The Covid-19 pandemic as an accelerator of economic worries and labor-related mental health polarization in Germany? A longitudinal interacted mediation analysis with a difference-in-difference comparison

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ABSTRACT

Objectives: Labor-related mental health polarization refers to exposure to low-paid employment and unemployment decreasing mental health. Previous research identified economic worries as a key mediator. Against this background, the Covid-19 pandemic is often assumed to have accelerated already existing processes and affected vulnerable populations the most. Our study sought to investigate whether the Covid-19 pandemic accelerated the mediation by economic worries between employment type and mental health.

Method: Using the German Socioeconomic Panel (GSOEP) from 2016 onwards, we created a pre-Covid-19 sample (N = 8266) and a per-Covid-19 sample (N = 7294), with each having a t_0 wave (2016/2018) and a t_1 wave (2018/2020). We applied the mediational g-formula for longitudinal mediation with exposure-mediator (XM) interaction between employment type (X) and economic worries (M). We decomposed the total effect into a direct, indirect, and interacted effect of employment on mental health and provided a difference-in-difference comparison of the effects.

Results: During the Covid-19 pandemic, economic worries increased, and mental health decreased. However, the mediation by economic worries reduced by approx. 18.0% (e.g., from 35.0% to 28.9%). A decreased indirect effect caused the reduction in mediation, while the direct and interacted effect remained rather stable. We also found stark gender differences towards males having a higher total effect but a lower mediated effect during the Covid-19 pandemic.

Conclusion: Our results highlight that mediators competing to economic worries must have emerged during the Covid-19 pandemic. Such mediators could be the risk of infection at the workplace, the possibility of remote work, and gender-specific mediators. Our study is also the first to extend the mediational g-formula with the difference-in-difference approach. It can be used as a blueprint for researchers interested in evaluating the impact of events, such as the Covid-19 pandemic, on preexisting processes.

1. Introduction

A dualization of labor segments emerged due to the increase in low-income employment and unemployment in western labor markets around the mid-1980s (Kalleberg, 2018). Dualized labor markets have a primary sector with regular employment and a secondary sector with unstable and low-income employment (Brady & Biegert, 2017; Emmenegger, 2012; Standing, 2014). Referring to the dualized labor–polarized health hypothesis (Klug et al., 2021; Pförtner et al., 2022), researchers investigated the consequences of these dualized labor segments on health (Bardasi & Francesconi, 2004; Pförtner et al., 2019).

These polarization processes have been well elaborated, with working and living conditions, health behaviors, stress, and insecurities being the main mediators (Caroli & Godard, 2016; Pförtner & Demirer, 2022). Concerning mental health in particular, economic insecurities are the key stressor since they can have a determinantal impact on mental health if not adequately coped with (Kim & von dem Knesebeck, 2016). However, dealing with economic insecurities is rarely feasible for those employed in the secondary sector due to the lack of adequate coping strategies and resources (Tompa et al., 2007) and the mere fact

that economic insecurities are rarely tangible. Therefore, the exposure to economic worries caused by working poverty or unemployment imposes substantial mental health risks (Ferrie, 2001; Paul & Moser, 2009; Rönnblad et al., 2019).

Regarding the dualized labor–polarized health hypothesis in the context of crises, researchers have highlighted that these exogenous shocks affect those parts of the population that are already vulnerable the most (Buss, 2009; Frasquilho et al., 2016; Reibling et al., 2017). Similarly, the Covid-19 pandemic has been interpreted as an exogenous shock (Adams et al., 2020). It is, therefore, under suspicion to be an accelerator of social inequalities in health (Kawachi, 2020; McNamara et al., 2021). Such mental health inequalities during the Covid-19 pandemic are indirectly linked to increases in economic worries (Kämpfen et al., 2020; Kraut et al., 2022), and we view three processes to substantiate this link.

First, the risk of unemployment or income losses increased for those in the secondary sector during the pandemic, especially in Germany (Pichler and Küffner, 2022; Schröder et al., 2020), consequently the economic worries in those already facing higher economic burdens. Second, individuals facing such deprivations are also constrained to working and living conditions that increase the risks of experiencing a Covid-19 infection (Beese et al., 2022; Chen et al., 2021). Third, the combination of increased economic worries and physical health threats could correspond to an increased stress load that must be coped with. Successful coping, however, is less likely in settings of resource precarity caused by working poverty and unemployment (Scott-Marshall & Tompa, 2011), resulting in a higher mental health burden for individuals constrained to the secondary sector (Reme et al., 2022).

Hence, the mediation by economic worries on the employment-related mental health polarization is likely to be interacted/moderated with one another (XM-interaction). XM-interaction means that the mediation differs in level and slope (MacKinnon et al., 2020). For instance, the mediation process in the working poor group might be stronger in slope than for the regularly employed group since the unemployed group might be more sensitive towards economic worries due to harsher deprivation while having fewer coping capabilities. However, determining the effect of unemployment is difficult, as timing, duration, endogeneity and reverse-causality could be present. For example, when just recently experienced unemployment (timing) may have a stronger effect on health than those that are accustomed to unemployment (Böckerman & Ilmakunnas, 2009; Cygan-Rehm et al., 2017). Similarly, poor health could be the cause of unemployment inducing reverse-causality (Haan & Myck, 2009). The endogenous factors of poor health, therefore, could induce the association between (un-)employment and poor health, while the true effect of unemployment might be close to zero (Picchio & Ubaldi, 2022).

Identifying the influence of the Covid-19 pandemic on such preexisting processes requires sophisticated methods for three reasons. First, (non-)parametric identification of longitudinal, time-varying mediation and interaction. Second, observation and comparison in a pre-and per-Covid-19 pandemic setting. Third, differentiation and interpretation of changes in the parameters. For instance, a difference in the share mediated might be due to a reduced direct effect, an increased indirect effect, or both. Such an investigation is of immediate use for public health because it can inform on the context-dependent potency of a potential intervention on economic worries, e.g., via relief funds. We will expand upon novel longitudinal mediation analysis (mediational g-formula) with a quasi-experimental difference-in-difference (DiD) comparison to provide such an investigation. Therefore, this study also provides a substantial methodological contribution for researchers that desire to investigate the influence of the Covid-19 pandemic on preexisting processes.

Overall, we seek to answer two research questions:

RQ1. Did economic worries mediate the effect of employment type on mental health?

RQ2. Did the Covid-19 pandemic increase the strength of mediation by economic worries?

