>Diastolic blood pressure†</td>
<td>0.679*</td>
<td>0.004 to 1.400</td>
<td>−0.386</td>
</tr>
<tr>
<td>Body mass index‡</td>
<td>0.024</td>
<td>−0.637 to 0.685</td>
<td>−0.679</td>
</tr>
<tr>
<td>High-density lipoprotein§¶</td>
<td>0.396</td>
<td>−0.470 to 1.263</td>
<td>0.538</td>
</tr>
<tr>
<td>Triglyceride§††</td>
<td>−0.306</td>
<td>−2.216 to 1.605</td>
<td>−1.155</td>
</tr>
</tbody>
</table>

ATE which we obtained from propensity score matching; see online supplemental table S6 for calculations of the propensity score.

Bold values indicate significant coefficients.

Significance levels: ***p<0.001, **p<0.01, *p<0.05.

Interpretation of measures: †mmHg; ‡kg/square metre; §mg/dL in blood; ¶lower high-density lipoprotein means higher cholesterol levels.

ATE, average treatment effect.
Discussions of results

Our finding that individuals exposed to the postreunification economic crisis in East Germany had a higher number of above-average metabolic health risks in young adulthood can very likely be linked to their experiences of economic stress in early life, which may have negatively affected their long-term metabolic health.8 10 Our observation that the blood pressure and the BMI of these young adults were particularly affected by exposure to the crisis can be explained by research showing that these health indicators are especially sensitive to stress.32 33

Moreover, our finding that these effects were only significant for females is in line with previous research that detected gender differences in physiological regulation in response to increased distress.32 33 External stressors in particular often lead to hormonal and physical dysregulation in women,33 and thus, can also have an impact on their metabolic health.32 Our observation that the differences in the metabolic health of females were already evident in young adulthood reflects the severity of the economic crisis.

Particularly for those East German cohorts who were exposed to the economic crisis in utero—that is, the birth cohorts of 1992 and 1993—our results show significantly increased above-average metabolic health risks among females. These findings are in line with the critical period model,9 as well as with previous research showing that experiences in the early years of life can have long-term effects on health, including on metabolism.34 They also provide support for the fetal stress hypothesis, which argues that external stressors in the womb have long-term effects on development and health.35–37 Thus, our findings indicate that the postreunification economic crisis in East Germany likely exposed unborn children to extreme in utero stress resulting from their mothers’ economic distress. Why no significant effects were found for East Germans who were exposed to the crisis later in childhood is unclear. Although the negative impact of in utero exposure to economic stress is well known,32 33 studies that compare the effects of economic stress on children who were exposed at different ages are rare. Future research should investigate possible differences by age in the effects of exposure to economic stress and seek to disentangle the corresponding mechanisms.

Socioeconomic factors may play a crucial role in explaining the adverse effects on metabolic health of early-life exposure to economic crises, as being socioeconomically disadvantaged early in life has been found to negatively affect metabolic health outcomes in adulthood.27 Experiencing elevated levels of economic stress during an economic crisis may exacerbate this effect and drive negative health selection. Research has clearly shown that children from socioeconomically disadvantaged backgrounds are particularly likely to suffer negative health consequences during economic crises.36 While our study cannot provide insights into socioeconomic selection into experiencing negative metabolic health consequences due to early-life exposure to economic crises (see 4.2 Evaluation of data and methods), we acknowledge the relevance of these factors for individual metabolic health.

Alongside the explanatory mechanisms, it is important to discuss the magnitude of the observed effect sizes. In general, the differences we found in the metabolic health outcomes of the exposed and the unexposed groups were rather small. This is partially because we only observed effects for females and for individuals exposed to the economic crisis in utero. We, thus, acknowledge that gender differences likely drove the observed overall effect of early-life exposure to the economic crisis on average metabolic health risks in young adulthood.

Third, although our outcome measures are objective measures and relevant predictors of metabolic health, two key indicators for the metabolic syndrome, namely abdominal obesity and hyperglycaemia,13 are not available in the KiGGS. Additionally, clinical benchmarks for metabolic syndrome risk cut-off points for the available metabolic health measures that were exclusively adapted to the young age of our study population13 28 are limited in the literature. For that reason, we did not use clinically relevant thresholds for the composite measure of the combined metabolic risk score. Instead, we relied on a sample-based operationalisation of the thresholds for increased metabolic risks, in line with previous studies on metabolic health in comparably young study populations.29
metabolic risks in young adulthood. In addition, socioeco-
nomic gains over the life course may have counteracted the 
advantage of the economic crisis on the exposed group. 
The rapid convergence of living standards, educational levels 
and health policies in reunified Germany might have offset some 
of the adversity experienced by children who were exposed to the 
economic crisis in East Germany.3839 Moreover, health 
behaviours at young adult ages, such as physical activity, smoking 
and alcohol consumption, might have influenced the effects on 
metabolic health of early-life exposure to the economic crisis by 
either reinforcing or counteracting the negative effects through 
unhealthy or healthy behaviours.40 However, given that the 
scarce existing research on East-West German differences in 
behavioural health has found no significant differences between 
the cohorts exposed to the postreunification economic crisis,4142 
we cannot determine whether health behaviour played a role. 

To better understand and contextualise the effect sizes, 
we conducted an additional analysis using the experience of 
parental separation during childhood as a treatment. We chose 
this comparative treatment because previous studies identified 
parental separation as a significant stressor for children, and 
emphasised its association with long-term adverse metabolic 
health effects.43 The additional analyses (online supplemental 
table S8) showed that the effect of early-life exposure to the 
postreunification economic crisis in East Germany on the meta-
abolic health risks in young adulthood was three times larger than 
that of parental separation during childhood. For females, the 
effect was almost five times larger. These findings again illus-
trate the severity of the postreunification economic crisis in East 
Germany, and the subsequent consequences for the metabolic 
health of individuals who were exposed to the crisis early in life. 

Additionally, as we observed the differences in metabolic 
health in young adulthood, it is possible that the exposed popu-
lation will develop more serious health consequences over time, 
as previous research has shown that the prevalence of metabolic 
syndrome44 and cardiovascular mortality8 increases with age.

Conclusion 
Early-life exposure to economic stress during the postreunifi-
cation economic crisis in East Germany led to increased meta-
bolic health risks for young adults, although only for women. In 
particular, BMI and blood pressure were higher for the exposed 
females. As BMI and blood pressure are common stress markers, 
these findings can be attributed to stress responses to the 
economic crisis. Moreover, these results emphasise the impor-
tance of taking gender differences in responses fetal stress into 
account when considering the long-term health consequences of 
early-life exposure to economic crises. 

Although the differences in the metabolic health outcomes we 
detected were small—possibly due to the compensating effects of 
later-life improvements in the socioeconomic status of the East 
Germans in our sample—the effects were certainly not negligible 
(compared with, eg, the effects of parental separation). Our find-
ings could well signal that the exposed individuals face a higher 
risk of physical dysregulation and cardiovascular health hazards 
later in life. This could result in a very large but delayed burden on 
the health system due to increased treatment requirements. 

We recommend that policy-makers in East Germany 
adopt measures to alleviate the economic stress of families 
during economic crises, and to promote compensating health 
behaviours among the birth cohorts affected by the postreunifi-
cation economic crisis to help counteract the adverse long-term 
metabolic health consequences of exposure to this crisis.

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