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RESEARCH PAPER

The Effect of the COVID-19 Pandemic on Life Satisfaction: Does Social Belonging Matter as a Mechanism and are There Differences by Age?

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Abstract
The effect of the COVID-19 pandemic on life satisfaction has been a topic of worldwide research, mostly indicating a drop in individual's life satisfaction with some differences between subgroups. However, literature on related mechanisms is scarce. This study examines whether the sense of social belonging is a mechanism that explains pandemic-related changes in life satisfaction across different age groups. Using a rich longitudinal data set of the adult cohort of the German National Educational Panel Study and employing fixed effects panel regression models, we show that the COVID-19 pandemic is, on average, negatively associated with individual life satisfaction and social belonging. Yet, mediation and sensitivity analysis questions the general importance of social belonging as a relevant mechanism irrespective of individuals' age. The results also suggest that the negative effects of the pandemic on social belonging were indeed significant for individuals with average or high pre-pandemic social belonging, while individuals with low pre-pandemic social belonging experienced an increase in their sense of social belonging. This leads to an expanded discussion of which groups of people are most affected by the impact of the COVID-19 pandemic and what other mechanisms can be hypothesized to explain this negative impact on people's life satisfaction.

Keywords COVID-19 pandemic · Life satisfaction · Social belonging · Mediation analysis · Age

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1 Introduction

A high level of individual life satisfaction is a universal goal (Lindenberg, 1996), and literature often highlights social crises as having a decisive influence on the level of satisfaction of the population (for a review, see Gudmundsdottir, 2013). Thus, the effect of the COVID-19 pandemic on life satisfaction has been a topic of worldwide research, examining how individuals rated their lives during the COVID-19 pandemic or comparing changes to the pre-pandemic period (see, e.g., Aknin et al., 2022; Prati & Mancini, 2021, or Croda & Grossbard, 2021 for a review).

However, longitudinal studies on changes in individuals' life satisfaction before and during the pandemic show ambiguous results, and the specific mechanisms remain unclear. Most studies have detected a decrease in life satisfaction (e.g., Bähr et al., 2022; Bittmann, 2022a, 2022b; Entringer & Kröger, 2021; Handschuh et al., 2021; Huebener et al., 2021; Zacher & Rudolph, 2021). However, the effect of the COVID-19 pandemic varies by individual characteristics, such as gender, age, family status, or psychological preconditions (e.g., Knepple et al., 2021; Wettstein et al., 2022; Zacher & Rudolph, 2021; Zoch et al., 2021). For example, Kivi et al. (2021) found stable life satisfaction among older adults, whereas Huebener et al. (2021) observed a decrease in life satisfaction among parents of young children. Moreover, only a small number of studies provide preliminary evidence of possible mechanisms linking the COVID-19 pandemic to life satisfaction (e.g., Aymerich-Franch, 2023; Lan et al., 2022; Pan et al., 2023). These studies do not, however, shed light on possible heterogeneities and largely focus on psychological mechanisms, e.g., perceived stress levels or hyperarousal. Thus, given the heterogeneity in the effect of the COVID-19 pandemic on life satisfaction and the small number of studies investigating mechanisms, the question of other mediating processes remains to be answered.

Some studies particularly highlight the limitations of social contacts and events (e.g., Graupensperger et al., 2022; Prati & Mancini, 2023) and the resulting loss of individuals' sense of social belonging as one potential mechanism in the link between the COVID-19 pandemic and life satisfaction (Marler et al., 2021). This is because during the COVID-19 pandemic physical contacts and group activities had to be reduced and social distancing measures forced people to adapt to this new situation, leading to activities that could be carried out alone or with a limited number of other people. This led to increased levels of loneliness and social isolation (see, e.g., Entringer et al., 2020; Entringer & Kröger, 2020, 2021; Ernst et al., 2022), which might indicate that individuals had difficulty fulfilling their need for social belonging. This need is best described as individual's deep feeling of connection with social groups, physical places, and individual and collective experiences (Allen et al., 2021). It contributes to personal affection and social well-being (Ormel et al., 1999) and also to the overall well-being of an individual (e.g., Hommerich & Tiefenbach, 2018; Jose et al., 2012). Thus, the individual sense of social belonging should be considered a decisive factor in the changes in individual life satisfaction related to the COVID-19 pandemic. Against this backdrop, empirical testing of this mechanism is crucial, and we ask to what extent social belonging mediates the effect of COVID-19 on life satisfaction. Of course, social belonging could also be of particular interest because it is a prerequisite for an individual's social participation, i.e. integration into social networks or membership of voluntary associations, and hence the source of a society's social capital (Ahn & Davis, 2020; Oyanedel & Paez, 2021; Putnam, 1993). This in turn is important for overall social crisis management processes, e.g. during a pandemic, as a high level of social capital in a society reduces the negative effects of far-reaching events and may support the effective

implementation of policy measures (Bartscher et al., 2021; Chuang et al., 2015). This could also reduce the negative effects on people's well-being, but through a different mechanism. However, the latter is not the focus of this study.

In this context, it is also important to consider heterogeneities by personal characteristics. Although the COVID-19 pandemic may influence all individuals in their sense of social belonging and life satisfaction, the effects of the pandemic might vary between individuals. This depends not only on the areas of life which were affected (e.g., work, family, or leisure time), but also on the perceived threat to social belonging as well as on individual coping strategies during the COVID-19 pandemic (Wettstein et al., 2022; Zacher & Rudolph, 2021). For example, factors such as age play a significant role in shaping responses to COVID-19-related challenges and emotion regulation, introducing heterogeneity into the proposed relationship (Brandtstädter & Renner, 1990; Mather & Carstensen, 2005). However, empirically, the impact of age differences on responses to the pandemic remains ambiguous. Despite older adults experiencing increased loneliness with the onset of the COVID-19 pandemic (van Tilburg et al., 2020), studies diverge on the effects on life satisfaction. Some suggest that older adults exhibit a less pronounced decline in life satisfaction (Biddle & Gray, 2021), while others report no age-group-related differences (Entringer & Kröger, 2021). It is important, therefore, to examine the role of people's sense of social belonging in the relationship between the COVID-19 pandemic and life satisfaction, with a particular focus on understanding these dynamics across different age groups.

Hence, the aim of this study is to determine whether changes in individuals' sense of social belonging mediate the effect of the COVID-19 pandemic on life satisfaction, and whether the relevance of this mechanism differ between sub-populations. In doing so, we add two main contributions to the previous literature. Firstly, we use longitudinal information on individuals' life satisfaction and sense of social belonging, applying the principles of modern causal mediation analysis as proposed by VanderWeele (2015). This approach enables us to investigate an assumed crucial mechanism connecting the COVID-19 pandemic to individuals' life satisfaction in adulthood, providing a nuanced and causal interpretation of these results. Secondly, we investigate the varying impacts of the COVID-19 pandemic on the primary variables of interest and their mediation for middle-aged and older adults, respectively, to gain a more profound understanding of the proposed associations among distinct subgroups.

2 Theoretical Background and Hypotheses

2.1 The Effect of the COVID-19 Pandemic on Life Satisfaction

The COVID-19 pandemic and its countermeasures have challenged individual life satisfaction by disrupting daily life across various domains. In this study, individual life satisfaction is defined as an overall evaluation of life referring to predefined goals and subjective criteria, including an individual's life circumstances and long-term consequences of life events (Diener, 1984). To illustrate the origins and mechanisms underlying life satisfaction, we draw upon the social production function theory. This theory posits that individuals actively produce their own subjective well-being, i.e., life satisfaction,[1] by optimizing the

[1] Life satisfaction is proposed to be a cognitive evaluation of subjective wellbeing (Diener, 1984).

attainment of two universal goals: physical well-being and social well-being (Lindenberg, 1996; Ormel et al., 1999).

Crucial factors for the individual's evaluation of life are life domains such as work and leisure time or social life, as they provide opportunities for the fulfillment of significant life goals. In terms of physical well-being, factors like occupation and income, associated with the work sphere, can be expected to affect individual life satisfaction due to their impact on individual status and comfort levels. Leisure activities, such as sports, hobbies, and group activities are closely linked to an individual's level of stimulation and activation. Regarding social well-being, social relationships emerge as major sources of behavioral confirmation and affection and provide, among other things, material, emotional and informational support in difficult situations (Argyle, 1999; Argyle & Martin, 1991; Ormel et al., 1999).