2. Methods

2.1. Study design and setting

This study utilizes the German Socioeconomic Panel (GSOEP) (Liebig et al., 2022), Germany's largest ongoing panel study. The GSOEP started as an annual survey in 1984, with the most recent available wave in 2021. We created a pre-Covid-19 sample based on the survey years at $2016(t_{0pre})$ – 2018 (t_{1pre}) (N = 8266), and a per-Covid-19 pandemic sample between $2018(t_{0per})$ – $2020(t_{1per})$ (N = 7294). Further, we restricted respondents in both samples to have been surveyed at t_1 after March in the respective year (2018/2020). This restriction aimed at achieving comparability in both samples due to two reasons. The first lockdown occurred in Germany in late March 2020 (around 22. March. 2020), including only respondents after March in the per-Covid-19 sample ensures that exposure to the Covid-19-pandemic measures has occurred. Second, the GSOEP respondents' characteristics differ between the months, e.g., respondents surveyed in January are, on average, older than those surveyed in April; therefore, restricting the respondents in both samples to be surveyed at the earliest in April of the respective year (t_1) ensures comparability between samples. Utilizing the quasi-experimental assignment of panel respondents in studies has recently been increasingly applied (e.g., Oude Groeniger et al., 2021).

Fig. 1 details both sample selection processes and the resulting sample sizes. Besides survey month, we required respondents to have complete entries on the primary analysis variables at t_0 and t_1. We also excluded individuals aged 65 or older at time-point t_1 in both samples due to potential heterogeneities caused by retirement entry. These restriction criteria created a further modest loss of 8-10% across both samples.

2.2. Measurements

2.2.1. Exposure: employment type

We created a categorical variable based on the employment and income records for the employment groups. The reference category is regularly employed individuals (regular employment = 0). We defined regular employed as having an equalized disposable household income of at least 40% of the median in the respective survey year. Contrary, we grouped individuals with employment but an equalized disposable household income of less than 40% as working poor (working poor = 1) (Pförtner & Schmidt-Catran, 2017). The last category comprises individuals without employment at the respective survey wave (unemployed = 2).

2.2.2. Mediator: economic worries

The GSOEP measures the subjective feeling of economic insecurity by surveying three questions concerning own financial, general economic, and job-loss-related insecurities. The respondents can answer the
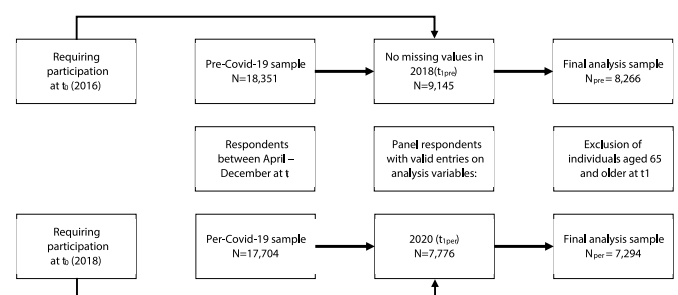

Fig. 1. Data selection process of the pre-Covid-19 and per-Covid-19 sample.

questions with "no worries", "moderate worries", and "high worries". Based on these questions, we created a sum-score of the economic worries, with higher values indicating more economic worries. However, we excluded information on job-loss-related economic worries because this question was not applicable to the unemployed group. The Cronbach's alpha of the three questions ranged between 0.60 and 0.63, and for the two questions, between 0.57 and 0.60, depending on the survey waves.

2.2.3. Outcome: mental health

The GSOEP surveys mental health biannually with the Mental Component Summary (MCS). The MCS is part of the Short Form-12 Health Survey (SF-12v2). The SF-12v2 has 12 items and derives from the SF-36v2, a multidimensional tool for health-related quality of life consisting of 36 items (Gandek et al., 1998). The SF-12v2 is widely used and has high validity (Grabka & Schupp, 2005). The MCS in the SF-12v2 ranges from 0 to 100 with a standard deviation (SD) of 10 (T-score), with higher values indicating better mental health (Nübling et al., 2007).

2.2.4. Confounding variables

Causal mediation analysis relies on the satisfaction of the non-parametric unconfoundedness assumptions. In detail, four unconfoundedness assumptions require observation and adjustment for any exposure–outcome (C-I), exposure-mediator (C-II), and mediator-outcome (C-III) confounders. The last assumption (C-IV) requires the absence of any C-III confounders that are also affected by the exposure, irrespective of observability and adjustment (VanderWeele & Tchetgen Tchetgen, 2017). Assumption C-IV poses a great challenge in identifying longitudinal causal mediation when investigating time-varying and reciprocal phenomena.

Next, we distinguished the confounders in time-constant (C) and time-varying (V). As time-constant confounders, we added information on year of birth (continuous), gender (binary, highest educational degree (ISCED-3 classification), and migration background (binary). Aging (C-I) modifies the probability of experiencing unemployment and low-income employment, with a u-shaped probability towards younger and older adults (Lohmann, 2009), and poses higher mental health risks at later age stages (Donnelly, 2022; Glavin, 2015). Therefore, we added age as a categorical factor variable (20–29, 30–39, 40–49,-50-59, >60) to allow for a potential non-linear confounding effect of age. With a modified male-breadwinner labor-market model, the German labor market is still gendered (C-I) (Trappe et al., 2015) as well as the impact of occupational health (Artazcoz et al., 2007) and employment (Bartoll et al., 2014). We assume similar confounding effects for migration background and educational degree (C-I) (Brady & Biegert, 2017). Furthermore, previous studies found the regional labor-market to play and important role for mental health (Buffel et al., 2017). Since in Germany, there is still a labor-market separation between Eastern and Western Germany concerning unemployment and low-income employment rates (Schnabel, 2016), the regional labor-market could cause heterogeneity in the mediation process. We, therefore, also included Eastern and Western Germany as a confounder.

Regarding time-varying confounding, we found the individual and social context to matter the most. The confounding factors on the individual level are time-varying and potentially reciprocal. We view health behaviors and individual health as primary sources of individual time-varying confounders. Health behaviors potentially confound the economic worries - mental health path (C-III), while also being affected by employment type since employment types are associated with disadvantageous health behaviors such as heavy drinking (binary) and smoking (binary) (Grafova & Stafford, 2009; Mossakowski, 2008). Moreover, health behaviors have changed during the Covid-19 pandemic (Mata et al., 2021), thus increasing heterogeneity in confounding. Such exposure-induced mediator-outcome confounders violate assumptions C-IV. Similarly, physical health (continuous: SF-36 physical health score, BMI) is a C-IV confounder since it affects mental

health and economic worries while also being affected by employment type (Huang et al., 2016; Scott-Marshall & Tompa, 2011; Wagenaar et al., 2012).

The social context refers again to the gendered labor markets. Therefore, the partner's employment status (binary: 0 = not full-time-employed/1 = full time-employed) could, especially for females, alter the perception of economic worries and their own decision for (re-) entering the labor market and the type of employment, e.g., voluntary part-time employment (Jacob & Kleinert, 2014). Likewise, the number of children (continuous) and the partnership status (categorical) might place additional financial burdens, increasing mental health sensitivity toward economic threats (C-III/C-IV) (Hiekel & Kühn, 2022). Additionally, a change in occupational status could be a consequence of choice, e.g., through parental leave or by voluntary opt-out of the labor market, thus causing heterogeneity in the association of economic worries and mental health. To address this issue, we also added information on the reason for a change in occupational status as a confounder (0 = no change, 1 = voluntary change, 2 = in-voluntary change).

Concerning the Covid-19 pandemic-specific confounders, we added the month of the interview to capture some proxy information on the ongoing infection rate, and whether a short-time allowance (Kurzarbeitergeld) was received. Starting in March 2020 the German government made short-time allowance easily accessible as a response to the Covid-19 pandemic, thus potentially confounding the mediation process, by reducing the effect of economic worries on mental health. Simultaneously, the German government reduced the formal barriers to obtaining unemployment support (SGB II).

Fig. 2 shows the according to directed acyclic graph (DAG) of the mediation and confounding processes (Shpitser & VanderWeele, 2011). We included all time-varying confounders at t_0 and t_1 of the respective samples. We depicted them as Vt_0 and Vt_1 in Fig. 2, and, likewise, employment type (X), economic worries (M), and mental health (Y) at t_0 and t_1. The assumed process represented in Fig. 2 consists of the auto-correlative paths (e.g., $X_{t0} \rightarrow X_{t1}$, …) and cross-lagged-paths (e.g., $Y_{t0} \rightarrow M_{t1}$, …), as well as concurrent paths ($X_{t1} \rightarrow M_{t1}$; …). In this way, Fig. 2 contains the time-varying and reciprocal process. The time-varying confounders at V_{t1} are C-IV confounders on the path from $X_{t1} \rightarrow M_{t1} \rightarrow Y_{t1}$, therefore, traditional mediation approaches will remain non-parametrically unidentified, irrespective of observability and adjustment for these confounders.
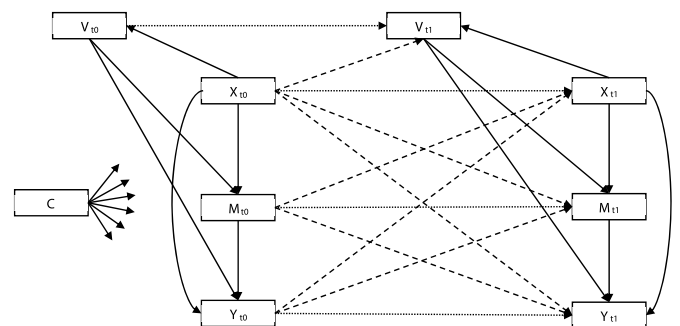

Fig. 2. Directed Acyclic Graph of longitudinal mediation with exposure-induced mediator-outcome confounding by V_{t1}
Note: For visualization purposes, paths of time-constant confounders (C) and cross-lagged confounding paths of V_{t0} are not depicted. Time-constant confounders C = ISCED-3, year of birth, migration background, gender, East/West Germany, month of interview. Time-varying confounders V_{t0}/V_{t1} = health behaviors (alcohol consumption, smoking), physical health (BMI, PCS), social factors (partnership status, number of children, partner's employment status, (in-)voluntary opt-out of the labor market, reception of short-term-allowance).

2.3. Statistical analyses

2.3.1. Mediational g-formula

VanderWeele and Tchetgen Tchetgen (2017) proposed the mediational g-formula to identify mediation despite having C-IV confounding. Multiple sets of inverse-probability weights (IPW) disentangle the C-IV confounders from the exposure. The mediational g-formula can integrate non-linearities and XM-interactions. Especially the latter is important for addressing RQ1 adequately since we assumed the mediation to increase in slope for the working poor and unemployed group due to lesser coping capabilities and higher deprivation. The mediational g-formula also provides an interpretation based on the so-called interventional indirect effect (IIE). The IIE interprets as the potential change in mental health due to a hypothetical intervention on the mediator (economic worries). This interpretation is often of greater interest to public health since the exposures (e.g., employment type, diseases, etc.) are less tangible than the mediators. Applying the mediational g-formula is straightforward and only requires three steps.

Step 1 is calculating the IPW for an outcome and a mediator model. The outcome IPW is the product of the IPW for receiving the exposure and mediator depending on the confounders (C, V_{t0}, V_{t1}) and previous values of the employment type, economic worries, and mental health (X_{t0}, M_{t0}, Y_{t0}). Similarly, the mediator IPW derives from the probability of having a certain employment type dependent on the confounders and previous values. In Eq.1 and Eq.2, we provide the formulas for the outcome and mediator model IPW.

Eq. 1 Applied IPW for outcome model IPW

$$\frac{\widehat{P}\{M_{t1}|X_{t1}, X_{t0}, M_{t0} \ C\}| \ \widehat{P}\{X_{t1}| \ X_{t0}, M_{t0}, C\}}{\widehat{P}\{M_{t1}|X_{t1}, X_{t0}, M_{t0}, V_{t1}, V_{t0}, C\}|\widehat{P}\{X_{t1}| \ X_{t0}, M_{t0}, C, V_{t1}, V_{t0}\}}$$

Eq. 2 Applied IPW for mediator model IPW

$$\frac{\widehat{P}\{X_{t1}| \ X_{t0} \ C\}}{\widehat{P}\{X_{t1}| \ X_{t0}, M_{t0}, C, V_{t1}, V_{t0}\}}$$

Step 2 estimates the outcome (Eq.3) and mediator (Eq.4) marginal structural model (MSM). Eq.3 contains the effects of employment (Yb_1), and economic worries (Yb_2) on mental health while also allowing for an XM-interaction (Yb_3), thus including different effects for the level combinations of employment and economic worries. Eq. 4 estimates the strength of the association between employment and having economic worries (Mb_1). Where, Yb_1 is often referred to as the c-path, Yb_2 as the b-path and Mb_1 as the a-path by traditional mediation analysts (MacKinnon et al., 2020).

Eq.3. Outcome MSM with XM-interaction

$$E\left(Y_{(xm)}\right) = Yb_0 + Yb_1 + Yb_2 + Yb_3$$

Eq.4. Mediator MSM

$$E\left(M_{(x)}\right) = Mb_0 + Mb_1$$

Step 3 provides the decomposition of the total effect (TE) parameter into its direct, indirect, and interacted parameters (Eq.5). The parameters are derived from the coefficients of the MSMs in Step 2 via the product method. Confidence intervals (CI) are obtained by bootstrapping with 5.000 iterations. The interventional direct effect (IDE) is the sum of the controlled direct effect (CDE) and the reference interaction (RefInt). The interventional indirect effect (IIE) consists of the pure indirect effect (PIE) and the mediated part of the interaction (MedInt). The decomposition of the mediation process is desirable since it also allows a distinguished comparison of the process between pre-and-per Covid-19 samples. For instance, the IDE could be increased during the pandemic, but is this increase due to a stronger effect of employment types with mental health (CDE)? – or due to a stronger interaction effect with economic worries on mental health (RefInt) during the pandemic?