During the COVID-19 pandemic, countermeasures, especially those associated with social distancing, disrupted most of the areas essential to individual life satisfaction. For example, through COVID-19 pandemic measures, certain professions could not be carried out, working hours had to be reduced, and exchanges as well as cooperation had to be reconstructed, leading to a disruption of daily working routines and income. Similarly, due to these restrictions, some leisure activities–especially group activities–were no longer possible, resulting in fewer potentially positive experiences. Alongside the contact restrictions, these measures simultaneously diminished social relationships, resulting in a decline in crucial material and personal resources. This situation poses a threat to essential individual goals and needs, which are vital for a positive life evaluation. Therefore, we derive our first hypothesis:

H1 The COVID-19 pandemic decreased individuals' life satisfaction.

The reasons described above that affect life satisfaction may also affect the sense of social belonging. Social belonging reflects individuals' deep feelings of connection with social groups, physical places, and individual and collective experiences (Allen et al., 2021). Feelings of social belonging depend on individual's competencies, opportunities, motivations and perceptions. In the absence of any extraordinary circumstances, individuals develop a set of skills and abilities to connect and belong to others. If individuals have the opportunity to belong, that is, if they are able to connect with others through the availability of groups, people, places, times, and spaces (Allen et al., 2021), they may be able to form connections with others. However, the depth of these connections depends on underlying motivations, which can be defined as the need for social belonging. Furthermore, the extent to which individuals evaluate their level of social belonging is influenced by their individual perceptions. It can be posited that a sense of social belonging can only be achieved when all the requisite conditions are met (Allen et al., 2021).

In the context of the COVID-19 pandemic, however, the opportunities for individuals to experience social belonging were vulnerable to disruption. The implementation of social distancing measures and lockdowns made it impossible to engage with friends and close relatives in the same manner as before the pandemic. In addition, participation in collective experiences and connecting to places has not only changed, but in some cases was no longer possible (e.g. group activities). Consequently, these opportunities vanished, leading to a reduction in real-life social experiences, which inevitably should have affected the individual's sense of social belonging.

In addition, the quality of opportunities for social belonging may have changed due to the pandemic situations. When it came to interactions with other individuals or in a group,

it was different due to the measures such as keeping distance and wearing a mask, and people had to adapt to these new regulations. These changes could influence the quality and pleasantness of the encounters. While virtual interaction increased (e.g., Lange, 2020), the extent to which technology can replace face-to-face interactions remains uncertain (Allen et al., 2021). Consequently, disruptions in social experiences may result in diminished feelings of connection with others and less positive evaluations of these experiences, which in turn may lead to a diminished sense of belonging.

Taken together, the reduction in opportunities and changes in social experiences may lead to a negative effect of the COVID-19 pandemic on individuals' sense of social belonging. This brings us to our second hypothesis:

H2 The COVID-19 pandemic had a negative effect on individuals' sense of social belonging.

Building on the basic assumptions of social production function theory (Lindenberg, 1996; Ormel et al., 1999), we argue that the COVID-19 pandemic and its associated countermeasures had a detrimental impact on individuals' life satisfaction by affecting individuals social belonging levels. This is because the concept of social belonging is of significant importance in the context of social well-being, as it reflects the attainment and the utilization of valuable resources in the instrumental goals of social well-being. These instrumental goals are affection, behavioral confirmation, and status (Steverink & Lindenberg, 2006). The concept of social belonging encompasses the individual's confirmation in their interactions with others, both in personal contacts and in collective settings. This is an important basic condition for the feeling of behavioral affirmation. Furthermore, social belonging reflects one's level of affection, with those who exhibit high levels of social belonging perceiving their contacts as satisfying. Moreover, social belonging is an essential resource for individual's perceptions of social status. Only if someone can have social experiences and experience them as satisfying can the individual realize their social status. Thus, social belonging summarizes essential resources for achieving the individual`s goals in producing wellbeing, and can be considered a crucial determinant of life satisfaction (c.f. Hommerich & Tiefenbach, 2018; Mellor et al., 2008). Driving from the relevance of these resources related to social belonging for overall well-being, i.e., life satisfaction, we propose that the sense of social belonging should be a significant mediator in the effect of the COVID-19 pandemic on life satisfaction. This is because our feeling of belonging undergoes changes when opportunities to belong are disrupted and perceptions of social belonging changes by the effects of the COVID-19 pandemic. This might result in lower levels of affection as individuals no longer perceive the limited contacts as satisfying. In addition, since they do not feel belong in the similar way, experiences of behavioral confirmation as well as the experience of social status are reduced. All of which lead to a decrease in life satisfaction. These effects may be observed throughout the COVID-19 pandemic period since adjustments to the new situation as well as efforts to achieve goals through other means were significantly impeded by various interventions in all aspects of life. Hence, a part of the overall COVID-19-related changes in life satisfaction should be explained by changes in the sense of social belonging. Based on these theoretical arguments, we derive our third hypothesis:

H3 The individuals' sense of social belonging partially mediates the effect of the COVID-19 pandemic on individual life satisfaction.

2.2 Moderation by Individuals' Age

As one important factor of dealing with the COVID-19 pandemics' negative effects on social life, age might be of relevance due to its association with specific aims, cognitions and coping strategies. As older adults are a very heterogeneous group, we primarily focus here on the younger old, aged between 65 and 74 (Baltes & Smith, 2003), a life period typically connected to retirement and associated with significant changes in life circumstances that may also affect social life (e.g., Comi et al., 2022). Moreover, we address older adults residing outside nursing homes to ensure meaningful comparisons between age groups based on the presented theory.

In accordance with the principles of the social production function theory and its extension to successful aging, the relative salience, opportunities, and availability of resources to fulfil evolving needs change with higher age (Steverink & Lindenberg, 2006). Drawing on the arguments of the social production function theory, one could posit that social belonging becomes increasingly important in later life. As individuals age, certain instrumental goals (e.g., social status provided by one's occupation) may become more difficult to achieve. However, social well-being can still be maintained by focusing on other resources (e.g., intimate ties). This shift in priorities makes goals related to experiencing affection more crucial in older age. In essence, the significance of social belonging increases with age, emerging as a vital component in the overall well-being and successful aging of older individuals.

Moreover, beyond the previously mentioned arguments, changes in the availability of resources with advancing age are not the sole factor. Goals and cognition also play a crucial role. Carstensen, for example, states in her socioemotional selectivity theory (Carstensen, 2006; Carstensen et al., 1999) that late life is marked by a motivational shift driven by perceived constraints on time. When time is perceived as limited, which is typically associated with higher age, people prioritize emotionally meaningful goals over goals about exploration and expanding horizons. According to the socioemotional selectivity theory, these changes in cognition and memory by age lead to a growing focus on emotion regulation and control mechanisms that favor positive over negative information—an effect known as the positivity effect in memory (Mather & Carstensen, 2005). Hence, by focusing on emotional goals, older adults remember in ways that enhance their well-being (Mather, 2012; Mather & Carstensen, 2005). This emphasis on positive information may serve as a compensatory mechanism for the lack of goal achievement without any form of substitution.

In the context of the COVID-19 pandemic, these cognitive processes might become crucial. Even amid challenging circumstances, older adults, in contrast to their younger counterparts, are likely to direct their attention and memory to emotionally meaningful goals, fostering positive affect and well-being (Carstensen et al., 1999; Mather & Carstensen, 2005). By doing so, older adults might mitigate the potential negative impact of the pandemic on their emotional well-being and, consequently, protect their life satisfaction from the adverse effects of this period without compensating through increased efforts to satisfy needs for affection, as suggested by the social production function theory (cf. Carstensen et al., 2020; Steverink & Lindenberg, 2006). Understanding these cognitive processes sheds light on the resilience of older individuals in the face of external challenges and emphasizes the role of emotion-focused goals in shaping their overall well-being.

In addition, Brandtstädter and colleagues (Brandtstädter & Renner, 1990; Brandtstädter et al., 1993) have proposed that the coping strategy of accommodation becomes

more important in older age compared to assimilation. Both strategies aim at maintaining a positive view on the self. While assimilation focuses on changing the situation, accommodation seeks to change personal aims and goals, the latter being especially useful for situations, which are difficult to control, as is the case with a global pandemic. Here, older adults are assumed to have an advantage, as they are more experienced in using this strategy. Since older adults differ in their way of dealing with negative emotions and circumstances, their life satisfaction should be less impaired by COVID-19 pandemic-related threats when compared to younger adults. Consequently, although they might undergo similar changes in social belonging, these alterations may not result in a comparable reduction in life satisfaction, resulting in age-related differences in the mediation effect. Consequently, we derive our last hypothesis:

H4 Age moderates the mediating effect of social belonging on COVID-19 pandemic on individual life satisfaction such that the effect will be smaller for the oldest age group than for younger age groups.