Eq.5. Decomposition of TE with XM-interaction

$$TE = (CDE + RefInt) + (MedInt + PIE) = IDE + IIE = (Yb_1 + Mb_0 Yb_3)$$
$$+ (Mb_1 Yb_3 + Mb_1 Yb_2)$$

2.3.2. Difference-in-difference approach

We used the DiD approach to evaluate potential differences in the assumed mediation process before and during the pandemic. The DiD estimates in Eq.6 are the simple difference in parameters of Eq.5 between the per- and pre–Covid-19 samples. Consequently, we assumed the parameters obtained from Eq.5 in the pre-Covid-19 sample to correspond to the quasi-control group and the same parameters in the per-Covid-19 sample to correspond to the treatment group.

Eq.6 DiD comparison of the mediational g-formula

$$DiD = PER[TE, CDE \ RefInt, MedInt, PIE, IDE, IIE]$$
$$- PRE[TE, CDE \ RefInt, MedInt, PIE, IDE, IIE]$$

The DiD comparison, however, requires the satisfaction of mainly three further assumptions: (1) quasi-experimental assignment, (2) parallel trend, and (3) stable unit treatment value assumption (SUTVA). Comparing a pre-Covid-19 and a per-Covid-19 sample in a longitudinal study can justify the quasi-experimental assignment assumption (1), as previous research has shown (Oude Groeniger et al., 2021) since individuals could not directly self-select themselves in the pre-and per-Covid-19 survey waves. The parallel trend assumption (2) requires, for instance, the mental health trends for individuals in the working poor group between t_{0pre} and t_{1pre} to be parallel to those with regular employment at the same time points. Utilizing four-time points (t_{0pre}, t_{1pre}; t_{0per}, t_{1per}) allows visually inspecting the parallel trend assumption. Lastly, we can satisfy the SUTVA assumption (3) since we estimate the effect of employment type at t_1 while adjusting for the employment type at t_0 in the respective samples. Consequently, instability of the treatment value is implausible to occur during t_1.

2.3.3. Sensitivity analysis

Mediation analysis should always perform sensitivity analysis. We inspect the sensitivity of our analysis in five ways:

(1) The IPW stability (Cole & Hernán, 2008);
(2) the error-term between outcome MSM (Eq.3) and mediator MSM (Eq.4) (Imai et al., 2010);
(3) comparison between mediational g-formula and traditional mediation analysis;
(4) inspection of potential selectivity in the pre-and per-Covid-19 samples;
(5) visual inspection of the parallel trend assumption required for the DiD comparison.

(1) The IPWs should have a mean of around one and a standard deviation (SD) below one. Unstable IPWs can be attributed to an inefficient exposure and mediator prediction model. (2) A high error-term correlation indicates the presence of unobserved confounding. (3) We provide covariate-adjusted traditional mediation analysis in Table A1, these should provide severely underestimated mediation parameters due to the adjustment of C-IV confounders, a particular form of over-control bias (Elwert & Winship, 2014). (4) Sample selectivity (SS) can inform on the selectivity in the sample caused by requiring valid observation during the Covid-19 pandemic. Lastly (5), we visually inspect the parallel-trend assumption in Fig. 3.

3. Results

3.1. Descriptive statistics

Table 1 presents the descriptive statistics of economic worries, mental health, gender, and age for the pre-and per-Covid-19 sample
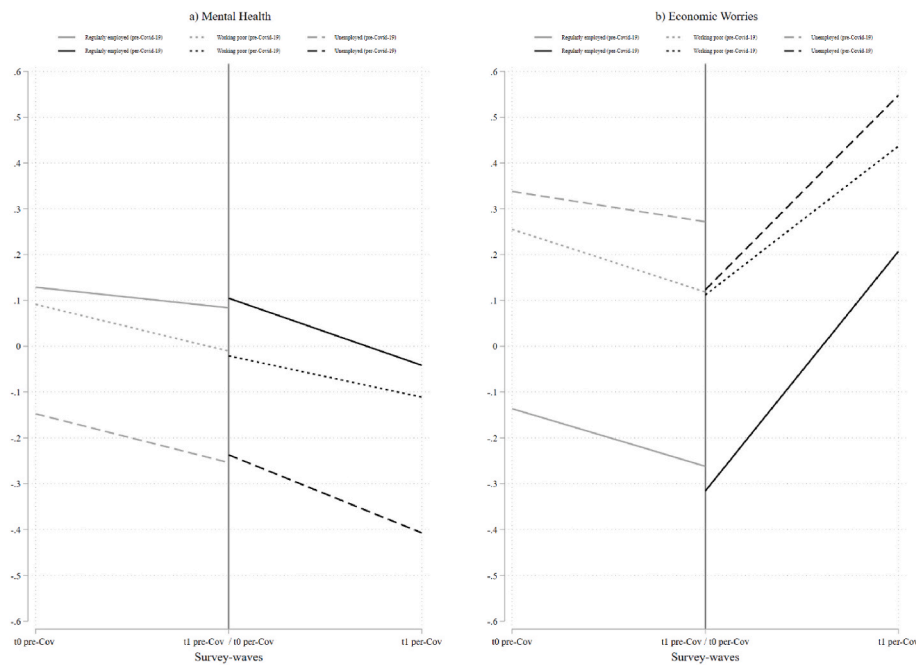
Fig. 3. a&b) Z-standardized trends at each survey wave between samples and employment type
Note. Shadings: gray = pre-Covid-19); black = per-Covid-19; Solid-lines: regularly employed; dotted-lines: working poor; dashed-lines: unemployed.

Table 1
Descriptive sample characteristics stratified by employment type.