3 Methods

3.1 Data

To test our theory-driven hypotheses, we utilized data from the adult cohort (SC6) of the German National Educational Panel Study (NEPS), which has been collected annually since 2009. This rich dataset spans 12 survey waves and includes 17,140 individuals born between 1944 and 1986, residing in private households in Germany. The dataset offers detailed insights into respondents' current life circumstances, accompanied by a wide array of repeated measures capturing individuals' perceptions of their lives, including dimensions such as social belonging and life satisfaction. It is well suited for the purposes of our study, as the data offers annual information on the concepts of interest as well as valuable data collected during the second wave of the COVID-19 pandemic in the winter of 2020/2021. The observation period in our study spans from 2016 to 2021, during which all necessary measurements were conducted. To ensure a sufficient number of cases in all age groups, we only considered adults aged 30 years and older at the time of the COVID-19 pandemic. For our analysis, we used individuals with at least three observations without missing information in the relevant variables. This is because the panel regression model applied requires at least three observations for each individual. Finally, our sample contains 34,923 observations from 7730 individuals who were surveyed on average about 4.5 times during the observation period (for descriptive statistics of the sample see Tables 5 and 6 of the Appendix).

3.2 Analytical Strategy

To identify the effect of the COVID-19 pandemic period on individual life satisfaction, the effect of this period on social belonging, the mediation of the link between the period of the COVID-19 pandemic and individual life satisfaction via individual feelings of social belonging, and the heterogeneity of the effect by age, we used fixed-effects panel regression models grounded in the following basic model:

$$y_{it} = X_{it}\beta + \alpha_i + \varepsilon_{it} \tag{1}$$

The basic model reflects the linear relationship between the dependent variable (y_{it}), and the independent variables (X_{it}) measured repeatedly in the subject and over time. It has two error components, one representing the time-constant error term (α_i), which reflects time-constant individual characteristics and living conditions, and an idiosyncratic error term, which varies over time and between subjects (ε_{it}). Fixed-effects regression models, however, only use the variation within subjects to predict changes in y_{it} due to changes in X_{it}. This procedure eliminates time-constant confounding factors and, consequently, reduces bias based on unobserved heterogeneity (Brüderl, 2010). This helps to more closely approach a causal interpretation of the mediation through the feelings of social belonging, since we assume to observe changes in individuals' life satisfaction based only on changes due to the COVID-19 pandemic. However, the estimates may be not consistent if the outcome before and after treatment does not follow the same trend, since confounding factors have an impact on the development of the outcome and the main independent concept. Thus, we implemented individual slopes by year to detrend the data as suggested by Wooldridge (2005) and Rüttenauer and Ludwig (2020). This allows us to consider secular changes in the relevant concepts based on the year of observation (Wooldridge, 2005).[2] The final model reads as follows:

$$y_{it} = X_{it}\beta + \alpha_{1i} + \alpha_{2i}t + \varepsilon_{it} \tag{2}$$

α_{1i} represents the time-constant error term as in Eq. (1), t reflects the slope variable, and α_{2i} the individual-specific slope parameters including a constant term.

We conducted our moderated mediation analysis in several steps. We began by investigating the unmoderated mediation of social belonging (see Fig. 1 for an overview), following the strategy suggested by Baron and Kenny (1986) and VanderWeele (2015). Referring to the first hypothesis, we investigated the total effect of the COVID-19 pandemic ($COVID19_{it}$) on individual life satisfaction ($satis_{it}$) also considering time-varying confounding factors ($controls_{it}$) based on the following equation:

$$satis_{it} = COVID19_{it}\beta_1 + controls_{it}\beta_2 + \alpha_{1i} + \alpha_{2i}t + \varepsilon_{it} \tag{3}$$

Secondly, we tested whether the COVID-19 pandemic affects individuals' social belonging (*socialbelong*), referring to the first part of the mediation chain and reflecting hypothesis two. Therefore, we estimated δ_1 within the following equation:

$$socialbelong_{it} = COVID19_{it}\delta_1 + controls_{it}\delta_2 + \alpha_{1i} + \alpha_{2i}t + \varepsilon_{it} \tag{4}$$

Thirdly, we augmented Eq. (3) by social belonging to investigate the effect of social belonging on individuals' life satisfaction conditioned on the COVID-19 pandemic period, reflecting the second part of the mediation chain (see γ_2 in Fig. 1 and Eq. 5) as well as yielding the direct effect of the COVID-19 pandemic period on life satisfaction (see γ_1 in Fig. 1 and Eq. 5).

$$satis_{it} = COVID19_{it}\gamma_1 + socialbelong_{it}\gamma_2 + controls_{it}\gamma_3 + \alpha_{1i} + \alpha_{2i}t + \varepsilon_{it} \tag{5}$$

[2] We estimate the model using the stata package xtfeis as provided by Ludwig (2019).

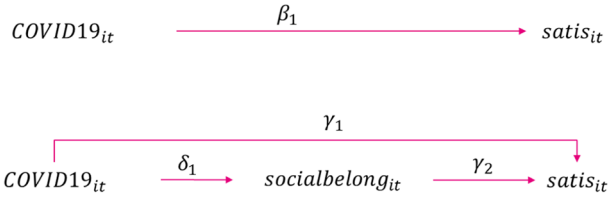

Fig. 1 Mediation analysis–overview (stylized DAG)

Finally, we calculated the indirect effect of the COVID-19 pandemic period on life satisfaction through the changes in social belonging to test our third hypothesis. We subtracted the direct effect (γ_1) from the total effect (β_1) of the COVID-19 pandemic indicator (β_1-γ_1) to obtain the indirect effect. To test whether the indirect effect is statistically significantly different from zero, we used the bootstrapping method with 1000 replications.

To test our last hypothesis, we repeated steps one to four for individuals aged from 30 up to 40, 40 up to 50, 50 up to 65, and 65 and older, separately. We defined the affiliation to each age group based on the last available observation, since we assume that the age group at the time of the onset of the COVID-19 pandemic is particularly relevant to examine differences in the pandemic's effect. We estimated the total, direct, and indirect effects for each age group and tested whether the indirect effect is statistically significantly different from zero or not. In a sensitivity analysis, we also estimated moderated mediation by pre-pandemic social belonging levels relative to the sample distribution and corresponding age group differences, testing whether these levels caused systematic differences in the mediation effect.

3.3 Operationalization

COVID-19 pandemic To investigate the effect of the COVID-19 pandemic period on individuals' life satisfaction and to conduct the mediation analysis, we refer to a binary indicator reflecting the period before and during the pandemic.[3] For this purpose, we defined the starting point of the pandemic as the declaration of a nationwide emergency in Germany at March, 16th of 2020. We classified an observation as 'before the COVID-19 pandemic' if the interview was conducted prior to March, 16th 2020, and as 'during the COVID-19 pandemic' if the interview took place after March, 16th 2020. In total, 6,365 interviews were conducted during the COVID-19 pandemic period, representing 18 percent of the total observations in the sample. The interviews were conducted during survey waves 12 (2019/2020) and 13 (2020/2021), encompassing the first year of the pandemic, as illustrated in Fig. 2.

Life satisfaction To measure individuals' life satisfaction, we referred to respondents' overall evaluations of their life, using a single-item question that asks "How satisfied are

[3] It remains unclear what specific type of political measure or situational aspect of the pandemic drives the effects. We assume heterogeneous mechanisms here as well. While for some individuals strict social distancing measures or even curfews might be the most relevant aspect, others might already be strongly influenced by media messages about high incidence rates, travel restrictions, closure of personal services (such as hairdressers, etc.) or restaurants. Overall, therefore, it seems reasonable to consider the entire pandemic period as a general or combined driver of declines in life satisfaction and social belonging, rather than focusing only on selected measures. A sensitivity analysis adding different types of measures to the data on a daily basis to test these assumptions resulted in a partialization of the effect and would hide the overall effect of the decline that we found (results are available upon request).