	Pre-Covid-19				Per-Covid-19				
	Total				Total				
Variables	Mean/%	Min	Max	SD	Mean/%	Min	Max	SD	SM
MCS t_0	51.10	3.80	77.40	9.67	50.50	6.90	74.40	9.68	-0.062
MCS t_1	50.40	3.59	75.70	9.73	49.20	4.97	75.00	9.73	-0.123
Economic worries t_0	2.73	1.00	5.00	1.13	2.65	1.00	5.00	1.13	-0.071
Economic worries t_1	2.57	1.00	5.00	1.09	2.98	1.00	5.00	1.09	0.376
Age at t_1	43.20	20.00	64.00	11.70	43.50	20.00	64.00	11.60	0.026
Females	56%				56%				
	Regularly employed at t_1 (48.26%)				Regularly employed at t_1 (52.26%)				
MCS t_0	51.90	12.60	77.40	8.84	51.60	7.52	73.60	8.76	-0.034
MCS t_1	51.40	7.85	73.10	8.81	50.10	5.80	74.10	9.37	-0.148
Economic worries t_0	2.48	1.00	5.00	1.05	2.44	1.00	5.00	1.02	-0.038
Economic worries t_1	2.32	1.00	5.00	1.00	2.84	1.00	5.00	1.07	0.520
Age at t_1	44.60	20.00	64.00	10.90	44.90	20.00	64.00	11.40	0.028
Females	52%				52%				
	Working poor at t_1 (30.66%)				Working poor at t_1 (27.42%)				
MCS t_0	51.30	7.46	75.60	9.40	50.40	13.30	71.70	9.70	-0.096
MCS t_1	50.50	9.50	74.00	9.40	49.40	4.97	75.00	10.00	-0.117
Economic worries t_0	2.94	1.00	5.00	1.10	2.88	1.00	5.00	1.09	-0.055
Economic worries t_1	2.74	1.00	5.00	1.06	3.09	1.00	5.00	1.11	0.330
Age at t_1	42.30	20.00	64.00	11.20	42.70	20.00	64.00	12.10	0.036
Females	54%				56%				
	Unemployed at t_1 (21.09%)				Unemployed at t_1 (20.32%)				
MCS t_0	49.00	3.80	76.30	11.40	47.90	6.90	74.40	11.50	-0.096
MCS t_1	48.00	3.59	75.70	11.60	46.40	6.74	72.70	11.60	-0.138
Economic worries t_0	3.02	1.00	5.00	1.22	2.90	1.00	5.00	1.16	-0.098
Economic worries t_1	2.91	1.00	5.00	1.19	3.22	1.00	5.00	1.15	0.261
Age at t_1	41.20	20.00	64.00	13.60	41.00	20.00	64.00	14.30	-0.015
Females	69%				68%				

Note. Nprecov = 8266; Total Npercov = 7294. SM = (Mean$_{tper}$ - Mean$_{tpre}$)/SD$_{pre}$.

stratified by the three employment types. The comparisons of the main variables and the samples show that in the pre-Covid-19 sample, the participation of individuals with working poor status was higher than in the per-Covid-19 sample (30.66% vs. 27.42%). Still, individuals with regular employment were observed more often in the per-Covid-19

sample (48.26% vs. 52.26%), and the share of unemployed individuals was only slightly higher in the pre-Covid-19 sample. Concerning age and sex differences, there are only a few differences between the samples, with more females working poor or unemployed, confirming the modified male-breadwinner model in Germany. Further, unemployed

individuals were more often at a younger age on average (ca. three years), irrespective of pre- or per-Covid-19 sample. A gradient in mental health based on the employment type is also apparent towards lower mental health for the working poor and unemployed, with overall lower levels of mental health during the Covid-19 pandemic.

However, a similar gradient due to employment type is also apparent for the economic worries, with major differences between the samples. Where economic worries seem to decrease slightly between t_0 and t_1 in the pre-Covid-19 samples, the economic worries increased during the Covid-19 pandemic. For instance, those regularly employed at t_{1per} had higher economic worries (2.84) than working poor individuals at t_{1pre} (2.74), and the overall level across all employment groups at t_1 rose from 2.57 to 2.98.

For quantification of sample selectivity bias due to the Covid-19 pandemic (Millard et al., 2023), Table 1 contains a selectivity measure (SM) similar to the experimental selectivity Lindenberger et al. (2002), where we use the baseline differences of the samples divided by the SD of the pre-Covid-19 sample as an indicator for selectivity (SM = Mean$_{per}$ - Mean$_{pre}$/SD$_{pre}$). The SM values should be near zero between pre- and per-Covid-19; otherwise, a selection due to the Covid-19 pandemic would be indicated. The SM indicates low selectivity towards less mental health at baseline (t_0) (SM = -0.062) and fewer economic worries (SM = -0.071). These selectivities increase for the working poor and unemployed group but remain below -0.1.

Fig. 3a shows the Z-standardized averages for mental health and economic worries (Fig. 3b) at t_0 and t_1 in the respective samples for the three employment types. Z-standardization to a mean of zero and a SD of one enables comparability of mean and deviation on the Y-axis between mental health and economic worries. Concerning mental health in the pre-Covid-19 sample, large initial level differences between the employment types are apparent, with unemployed individuals (dotted line) having the lowest mental health. In contrast, the difference in mental health for the regularly employed and working poor group is relatively low (solid vs. dashed line). Between t_0 and t_1, mental health reduces across all employment types. This negative trend in mental health is also apparent in the per-Covid-19 sample, but steeper for those being regularly employed and unemployed and relatively stable for those working poor. Overall, mental health was the lowest at t_1 (2020) in the per-Covid-19 sample.

Concerning economic worries, Fig. 3 reveals greater differences between the pre-and per-Covid-19 samples. Unlike mental health, economic worries are much closer between the working poor and the unemployed group, while the economic worries for the regularly employed group are the lowest. The pre-Covid-19 sample has a decreasing trend of economic worries for all employment types between t_0 and t_1. In contrast, the trend reverses in the per-Covid-19 sample for all employment types. At t_0 in the per-Covid-19 sample, the overall lowest economic worries were observed, yet the increase at t1 was so steep that the overall highest economic worries are present for all employment types across all survey waves.

3.2. Mediation analysis

Table 2 contains the coefficients of the IP-weighted MSMs from Eq.3 and Eq.4, where the exposure variable (Yb1) coefficients are derived from categorical variables, with regularly employed as the reference category (=0). In the pre-Covid-19 sample, Mb$_1$ of the mediator MSM for the working poor group indicates a significant increase of 0.440*** in economic worries and increasing to 0.628*** when being unemployed instead of regularly employed. In the per-Covid-19 sample, the relation is similar but at lower levels, with 0.272*** for the working poor group and 0.414*** for the unemployed group. The outcome MSM shows a significant interaction term in the pre-and per-Covid-19 sample -0.499*** and -0.356**, supporting the addition of XM-interactions. The sensitivity parameters in Table 2 confirm the success of the weighting procedure and the absence of remaining unobserved confounding. The

Table 2
Results of the inverse-probability weighted marginal structural models and sensitivity parameters.