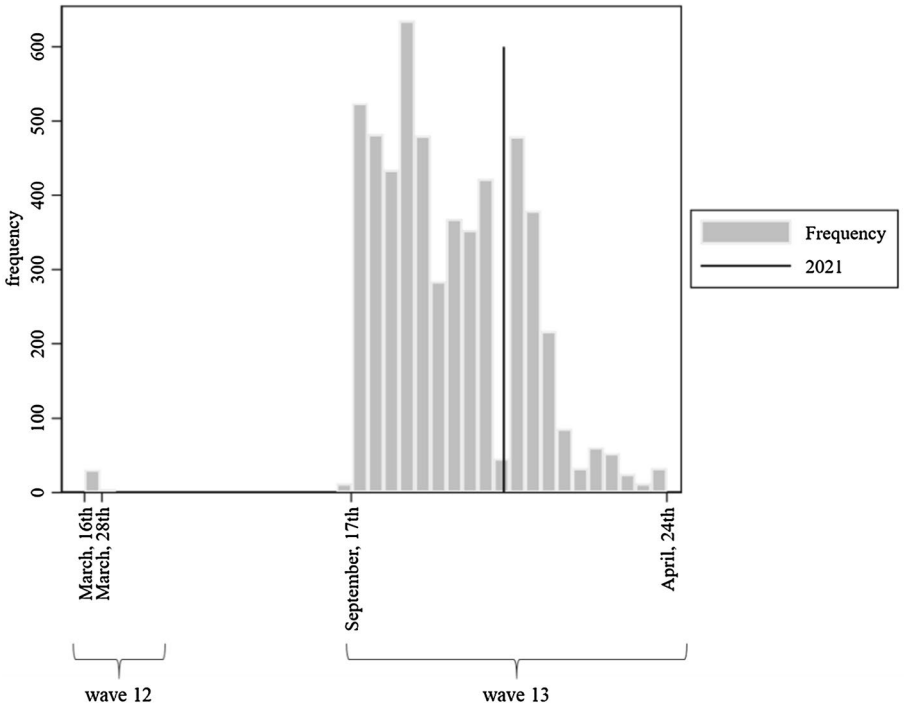

Fig. 2 Interview dates in 2020 and 2021 during the COVID-19 pandemic. *Source:* NEPS SUF SC6 (DOI: https://doi.org/10.5157/NEPS:SC6:13.0.0). Own illustration

you currently and in general terms with your life?". The scale ranges from 0 "very unsatisfied" to 10 "very satisfied". The measurement is solidly established in well-being research and shows high reliability compared to multi-item scales (e.g., Frey & Stutzer, 2002; Kahneman & Krueger, 2006). It reflects an individual's assessment of goal attainment, thereby including evaluations on subjectively important areas of life. An individual is expected to be highly satisfied with life if personal goals are reached and subjective standards of a satisfying life are fulfilled (Diener, 1984). We treated the measurement as a metric variable in our empirical analysis. Descriptive results indicate that individuals report a life satisfaction of 7.64 scale points on average, and that the within variation is about 0.85 during the observation period (see Table 7 of the Appendix). During the observation period, we observe a slight decrease in life satisfaction in all age groups, corresponding to the panel wave in winter 2020/2021 (see Fig. 3 of the Appendix).

Sense of social belonging To determine the mediating effect of an individual's sense of social belonging, we used individuals' assessments of whether they feel socially more or less belonging. We referred to the question "You may feel that you are part of society and that you belong to it or that you feel excluded. What about you? To what extent do you feel more like belonging or being excluded?" The scale ranges from 0 to 10, with "0" meaning that someone feels completely excluded and "10" indicating that respondents feel they completely belong. This measurement indicates whether someone feels connected to others and includes an assessment of their level of integration (Gundert & Hohendanner, 2015). We treated the measurement as a metric variable in our main part of the analysis. For the moderated mediation analysis in

the sensitivity section, however, we additionally generated a categorical variable based on the respondents' grand-mean centered levels of social belonging per panel wave. We subtracted the individuals' level of social belonging from the sample mean and built categories to identify individuals with low, average, and high levels of social belonging in each panel wave. Individuals with social belonging scores more than one standard deviation below the mean were classified as having a low level of social belonging; individuals with scores between one standard deviation below and above the mean were classified as average, and individuals with scores more than one standard deviation above the mean were classified as having a high level of social belonging. The descriptive results indicate that, on average, individuals reported a level of social belonging of 8.04 scale points and the within variation is about 0.99 during the observation period (see Table 7 of the Appendix). In addition, they show no systematic shift in the average sense of social belonging level due to the COVID-19 pandemic (see Fig. 4 of the Appendix).

Confounding factors and control variables To approach a more nuanced causal interpretation in our mediation analysis, we needed to account for confounding factors that we anticipate could interfere with the theoretical pathways mentioned. Given the strong rationale that the COVID-19 pandemic served as an exogenous shock to the entire population, we do not expect confounding factors to significantly impact the effects of the pandemic on life satisfaction and the sense of social belonging. However, to ensure robust and consistent results in the mediation analysis, we rigorously considered confounding factors specifically in the link between the sense of social belonging and life satisfaction. Since time-constant confounding variables are already captured by the analytical strategy, we only include control variables that we expect to be time-varying and not to mediate the effect of the COVID-19 pandemic or social belonging on life satisfaction. First, we control for marital status of individuals as we expect changes to affect both their social belonging levels and their life satisfaction. For instance, the loss of a spouse, whether through divorce or death, can have significant impacts on individuals social belonging levels (see, e.g., Cheung et al., 2013) and their life satisfaction (see, e.g., Vignoli et al., 2014). Second, we control for individuals' household composition, as empirical studies suggest that variations in household living conditions—such as household size and the presence of minor children—can influence individuals' levels of life satisfaction and social belonging (refer, for example, to Vignoli et al., 2014, and Kitchen et al., 2012). Finally, we adjusted for the month of interview to account for the influence of the time of year on COVID-19 measures as it is widely recognized that reports of life satisfaction are strongly dependent on seasonality (see, e.g., Blanchflower & Bryson, 2023). Correlations between our main concepts and control variables largely support our expectations (see Table 1). Specifically, household size and marital status reveal at least moderate correlations with both life satisfaction and social belonging.[4]

4 Results

4.1 Results of the Unmoderated Mediation Analysis

Table 2 presents our results of the unmoderated mediation analysis referring to hypotheses one to four. To test the first hypothesis (H1), we investigated the effect of the COVID-19 pandemic on individuals' life satisfaction as a first step of our analysis (see Eq. (3)). Results show a small but highly significant decrease in individuals' life satisfaction during

[4] While children in a household are primarily associated with the individual household's size and not with life satisfaction or social belonging, we controlled for this factor for theoretical reasons, as the correlations presented in Table 1 could be biased by confounding.

the COVID-19 pandemic period, which refers to the total effect (see Table 2, column 1). With the onset of the COVID-19 pandemic, the reported average life satisfaction decreased by approximately 0.23 scale points compared to the pre-pandemic period. To test the second hypothesis (H2), in the second step of our analysis and in line with Eq. (4), we investigated whether individuals' sense of social belonging changed during the first year of the COVID-19 pandemic. We observe a very small decrease in individuals' reported levels of social belonging (see Table 2, column 2). On average, social belonging dropped by about 0.05 scale points, which is only statistically significant on the ten percent level. In the third step, we examined the relationship between social belonging and life satisfaction conditioned on the COVID-19 pandemic period (see Eq. (5)). Our results here indicate that a positive change in social belonging is associated with a positive change in individuals' life satisfaction (see Table 2, column 3). An increase in an individual's sense of social belonging by one scale point is accompanied by an increase of life satisfaction by about 0.07 scale points. Thus, the first part of our analysis suggests that the first year of the COVID-19 pandemic period had the expected impact on individuals' life satisfaction and, to a very small extent, on their sense of belonging, and that social belonging is also related to individuals' life satisfaction in the anticipated direction.

Given the negative associations between the COVID-19 pandemic and life satisfaction as well as between the COVID-19 pandemic and social belonging, and the positive association between social belonging and life satisfaction, we conducted the final steps of our mediation analysis. To evaluate the third hypothesis (H3), we estimated the indirect effect of the COVID-19 pandemic on life satisfaction through social belonging and tested its significance using the bootstrapping method. In addition, we estimated the proportion of the total effect of the COVID-19 pandemic on life satisfaction explained by the indirect effect to determine the relative importance of an individual's sense of social belonging in the relationship between the two (see Table 2, columns five and six). Our results indicate that the indirect effect is very small ($\beta_1 - \gamma_1 = -0.003$), explaining only 1.32 percent of the total effect of the COVID-19 pandemic on life satisfaction. Nevertheless, bootstrapping results highlight that the indirect effect is statistically different from zero at the five percent level, suggesting a marginal but statistically relevant mediation effect when looking at the entire adult sample.

4.2 Results of the Moderated Mediation by Age Group

While our first part of the analysis suggests a very small but statistically significant mediation effect of social belonging in the relationship between the COVID-19 pandemic and life satisfaction, we further tested our fourth hypothesis (H4), examining the heterogeneity of the mediation effect between younger and older adults. We assessed whether an individual's affiliation to a specific age group moderates the mediation by conducting separate mediation analysis for the age groups 30 up to 40, 40 up to 50, 50 up to 65, and 65 or older.[5]

Table 3 presents the results of the four steps of the mediation analysis. For all age groups, they indicate that the COVID-19 pandemic is negatively associated with individuals' life

[5] To test the differences between the age groups, we also employed models with interaction effects. These models yielded comparable results to the separate analyses, yet also demonstrated the absence of statistical differences between the age groups. However, it is not feasible to conduct mediation analyses with interaction effects in this form; thus, we calculated separate models to elucidate the mediation. Results of the interaction effects are presented in Table 13 of the Appendix.

Table 1 Pearson correlation coefficients between the main concepts and control variables. NEPS SUF SC6 (DOI: https://doi.org/10.5157/NEPS:SC6:13.0.0), N = 34,923 (n = 7,730)

	Life satisfaction	Social belonging	Household size	Number of minor children (age < 14) in the household	Married
Life satisfaction	1.000				
Social belonging	0.768***	1.000			
Household size	0.416***	0.383***	1.000		
Number of minor children (age < 14) in the household	0.124***	0.090***	0.621***	1.000	
Married	0.461***	0.422***	0.497***	0.145***	1.000

Since our analysis uses panel data, we provide correlations between individuals' means across panel waves to consider the structure of our data, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

satisfaction (see Table 3, column 2). The coefficients suggest a modest decrease in individuals' life satisfaction, ranging from approximately 0.19 to 0.27, with more pronounced declines observed among individuals aged between 40 and 65. In addition, the analysis differentiated by age highlights that the coefficients of the link between the COVID-19 pandemic and the sense of social belonging are very small in all age groups. However, for adults aged between 40 and 50 and between 50 and 65, the coefficients, while of similar size or slightly higher than in the analyses based on the entire sample (see Table 3, column 3), are no longer statistically significant, indicating less clear patterns. In contrast, younger and older adults do not appear to be significantly affected in their sense of social belonging, as the coefficients are substantially smaller than in our initial set of analyses based on the entire sample. However, we consistently observe a positive link between the sense of social belonging and life satisfaction in all age groups (see Table 3, column 4). Altogether, based on these results, we can state that the expected relationships are most likely to exist for individuals in the middle age groups, but not for the younger and older individuals in our sample.

Building upon the aforementioned results, we subsequently computed the mediation effects specifically for the age groups 40 to 50 and 50 to 65. This targeted analysis was prompted by the higher associations observed for these age groups and the results indicating only marginal effects of pandemic-related changes on social belonging for the youngest

Table 2 Results of the mediation analysis based on fixed effects regressions (steps 1 to 4). *Source:* NEPS SUF SC6 (DOI: https://doi.org/10.5157/NEPS:SC6:13.0.0), N = 34,923 (n = 7,730)

Total effect (β_1, Eq. (3))	COVID-19 → social belonging (δ_1, Eq. (4))	social belonging → life satisfaction (γ_2, Eq. (5))	COVID-19 → life satisfaction (γ_1,Eq. (5))	Indirect effect ($\beta_1 - \gamma_1$)	Proportion of the indirect effect on the total effect in %
-0.226***	−0.046†	0.073***	−0.223***	−0.003*	1.32
(0.021)	(0.024)	(0.007)	(0.021)	(0.002)	

Clustered standard errors in parentheses, † $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, standard errors clustered by individual, full-regression models with control variables are presented in Table 8 of the Appendix

and oldest groups. However, even for individuals aged 40 to 50 and 50 to 65, the indirect effects suggest negligible mediations that are also not statistically significant. The increased standard errors cast doubt on any mediation effect, questioning the relevance of social belonging in the relationship between the COVID-19 pandemic and life satisfaction in all age groups.

5 Sensitivity Analysis

The results of the main part of the analysis as well as of the moderated mediation analysis by age cast doubt on the effect of the COVID-19 pandemic on the individuals' sense of social belonging, and on the mediating link between the COVID-19 pandemic and individuals life satisfaction through changes in their sense of social belonging. However, the estimation results may be undermined by the fact that these findings do not take into account the individual's initial level of social belonging prior to the pandemic. In the main analysis, opposing trends may lead to an underestimation as individuals may have responded differently to the COVID-19 pandemic based on their pre-existing levels of social belonging. Therefore, as suggested by VanderWeele (2015), we implemented a moderation by subgroups based on their prior levels of social belonging to investigate heterogeneity of effects. In an additional sensitivity analysis, we investigate differences by the grand mean-centered level of individuals' lagged social belonging, categorized into low, average, and high levels of social belonging. We added interaction terms without main effects, reflecting the different effects of the COVID-19 pandemic by an individual's relative position on the social belonging scale one observation earlier.

To investigate the sensitivity of our main results, we first replicated the results for the main model in order to check the comparability of the subsample with the sample analyzed in the main part. This is because our sample was reduced due to the introduction of lagged social belonging levels and the resulting removal of the first observation of social belonging for the main effect. Second, we conducted the mediation analysis, following the same strategy as in the main part of the study for the different subgroups of social belonging.

The results of our sensitivity analysis highlight some remarkable differences between subgroups of (prior) social belonging (see Table 4). Notably, our replication of the main analysis based on the reduced sample yields similar results compared to the analysis presented in Sect. 4 (see Table 14 in Appendix). While the pattern for individuals with lagged average social belonging is similar but slightly more pronounced compared to the unmoderated analysis, the patterns appear to differ for individuals with low or high levels of lagged social belonging.

For individuals with low levels of lagged social belonging, we observe no significant association between the COVID-19 pandemic period and life satisfaction, but a positive link between the COVID-19 pandemic and their social belonging. In addition, the positive indirect effect suggests a suppression effect for those individuals. This means that if they had not experienced an increase in their social belonging levels, they would have experienced a stronger decrease in their life satisfaction. In contrast, for individuals with high levels of social belonging, we see stronger negative associations between the COVID-19 pandemic and all the relevant concepts; however, we detect only a very small link between social belonging levels and their life satisfaction, which is not statistically significant. Yet, the strong decrease in their social belonging levels during the COVID-19 pandemic seems to explain a remarkable part of the negative effect of the pandemic

period on life satisfaction in this subgroup. We observe similar results for individuals with average pre-pandemic social belonging levels, but with minor variations. Individuals with lagged average social belonging levels show a decrease in their life satisfaction and social belonging due to the COVID-19 pandemic, and their sense of social belonging appears to have a positive impact on their life satisfaction. Moreover, changes in their social belonging levels seem to explain about 7% of the effect of the COVID-19 pandemic on their life satisfaction.[6]

To conclude, the sensitivity analysis suggests that the main part of our analysis underestimates the relevance of social belonging in the relationship between the COVID-19 pandemic and life satisfaction. For individuals with low levels of prior social belonging, an increase in social belonging during the pandemic appears to suppress negative reactions to life satisfaction. For individuals with average and high levels of prior social belonging, the decrease in their social belonging seems to explain some part of their drop in life satisfaction. The suppression effect appears to have partially undermined the mediation effect in the main analyses, which we consider in the discussion of the results in the following.

6 Discussion and Conclusion

This study aimed to investigate the mediating role of social belonging in the relationship between the COVID-19 pandemic and life satisfaction, as well as the heterogeneity in this link by individuals' age. Due to various challenges and policy countermeasures caused by the COVID-19 pandemic, we expected changes in life satisfaction due to changes in individuals' sense of social belonging. In addition, we focused on different age groups and especially on older adults, since age-related differences in cognitive processing and strategies in dealing with challenging situations are also relevant in the COVID-19 context. Based on psychological theories, we hypothesized among other things, that the mediation should be less relevant for individuals aged 65 and older. To test related hypotheses, we used rich longitudinal data from the German National Educational Panel Study (NEPS) and estimated fixed-effects regressions with individual slopes by year of observation. We thereby followed an analytical strategy in line with causal mediation analyses (VanderWeele, 2015).

Our results suggest that the COVID-19 pandemic is negatively associated with individuals' life satisfaction and support a small, positive relationship between social belonging and life satisfaction. Taking into account time-constant individual characteristics and individual-specific trends, we observe a slight COVID-19 -induced decrease in life satisfaction, supporting our first hypothesis. Thus, our results substantiate previous studies that have highlighted a negative impact of the COVID-19 pandemic on life satisfaction (e.g., Bähr et al., 2022; Bittmann, 2022a, 2022b; Entringer & Kröger, 2021; Handschuh et al., 2021; Huebener et al., 2021; Zacher & Rudolph, 2021). In addition, we also detect indication for the relevance of social belonging for individuals' life satisfaction while controlling for important time-constant confounding variables.

[6] To check whether we observe similar pattern in all age groups, we replicated these moderation analyses for each age group separately. The results highlight that the overall pattern of the sensitivity analyses presented also show up irrespective of individuals' age (see Table 15 of the Appendix). However, due to smaller sample sizes, these analyses should be treated with caution since high standard errors implicate imprecise estimates.