	Pre-Covid-19	Per-Covid-19
	Coefficient [C.I.]	Coefficient [C.I.]
Estimates of MSM		
Eq.3 Mb$_0$ constant	2.297*** [2.264; 2.329]	2.812*** [2.775; 2.848]
Eq.3 Mb$_1$ Working poor on economic worries	0.440*** [0.387; 0.493]	0.272*** [0.210; 0.333]
Eq.3 Mb$_1$ Unemployed on economic worries	0.628*** [0.563; 0.694]	0.414*** [0.342; 0.485]
Eq.4 Yb$_1$ Working poor on mental health	1.188** [0.416; 1.960]	0.864 [-0.109; 1.838]
Eq.4 Yb$_1$ Unemployed on mental health	0.462 [-0.979; 1.902]	-0.970 [-2.828; 0.889]
Eq.4 Yb$_2$ Economic worries on mental health	-2.120*** [-2.414; -1.826]	-1.908*** [-2.198; -1.618]
Eq.4 Yb$_3$ XM-interaction on DS	-0.499*** [-0.776; -0.223]	-0.356** [-0.650; -0.062]
Sensitivity parameters	Mean (SD) [Min; Max]	Mean (SD) [Min; Max]
Outcome MSM IPW	1.083 (0.341) [0.241; 5.047]	1.105 (0.378) [0.252; 3.847]
Mediator MSM IPW	1.057 (0.268) [0.270; 3.380]	1.109 (0.374) [0.265; 3.536]
Rho Eq.1 & Eq.3	0.039	0.028

Note. Eq.3-4 IP-weighted generalized linear models; Eq. 4-5 given at the average level of social exclusion; *p<.05, **p<.01, ***p<.001.

IPWs are stable, with a mean around one and a SD below 0.5 with relatively low minima and maxima. The error-term correlations (Rho) between the mediator and outcome MSM are close to zero, following Imai et al. (2010), a correlation of unequal zero indicates the presence of remaining confounding between the mediator and outcome model. Comparing the coefficients between pre-and per-Covid-19 samples shows a decrease in coefficient magnitude for the mediator and outcome MSM in the per-Covid-19 sample.

To inform on the time-varying mediation process in detail, Table 3 contains the mediation and interaction parameters of Eq.5 and the DiD parameters of Eq.6. Table 3 confirms economic worries to be an important mediator of the employment type – mental health association with 33.85% mediation in the pre-Covid-19 sample and 27.70% in the per-Covid-19 sample. In the pre-Covid-19 sample, the relative importance of economic worries for mental health increases for the working poor group (35.01%) and increases even further for the unemployed group (61.73%). The relation between PIE and IntMed shows that a fourth of the IIE is due to mediated interaction. For instance, the IIE for the working poor group in the pre-Covid-19 sample is -3.110***, and since the IIE is the sum of PIE (-2.517***) and IntMed (-0.593*) not allowing for XM-interaction would yield an underestimation of the IIE by one fourth. Comparing the working poor group with the unemployed group confirms similar processes between the employment groups with higher magnitudes for those facing unemployment.

Of great interest for this study is comparing the mediation process between the pre-and per-Covid-19 samples (RQ 2). The last column of Table 3 provides information on the DiD estimates of Eq.6 (PER – PRE), which is the difference between column 3 (per-Covid-19) and clomun 2 (pre-Covid-19) estimates. Since the estimates point in a negative direction and Eq. 6 a positive value in the last column means a reduction from pre-to per-Covid-19. Between the samples, the share mediated reduced by approx. 6.15Pp. This reduction is mainly due to a decreased IIE. Both the PIE and the IntMed nearly halved between the samples. Unlike these indirect paths of economic worries, employment's direct and interacted paths (IDE, CDE, IntRef) on mental health remained relatively stable. Consequently, indicating significant reductions in the indirect paths for the working poor group (IIE$_{did}$ = 1.450***) and the unemployed group (IIE$_{did}$ = 4.089***). For comparisons, the average decrease of the direct effect paths of employment was insignificant at IDE$_{did}$ = 0.031.

Overall, Table 3 confirms economic worries are an important

Table 3

Direct, indirect, interacted, and DiD parameters for different employment types: overall, working poor and unemployed.

	Pre-Covid-19 sample	Per-Covid-19 sample	DiD (Eq.6)
Overall	Coefficient [C.I.]	Coefficient [C.I.]	Coefficient [C.I.]
PIE	-0.677***	-0.402***	0.275***
	[-0.832; -0.522]	[-0.484; -0.319]	[0.114; 0.436]
IntMed	-0.189**	-0.089*	0.099
	[-0.321; -0.056]	[-0.160; -0.018]	[-0.038; 0.237]
IntRef	-1.322**	-1.164**	0.158
	[-2.195; -0.449]	[-2.032; -0.296]	[-0.950; 1.266]
Eq.4 IIE	-0.868***	-0.490***	0.378***
	[-1.028; -0.707]	[-0.586; -0.394]	[0.213; 0.543]
Eq.4 IDE	-0.828	-0.789	0.031
	[-1.704; 0.048]	[-1.646; 0.069]	[-1.073; 1.134]
Eq.4 TE	-2.563***	-1.768***	0.409
	[-3.578; -1.548]	[-2.706; -0.829]	[-0.748; 1.566]
Eq.4% of IIE on TE	33.85%	27.70%	-6.15Pp
Working poor	Coefficient [C.I.]	Coefficient [C.I.]	Coefficient [C.I.]
PIE	-2.517***	-1.399***	1.118**
	[-3.182; -1.852]	[-1.764; -1.034]	[0.406; 1.830]
IntMed	-0.593*	-0.261*	0.332
	[-1.060; -0.126]	[-0.492; -0.031]	[-0.155; 0.818]
IntRef	-3.097**	-2.703*	0.394
	[-5.439; -0.754]	[-5.021; -0.386]	[-2.592; 3.379]
Eq.4 IIE	-3.110***	-1.660***	1.450***
	[-3.741; -2.478]	[-2.062; -1.258]	[0.750; 2.149]
Eq.4 IDE	-2.657*	-2.432*	0.225
	[-5.009; -0.305]	[-4.750; -0.113]	[-2.763; 3.213]
Eq.4 TE	-8.876***	-5.752***	2.095
	[-11.703; -6.049]	[-8.341; -3.162]	[-1.232; 5.423]
Eq.4% of IIE on TE	35.01%	28.86%	-6.15Pp
Unemployed	Coefficient [C.I.]	Coefficient [C.I.]	Coefficient [C.I.]
PIE	-7.675***	-4.545***	3.129***
	[-9.452; -5.898]	[-5.517; -3.573]	[1.275; 4.984]
IntMed	-1.808*	-0.848*	0.959
	[-3.239; -0.377]	[-1.622; -0.075]	[-0.526; 2.445]
IntRef	-6.606**	-5.767*	0.840
	[-11.603; -1.609]	[-10.711; -0.822]	[-5.529; 7.208]
Eq.4 IIE	-9.482***	-5.394***	4.089***
	[-11.344; -7.621]	[-6.525; -4.262]	[2.211; 5.967]
Eq.4 IDE	-5.978*	-5.353*	0.625
	[-10.968; -0.988]	[-10.288; -0.418]	[-5.736; 6.985]
Eq.4 TE	-15.460***	-10.747***	4.713
	[-21.313; -9.608]	[-16.184; -5.310]	[-2.416; 11.843]
Eq.4% of IIE on TE	61.34%	50.19%	-11.16Pp

Note. Confidence intervals [C.I.] in brackets and obtained via bootstrapping with 1000 replications. Hypothetical intervention on the mediator to the population average. Regular employed as the reference category for working poor and unemployed. *p<.05, **p<.01, ***p<.001.

mediator, especially when facing working poverty and unemployment. However, contrary to the expectation in RQ2, Table 3 shows that mediation by economic worries of employment type - mental health association decreased during the Covid-19 pandemic. In contrast, the direct paths between employment type and mental health remained stable. These results show that a potential intervention to the population's average economic worries before the Covid-19 pandemic could alter the labor-related mental health polarization more strongly than during the Covid-19 pandemic.