Table 3 Results of the mediation analysis for the mediation separated by age group. *Source:* NEPS SUF SC6 (DOI: https://doi.org/10.5157/NEPS:SC6:13.0.0), N = 34,923 (n = 7,730)

Age Group	Total effect (β_1, Eq. (3))	COVID-19 → social belonging (δ_1, Eq. (4))	social belonging → life satisfaction (γ_2, Eq. (5))	COVID-19 → life satisfaction (γ_1, Eq. (5))	Indirect effect ($\beta_1 - \gamma_1$))	Proportion of the indirect effect on the total effect in %	N
30 up to 40	−0.185**	−0.022	0.158***	-0.189**	–	–	694
	(0.065)	(0.081)	(0.030)	(0.064)			
40 up to 50	−0.268***	−0.070	0.060**	−0.264***	−0.004	1.49	1,212
	(0.047)	(0.058)	(0.020)	(0.047)	(0.004)		
50 up to 65	−0.230***	−0.045	0.060***	−0.227***	−0.003	1.30	3,991
	(0.029)	(0.032)	(0.010)	(0.028)	(0.002)		
65 and older	−0.187***	−0.024	0.078***	−0.185***	–	–	1,833
	(0.048)	(0.055)	(0.015)	(0.048)			

Clustered standard errors in parentheses, † $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, standard errors clustered by individual, full-regression models with control variables are presented in Tables 9, 10, 11, and 12 of the Appendix

Regarding the effects of the pandemic on social belonging and the mediation effects, more ambiguous results emerge. We do not find a statistically significant uniform effect on individuals' social belonging and no mediation effect, suggesting that overall social capital remained quite stable due to mutually offsetting changes in individuals' sense of social belonging. However, with regard to the mediating role of sense of social belonging, our sensitivity analysis gives us a clearer picture when we look more closely at the prior levels of social belonging. The hypothesized negative effect of the COVID-19 pandemic is found among individuals with average or higher prior levels of social belonging, while a positive effect is found among individuals with lower prior levels. This partially supports our second hypothesis and highlights previous findings that not everyone is equally affected the same way by the COVID-19 pandemic (e.g., Wettstein et al., 2022). Consequently, we posit that the expected mediation only applies to those with average or higher levels of social belonging prior to the COVID-19 pandemic, partially supporting hypothesis three.

An explanation for the increased sense of social belonging in individuals with low prior levels could be that the individual's resources for maintaining social well-being remained stable while perceptions of belonging changed. The social production function theory suggests that resources can be compensated to ensure social well-being (Ormel et al., 1999). If an individual did not have a strong sense of social belonging prior to the COVID-19 pandemic, it is possible that other goals–unrelated to a sense of social belonging–are being used as resources at all times. In this case, changes in the fulfilment of these goals may not affect the individual's social well-being or, respectively, life-satisfaction. In addition, simultaneous changes in the relevant reference group may lead to changes in perceptions (see for example relative deprivation: Smith et al., 2012). Due to the subjective nature of the sense of social belonging, there are individual differences in the feelings and cognitions regarding experiences (Allen et al., 2021), leading to different reactions to the changes during the COVID-19 pandemic between individuals. For example, individuals who tend to have fewer and less frequent opportunities for belonging to occur do not only experience less disturbances due to social distancing measures, but also see reduced social behaviour within their reference group. The perceived similarities within the relevant peer group and the social acceptance of certain life circumstances could therefore even lead to an increased subjective feeling of connection and sense of social belonging. Both might in turn stabilize life satisfaction for this subgroup.

Concerning potential differences by age, our results suggest similar patterns across age groups while also highlighting some differences. With regard to potential differences in the mediation effect by age, we did not find mediation in all age groups. Nevertheless, we observe variations in the associations between the COVID-19 pandemic and individual life satisfaction, as well as in the importance of individuals' sense of social belonging for their life evaluations. In alignment with theoretical arguments, our results offer crucial insights into the heterogeneity of the relevance of social belonging for individuals' life evaluations. While social belonging seems to be an important determinant for individuals aged between 30 and 40, it is a less dominant determinant for the older age groups. Hence, one could state that differences in cognition and coping strategies protect older adults' life satisfaction from changes in social belonging, even though the important need for social well-being is threatened. However, this might not only be due to different coping strategies between age groups, but also due to different life circumstances and the specific characteristics and challenges of life stages.

Despite these important findings, some limitations of our study should be considered. First, our results are strongly related to a specific period during the pandemic, which does not necessarily allow us to generalize to the entire pandemic period. For example, in the context of life satisfaction during the COVID-19 pandemic, time of measurement has proved to be important,

Table 4 Moderated mediation analyses by levels of social belonging. *Source:* NEPS SUF SC6 (DOI: https://doi.org/10.5157/NEPS:SC6:12.0.1), N = 25,435 (n = 6,890)

	Total effect (β_1, Eq. (3))	COVID-19 → social belonging (δ_1, Eq. (4))	social belonging → life satisfaction (γ_2, Eq. (5))	COVID-19 → life satisfaction (γ_1, Eq. (5))	Indirect effect ($\beta_1 - \gamma_1$)	Proportion of the indirect effect on the total effect in %
Interaction with lagged levels of social belonging						
Low lagged level of social belonging	−0.064	0.863***	0.066***	−0.118	0.054***	–
	(0.093)	(0.105)	(0.021)	(0.093)	(0.013)	
Average lagged level of social belonging	−0.237***	−0.207***	0.070***	−0.221***	−0.016*	6.75
	(0.028)	(0.030)	(0.012)	(0.028)	(0.006)	
High lagged level of social belonging	−0.416***	−0.809***	0.036	−0.372***	−0.044***	10.58
	(0.051)	(0.052)	(0.024)	(0.053)	(0.012)	

Clustered standard errors in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, standard errors clustered by individual. Full-regression models are available upon request. Results for all interaction effects are presented in Table 16 of the Appendix 2

since there are studies showing lower levels of life satisfaction and well-being only during the lockdown periods in general in Australia and during the second lockdown compared to the first one in Europe (Biddle & Gray, 2021, 2022; Entringer & Kröger, 2021; Schradie et al., 2020). Second, our measure of social belonging only includes an overall assessment of respondents and may not be sensitive to minor changes, which could lead to an underestimation of the influence of social belonging. It might be possible that measuring social belonging with a more complex scale would lead to a more nuanced picture of the relationship between the COVID-19 pandemic and life satisfaction. Third, there may be a substantial time lag in how the sense of social belonging changes, so that looking at the change for the winter of 2020/2021 may have been too short-term to measure the expected theoretical relationship. Fourth, the prominent negative effect of the COVID-19 pandemic on the sense of social belonging of individuals with higher prior levels of social belonging may be influenced by ceiling effects. However, this is most likely only partially the case, as similar effects can be observed for individuals with average prior levels of social belonging. Finally, we limited our investigation to an overall indicator of the COVID-19 pandemic period in order to examine the overarching impact. This does not allow us to address the effects of specific policy measures during the COVID19 pandemic, which should be addressed in further research.

Despite these limitations, our study contributes to the previous literature by highlighting important insights into the effect of the COVID-19 pandemic on life satisfaction and social belonging, the relevance of social belonging for individuals' life satisfaction, and variation by age. First, we investigate a theoretically relevant mechanism often highlighted in previous studies and show that there is a large variation in the mediation depending on individuals' pre-COVID-19 conditions. This contributes to the wider discussions about potential risk groups during the COVID-19 pandemic and the impact of social distancing measures for certain groups of people (e.g., Entringer et al., 2020). In addition, our study investigates for the first time the effect of social belonging on individuals' life satisfaction and related age differences from a causal perspective. In doing so, we further support theoretical assumptions about the relevance of individuals' sense of social belonging for their positive life evaluations. Based on these results, we conclude that, at a methodological level, it is necessary to consider heterogeneous effects when investigating causal mechanisms and the impact of the COVID-19 pandemic on the individuals' lives, and that longitudinal data in particular offer great advantages in this regard.

Appendix 1

See Tables 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, and 15 and Figures 3, 4

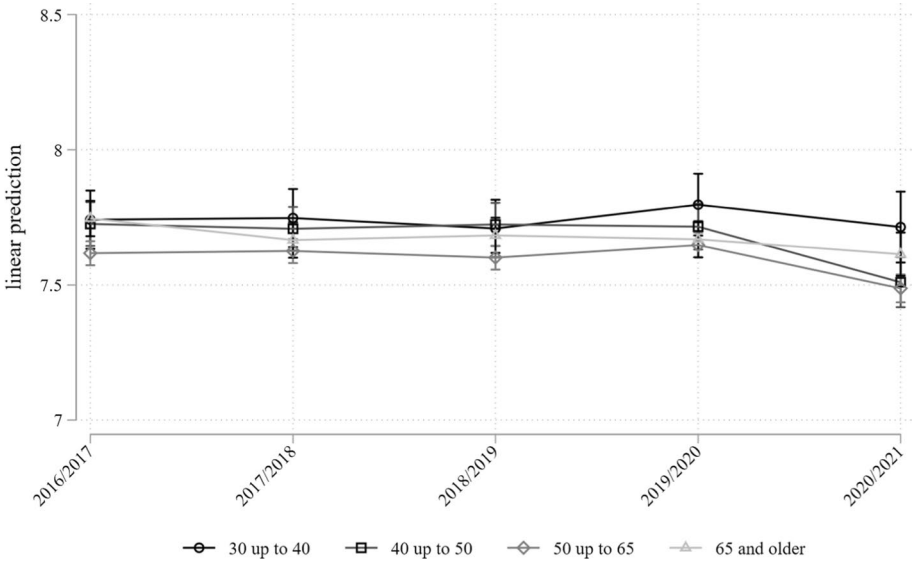

Fig. 3 Development of average life satisfaction by panel wave and separated by age group. *Source:* NEPS SUF SC6 (DOI: https://doi.org/10.5157/NEPS:SC6:13.0.0), N = 34,923 (n = 7,730)

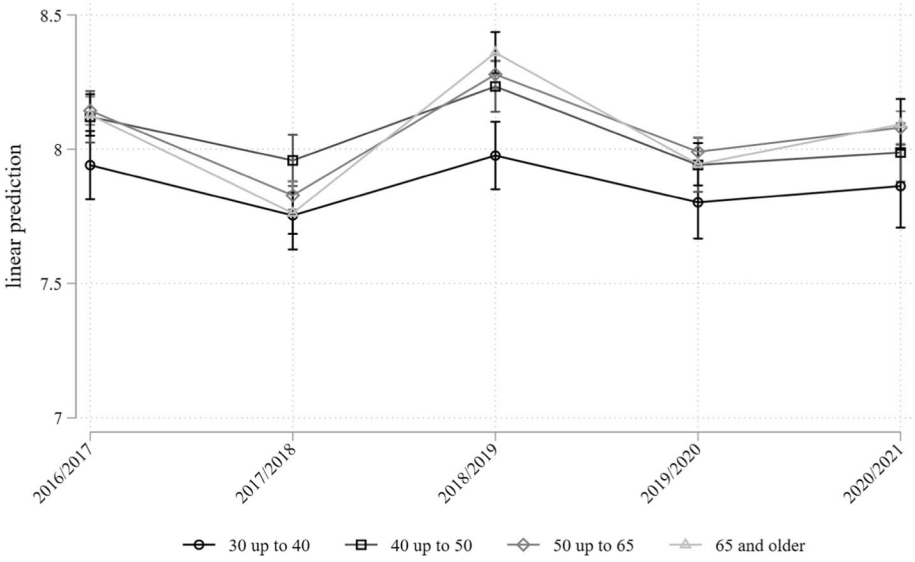

Fig. 4 Development of average sense of social belonging by panel wave and separated by age group. *Source:* NEPS SUF SC6 (DOI: https://doi.org/10.5157/NEPS:SC6:13.0.0), N = 34,923 (n = 7,730)

Table 5 Descriptive statistics of the sample-time-constant variables. *Source:* NEPS SUF SC6 (https://doi.org/10.5157/NEPS:SC6:13.0.0), N = 34,923 (n = 7,730)

Variable	Proportion in percent	
Gender	Female	50.80
	Male	49.20
Education	Max. lower secondary education	18.39
	intermediate secondary education	31.72
	Higher secondary education	19.00
	Tertiary education	30.86
Region	East	16.26
	West	83.74
Country of birth	Germany	93.23
	Born abroad	6.77

Table 6 Descriptive statistics of the sample-time-varying variables. *Source:* NEPS SUF SC6 (DOI: https://doi.org/10.5157/NEPS:SC6:13.0.0)

Variable		Mean	Std. Dev	Min	Max	Observations	
Age	Overall	54.90	10.63	29.75	77.00	N =	34,923
	Between		10.61	31.14	74.88	n =	7,730
	Within		1.37	52.30	57.53	T-bar =	4.52
30 up to 40	Overall	0.09	0.28	0.00	1.00	N =	34,923
	Between		0.29	0.00	1.00	n =	7,730
	Within		0	0.09	0.09	T-bar =	4.52
40 up to 50	Overall	0.16	0.36	0.00	1.00	N =	34,923
	Between		0.36	0.00	1.00	n =	7,730
	Within		0	0.16	0.16	T-bar =	4.52
50 up to 65	Overall	0.52	0.50	0.00	1.00	N =	34,923
	Between		0.50	0.00	1.00	n =	7,730
	Within		0	0.52	0.52	T-bar =	4.52
65 and older	Overall	0.24	0.43	0.00	1.00	N =	34,923
	Between		0.42	0.00	1.00	n =	7,730
	Within		0	0.24	0.24	T-bar =	4.52
Married	Overall	0.74	0.44	0.00	1.00	N =	34,923
	Between		0.44	0.00	1.00	n =	7,730
	Within		0.10	-0.06	1.54	T-bar =	4.52
Household size	Overall	2.26	0.72	1.00	4.00	N =	34,923
	Between		0.69	1.00	4.00	n =	7,730
	Within		0.24	0.26	4.05	T-bar =	4.52
Number of minor children in the household	Overall	0.287	0.62	0.00	2.00	N =	34,923
	Between		0.58	0.00	2.00	n =	7,730
	Within		0.20	-1.32	1.88	T-bar =	4.52

Table 7 Descriptive statistics of the main concepts. *Source:* NEPS SUF SC6 (DOI: https://doi.org/10.5157/NEPS:SC6:13.0.0)

Variable		Mean	Std. Dev	Min	Max	Observations	
Social belonging	overall	8.04	1.67	0.00	10.00	N =	34,923
	between		1.37	0.00	10.00	n =	7,730
	within		0.99	0.04	13.84	T-bar =	4.52
Life satisfaction	overall	7.64	1.41	0.00	10.00	N =	34,923
	between		1.14	0.00	10.00	n =	7,730
	within		0.85	0.44	12.39	T-bar =	4.52

Table 8 Full FE-regression results for the mediation of the effect of the COVID-19 pandemic on life-satisfaction via social belonging (total Sample, including all control variables). *Source:* NEPS SUF SC6 (DOI: https://doi.org/10.5157/NEPS:SC6:13.0.0)

	Life satisfaction (Eq. (3))	Social belonging (Eq. (4))	Life satisfaction (Eq. (5))
COVID-19 pandemic	−0.226***	−0.046	−0.223***
	(0.0210)	(0.0238)	(0.0210)
Social belonging			0.073***
			(0.0074)
Married	−0.039	0.012	−0.039
	(0.1014)	(0.0986)	(0.1008)
Household size	0.031	0.023	0.029
	(0.0158)	(0.0200)	(0.0158)
Number of minor Children in household	0.118**	0.062	0.114**
	(0.0432)	(0.0445)	(0.0429)
Month (Ref.: January)			
February	0.038	0.103*	0.031
	(0.0435)	(0.0513)	(0.0431)
March	−0.051	0.067	−0.056
	(0.0591)	(0.0752)	(0.0588)
April	−0.242	−0.291	−0.221
	(0.1690)	(0.3022)	(0.1664)
August	0.063	−0.307***	0.086*
	(0.0402)	(0.0483)	(0.0399)
September	0.129***	0.082*	0.123***
	(0.0299)	(0.0332)	(0.0298)
October	0.096***	0.083**	0.089**
	(0.0278)	(0.0309)	(0.0277)

Table 8 (continued)

	Life satisfaction (Eq. (3))	Social belonging (Eq. (4))	Life satisfaction (Eq. (5))
November	0.069*	0.104**	0.061*
	(0.0294)	(0.0325)	(0.0293)
December	0.030	−0.034	0.033
	(0.0329)	(0.0379)	(0.0328)
Observations	34,923	34,923	34,923
N	7,730	7,730	7,730
	34,923	34,923	34,923
N	7,730	7,730	7,730

Clustered standard errors in parentheses, * $p<0.05$, ** $p<0.01$, *** $p<0.001$, standard errors clustered by individual

Table 9 FE-regression results for the mediation of the effect of the COVID-19 pandemic on life satisfaction via social belonging for individuals aged 30 up to 40 (including all control variables). *Source:* NEPS SUF SC6 (DOI: https://doi.org/10.5157/NEPS:SC6:13.0.0)