As expected, the covariate-adjusted mediation in online-appendix Table A1 produced severely overcontrolled estimates. Further, we conducted the same analysis (Table 3) in online-appendix Table A2 stratified for gender. The motivation for providing additional gender stratification lies in Germany's modified male-breadwinner model, which might substantially alter the process between employment type

and economic worries on mental health. We found larger differences for males between pre-and per-Covid-19 pandemic. E.g., for unemployed males before the Covid-19 pandemic, economic worries nearly fully mediated the effect on mental health (~82%). However, during the Covid-19 pandemic, the share nearly halved to ~46%. For unemployed males, we found a significant increase in the IDE during the Covid-19 pandemic (DiD_{IDE} = -4.364**). In contrast, unemployed females had experienced no change in mediation with ~51% before and during the Covid-19 pandemic. (see online-appendix Table A2). Before the Covid-19 pandemic females and males showed similar magnitudes of TE, however, during the Covid-19 pandemic the TE for males increased, while, e.g., for females within the working poor group the TE nearly halved from TE_{pre} = -10.511*** to TE_{per} = -5.664**, and the source for this reduction of the TE is relatively evenly distributed across the direct and indirect paths.

4. Discussion

Guided by the dualized labor polarized health hypothesis, our study aimed at identifying the process between employment types (dualized labor) and mental health (polarized health). Economic worries are a strong mediator (RQ1) with a share mediated ranging from ~28% to ~61%, depending on the employment type and pre- or-per-Covid-19 pandemic context. Overall, we found a gradient towards the working poor and unemployed group. Based on past research on exogenous shocks and current findings of the Covid-19 pandemic that highlighted vulnerable populations to be more affected during crises, we expected the gradient and mediation to increase during the Covid-19 pandemic (RQ2). Indeed, on a descriptive level, we found the overall levels of mental health to decrease and the levels of economic worries to increase during the Covid-19 pandemic (see Fig. 3). Yet, during the Covid-19 pandemic, the mediation by economic worries decreased. Simultaneously, employment type's direct effect (IDE) and interacted effect components (IntRef) remained relatively stable. Contrary to our assumption in RQ2, the Covid-19 pandemic did not increase the mediation. In the following, we will discuss these results concerning the dualized labor polarized health hypothesis, methodology, and implications for future research.

Previous research framed the Covid-19 pandemic as an accelerator of persistent social inequalities in mental health (Kämpfen et al., 2020; Kraut et al., 2022; Reme et al., 2022). Consequently, we assumed the preexisting process to accelerate during the Covid-19 pandemic. We found strong evidence for the direct effect components of employment type on mental health to remain stable, while the magnitude of the indirect effect components decreased. In this manner, one could assume that the Covid-19 pandemic even reduced social inequalities. Although this interpretation is tempting, it is flawed because the overall economic worries increased across all employment types and were even more elevated for those with regular employment. This trend during the Covid-19 pandemic statistically weakened the association between employment type and economic worries (a-path). Simultaneously, across all employment types, mental health levels also decreased irrespective of the economic worries, statistically weakening the economic worries mental health association (b-path). Both led to a statistical decrease in mediation due to changes in economic worries and mental health during the pandemic that are independent of the mediation process. The direct effect components (IDE, CDE; IntRef) remained stable, which we view as supportive of the dualized labor polarized health hypothesis since the employment type gradient in mental health persists despite the Covid-19 pandemic-specific trends.

We interpret the stability of the direct effect components and the reduction of the indirect effect components as an increase of competing mediators during the Covid-19 pandemic. Such mediators must lay on the path between employment type and (mental) health and could be present in the workplace arrangement, as it changes the exposure risk of a Covid-19 infection (Godefroy & Lewis, 2022). Similarly, being able to

work remotely (Bajos et al., 2021; Kramer & Kramer, 2020) and the overall social gradient in the risk for Covid-19 infection (Beese et al., 2022; Wachtler et al., 2020). Stratified by the employment type, these aspects could emerge during the Covid-19 pandemic and create additional mental health burdens competing with economic worries.

Concerning gender differences, we found males to show a more pronounced decrease in mediation during the Covid-19 pandemic, while the direct and total effect increased. Contrary, females showed few changes in mediation but strong decreases in the total effect of employment on mental health. We interpret these results as supportive of the modified male-breadwinner model for three reasons. First, a fallback into traditional gender roles during the Covid-19 pandemic seems observable (Reichelt et al., 2021; Rosenfeld & Tomiyama, 2021). In line with this fallback is the decrease in the total effect of employment on mental health for females and the increase for males. Thus, the dualized-labor polarized (mental-) health process seems to substantiate for males during the Covid-19 pandemic. However, the mediation by economic worries also decreased for males, which might be partially explained by the described disentanglement of the a- and b-path and competing gender-labor-specific mediators. Future research should reflect on these gender-specific processes during the Covid-19 pandemic in depth.

It must be emphasized that economic worries are the key mediator, irrespective of the Covid-19 pandemic. Even in the lowest scenarios, the share mediated was comparatively high. Hence, we advise policymakers to reduce social inequalities in mental health by targeting economic worries. Based on the DiD estimates, such interventions should be considered before and not just during crises.

4.1. Strengths and limitations

This is the first study to provide a quasi-experimental extension to the mediational g-formula. Concerning the methodological approach to longitudinal mediation analysis, our study has three compelling strengths.

First, the mediational g-formula allows non-parametric identification of mediation despite exposure-induced mediator-outcome confounding (C-IV). C-IV confounding, however, is the rule rather than the exception when investigating time-varying phenomena (VanderWeele & Tchetgen Tchetgen, 2017). The DAG in Fig. 2 indicated that such confounders are likely to exist in the time-varying confounders, e.g., physical health and health behaviors.

Second, the integration of XM-interaction, since the assumption of equal mediation across the combination of employment type and economic worries is likely to be violated. Table 3 confirmed the presence of XM-interactions. Here the share mediated between the employment groups differed strongly, and the interaction term was significant, irrespective of the Covid-19 pandemic. Still, the effects of economic worries on mental health could be non-linear, especially across the different employment groups. In the online-appendix Figure A1, we provide a graphical inspection for potential non-linearities of the effects through a local polynomial regression with mental health on the y-axis and economic worries at the x-axis and a subgraph for each employment type. We mostly confirm linearity in the effects of economic worries on mental health across the employment types. However, we also observe some heterogeneity for those with low economic worries and high mental health in the unemployed group. This heterogeneity might be caused due to few observations at this combination, but could also give some support for earlier findings, that described a rather quick adaptation of mental health to unemployment (e.g., Böckerman & Ilmakunnas, 2009).

Third, the DiD estimation allowed decomposing the TE on mental health in a direct (CDE, IDE) path of employment type, an indirect (IIE, PIE) path mediated by economic worries, and an interacted path between employment type and economic worries (IntRef, IntMed). This decomposition allows comparison within and between the time-points (pre-and per-Covid-19). The advantage of this comparison is striking;

it quantifies the underlying mediation processes and potential changes due to the time-points. Our methodological approach can be used as a blueprint for researchers interested in investigating the impact of events, such as the Covid-19 pandemic, on preexisting processes. Concerning the overall interpretation of the found effects the mediational g-formula provides an interpretation based on a hypothetical intervention on the mediator. In our analyses, we imposed a hypothetical intervention on economic worries to the population average, however, alternatives are also plausible, especially when having a categorical mediator. Regarding the distribution of the outcome variable (see Table 1), the magnitude of the derived effects can be more comprehensible. For instance, the mean of mental health in the working poor group was 50.40 with a SD of 9.70. Thus, a total effect of -8.876*** indicates a significant reduction of nearly one SD-unit in mental health.

Yet the DiD comparison relied on additional assumptions. Although it is suitable to use the survey waves of panel studies before the Covid-19 pandemic as the quasi-control and the survey waves during the Covid-19 pandemic as the quasi-treatment group, selection bias in the data during Covid-19 can still come into play. As Millard et al. (2023) recently demonstrated, it should be tested for. Therefore, we inspected the selectivity measures in Table 1. Concerning sociodemographics, limiting both samples, pre-and-per Covid-19, to participants after March of the respective year (2018, 2020) achieved stabilization of the main sociodemographic variables. However, the trends for economic worries and mental health reflected a minor selection towards individuals with lower economic worries and mental health at t_0 (2018) in the per-Covid-19 sample. We interpret this selection as a potential conservative bias with a low magnitude (SM $<$ -0.1) because having fewer economic worries while having lower mental health might reduce the association of both. In such cases, future research should consider applying additional participation weights or even creating synthetic controls, as recently recommended by Abadie (2021). Regarding the SUTVA assumption, a switch of treatment status during the effect estimation period (t_1 of the respective sample) is implausible. The parallel trend assumption was valid between the employment types within the respective samples, although the trends reversed for economic worries in the per-Covid-19 sample.

Still, investigating cumulative effects could provide further insights. However, this would require identifying and modeling distinct employment trajectories (Eisenberg-Guyot et al., 2020). In this context, modeling for the transitions (timing) between the employment groups could also be worth investigating, e.g., the transition from regular employment to unemployment before and during the Covid-19 pandemic. A further limitation of our study consists in the relatively rough acknowledgment of regional labor-markets modifications of the mediation process, by only including Eastern/Western residency of the respondent as a confounder. A recent meta-analysis of 327 studies by Picchio and Ubaldi (2022) found that adverse labor market conditions are associated with stronger unemployment effects. In the online-appendix Table A3 we, therefore, present the parameters of Table 3 obtained by excluding Eastern Germany from the analysis. Table A3 shows that in the analysis of only Western Germany, the ratio of the parameters remains similar but at lower mediation levels and less decline between pre- and per-Covid-19. We encourage further studies to elaborate on the potency of other contexts, such as regional labor-markets or welfare policies, in modifying these processes during events, such as the Covid-19 pandemic. Likewise, how the contexts themselves change during these events (e.g., increase in unemployment rates, mental-health related hospitalizations) and reciprocally may affect the individuals within the context.

Concerning the Covid-19 pandemic timeframe, the per-Covid-19 sample consists of SOEP panel respondents between April and December 2020. Thus, capturing only the first pandemic year, which has ambivalent implications. The short-time allowance was implemented by the German government at 13. March.2020. We were able to adjust for the reception of short-time allowance as a confounder of the mediation

process, thus capturing this heterogeneity. Short-time allowance policies might have weakened the economic worries for the employed groups, yet our data suggested that economic worries increased quite drastically in the per-Covid-19 sample. The non-consideration of assets up to 60.000€ per household member was the largest change to the unemployment support (SGB II) during Covid-19 pandemic. This change potentially buffered some of the indirect effects on mental health for individuals that recently faced unemployment due to the Covid-19 pandemic. Further, it could be argued that the indirect path through economic worries on mental health requires time to unfold. Hence, the investigation of the mediation process throughout all stages of the Covid-19 pandemic and post-pandemic is worth future studies and, given the data, can be easily applied with the presented methodological approach.

A major strength of our study is the outlined methodology, which is not restricted to the German context and should be applied to other contexts and countries as well. For instance, a comparison of different welfare regimes (e.g., Germany as a proxy for a welfare state) could provide more details on the modification of the micro process by the meso-macro systems during the Covid-19 pandemic. Although we found economic worries increased for all employment types, such increases could be stronger when having a weak welfare state and potentially translate into an increase in the direct effect of economic worries on mental health but also an increased indirect effect by economic worries as initially assumed. Hence, a cross-country comparison using the outlined methodology would be worthwhile. Furthermore, we want to emphasize that the outlined methodology applies to all observable scenarios where events, such as new policies or labor-market disruptions (e.g., cost-of-living crises), affect pre-existing processes.

4.2. Conclusion

Our study highlights the urgent need for sophisticated methods when investigating the impact of the Covid-19 pandemic on preexisting processes. We applied the mediational g-formula to investigate longitudinal mediation and extended it with a quasi-experimental DiD comparison. Our results confirmed the dualized labor-polarized health hypothesis for mental health before and during the Covid-19 pandemic. We also confirmed economic worries to be a key mediator of this association. However, during the Covid-19 pandemic, mental health reduced more independently of economic worries. Simultaneously economic worries increased irrespective of employment type. These two processes reduced mediation by economic worries during the Covid-19 pandemic. Concerning the TE of employment on mental health, we found stark gender differences. While during the Covid-19 pandemic, the TE for males increased, females' TE nearly halved. In a gender-differenced approach, we encourage future researchers to investigate competing mediation processes, such as having the possibility of working remotely and the perceived threat of a Covid-19 infection at the workplace.

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CRediT authorship contribution statement

Ibrahim Demirer: Conceptualization, Methodology, Software, Validation, Formal analysis, Investigation, Writing – original draft, Visualization. **Timo-Kolja Pförtner:** Writing – review & editing, Supervision, Project administration, Funding acquisition, Validation.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The authors do not have permission to share data.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ssmph.2023.101469.

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