	Life satisfaction (Eq. (3))	Social belonging (Eq. (4))	Life satisfaction (Eq. (5))
COVID-19 pandemic	−0.185**	0.022	−0.189**
	(0.0651)	(0.0809)	(0.0636)
Social belonging			0.158***
			(0.0280)
Married	−0.212	0.237	−0.249
	(0.1669)	(0.1656)	(0.1656)
Household size	−0.016	−0.049	−0.008
	(0.0668)	(0.0719)	(0.0671)
Number of minor Children in household	0.263*	0.260*	0.221*
	(0.1046)	(0.1246)	(0.1060)
Month (Ref.: January)			
February	0.064	0.082	0.051
	(0.1165)	(0.1419)	(0.1142)
March	−0.122	−0.020	−0.119
	(0.1670)	(0.1604)	(0.1620)
April	0.390	−3.475*	0.938*
	(0.6275)	(1.5847)	(0.3956)
August	−0.058	−0.348*	−0.003
	(0.1390)	(0.1749)	(0.1302)
September	0.015	−0.066	0.025
	(0.0985)	(0.1172)	(0.0956)
October	−0.083	−0.014	−0.081
	(0.0892)	(0.1048)	(0.0873)

Table 9 (continued)

	Life satisfaction (Eq. (3))	Social belonging (Eq. (4))	Life satisfaction (Eq. (5))
November	−0.075	0.025	−0.079
	(0.0960)	(0.1071)	(0.0946)
December	−0.035	0.058	−0.044
	(0.0995)	(0.1281)	(0.0985)
Observations	3,021	3,021	3,021
N	694	694	694

Clustered standard errors in parentheses, * $p<0.05$, ** $p<0.01$, *** $p<0.001$, standard errors clustered by individual

Table 10 FE-regression results for the mediation of the effect of the COVID-19 pandemic on life satisfaction via social belonging for individuals aged 40 up to 50 (including all control variables). *Source:* NEPS SUF SC6 (DOI: https://doi.org/10.5157/NEPS:SC6:13.0.0)

	Life satisfaction (Eq. (3))	Social belonging (Eq. (4))	Life satisfaction (Eq. (5))
COVID-19 pandemic	−0.268***	−0.070	−0.264***
	(0.0474)	(0.0576)	(0.0473)
Social belonging			0.060**
			(0.0195)
Married	−0.212	−0.083	−0.208
	(0.2071)	(0.2404)	(0.2062)
Household size	0.085	0.093	0.079
	(0.0650)	(0.0637)	(0.0659)
Number of minor Children in household	0.115	0.098	0.109
	(0.0784)	(0.0696)	(0.0780)
Month (Ref.: January)			
February	0.033	0.080	0.028
	(0.0922)	(0.1016)	(0.0909)
March	0.040	0.103	0.034
	(0.1095)	(0.1623)	(0.1085)
April	−0.272	0.604	−0.308
	(0.3288)	(0.6463)	(0.3228)
August	0.057	−0.213	0.069
	(0.1068)	(0.1116)	(0.1061)
September	0.077	0.004	0.077
	(0.0699)	(0.0767)	(0.0695)
October	0.069	0.026	0.067
	(0.0625)	(0.0710)	(0.0621)

Table 10 (continued)

	Life satisfaction (Eq. (3))	Social belonging (Eq. (4))	Life satisfaction (Eq. (5))
November	0.074	0.087	0.069
	(0.0711)	(0.0742)	(0.0709)
December	−0.036	−0.009	−0.036
	(0.0741)	(0.0864)	(0.0738)
Observations	5,476	5,476	5,476
N	1,212	1,212	1,212

Clustered standard errors in parentheses, * $p<0.05$, ** $p<0.01$, *** $p<0.001$, standard errors clustered by individual

Table 11 FE-regression results for the mediation of the effect of the COVID-19 pandemic on life satisfaction via social belonging for individuals aged 50 up to 65 (including all control variables). *Source:* NEPS SUF SC6 (DOI: https://doi.org/10.5157/NEPS:SC6:13.0.0)

	Life satisfaction (Eq. (3))	Social belonging (Eq. (4))	Life satisfaction (Eq. (5))
COVID-19 pandemic	−0.230***	−0.045	−0.227***
	(0.0292)	(0.0321)	(0.0291)
Social belonging			0.060***
			(0.0100)
Married	0.131	−0.043	0.134
	(0.1647)	(0.1545)	(0.1636)
Household size	0.014	0.011	0.014
	(0.0178)	(0.0227)	(0.0181)
Number of minor Children in household	0.111	−0.036	0.113
	(0.0609)	(0.0710)	(0.0605)
Month (Ref.: January)			
February	0.002	0.076	−0.003
	(0.0579)	(0.0737)	(0.0575)
March	−0.011	0.160	−0.020
	(0.0847)	(0.1104)	(0.0846)
April	−0.364	−0.512	−0.334
	(0.2334)	(0.2950)	(0.2339)
August	0.087	−0.285***	0.104
	(0.0538)	(0.0676)	(0.0539)
September	0.173***	0.114*	0.166***
	(0.0401)	(0.0446)	(0.0400)
October	0.142***	0.104*	0.135***
	(0.0378)	(0.0411)	(0.0377)

Table 11 (continued)

	Life satisfaction (Eq. (3))	Social belonging (Eq. (4))	Life satisfaction (Eq. (5))
November	0.100*	0.124**	0.093*
	(0.0390)	(0.0435)	(0.0390)
December	0.065	−0.078	0.070
	(0.0447)	(0.0502)	(0.0446)
Observations	18,154	18,154	18,154
N	3,991	3,991	3,991

Clustered standard errors in parentheses, * $p<0.05$, ** $p<0.01$, *** $p<0.001$, standard errors clustered by individual

Table 12 FE-regression results for the mediation of the effect of the COVID-19 pandemic on life satisfaction via social belonging for individuals aged 65 and older (including all control variables). *Source:* NEPS SUF SC6 (DOI: https://doi.org/10.5157/NEPS:SC6:13.0.0)

	Life satisfaction (Eq. (3))	Social belonging (Eq. (4))	Life satisfaction (Eq. (5))
COVID-19 pandemic	−0.187***	−0.024	−0.185***
	(0.0485)	(0.0545)	(0.0481)
Social belonging			0.078***
			(0.0148)
Married	0.222	−0.183	0.236
	(0.3935)	(0.2896)	(0.3937)
Household size	0.067	0.034	0.065
	(0.0490)	(0.0425)	(0.0487)
Number of minor children in household	−0.634	−0.475	−0.597
	(0.4302)	(0.3083)	(0.4367)
Month (Ref.: January)			
February	0.121	0.225	0.104
	(0.1315)	(0.1314)	(0.1310)
March	−0.253	−0.208	−0.237
	(0.1641)	(0.2040)	(0.1638)
April	−0.052	−0.063	−0.048
	(0.3932)	(0.6436)	(0.3752)
August	0.053	−0.356***	0.081
	(0.0887)	(0.1034)	(0.0879)
September	0.108	0.107	0.100
	(0.0731)	(0.0799)	(0.0728)
October	0.074	0.110	0.066
	(0.0689)	(0.0778)	(0.0685)

Table 12 (continued)

	Life satisfaction (Eq. (3))	Social belonging (Eq. (4))	Life satisfaction (Eq. (5))
November	0.046	0.090	0.039
	(0.0725)	(0.0813)	(0.0724)
December	0.014	0.007	0.014
	(0.0830)	(0.0964)	(0.0827)
Observations	8,272	8,272	8,272
N	1,833	1,833	1,833

Clustered standard errors in parentheses, * $p<0.05$, ** $p<0.01$, *** $p<0.001$, standard errors clustered by individual

Table 13 Results of the test of age differences

	Life satisfaction (Eq. (3))	Social belonging (Eq. (4))	Life satisfaction (Eq. (5))
COVID-19 pandemic	−0.207***	−0.072	−0.201***
	(0.0428)	(0.0510)	(0.0426)
Interaction COVID-19 pandemic with age group (Ref.: older than 65)			
30 up to 40	0.020	0.058	0.015
	(0.0828)	(0.0988)	(0.0825)
40 up to 50	−0.074	−0.006	−0.074
	(0.0656)	(0.0783)	(0.0654)
50 up to 65	−0.032	−0.014	−0.031
	(0.0509)	(0.0608)	(0.0507)
Observations	34,923	34,923	34,923
N	7,730	7,730	7,730

Table 14 Results of the mediation analysis based on the subsample of the sensitivity analysis (Steps 1 to 4). *Source:* NEPS SUF SC6 (DOI: https://doi.org/10.5157/NEPS:SC6:13.0.0), N = 25,435 (n = 6,890)

Total effect of COVID-19 pandemic on life satisfaction β_1	Effect of COVID-19 pandemic on social belonging δ_1	Effect of social belonging on life satisfaction γ_2	Effect of COVID-19 pandemic on life satisfaction net of the mediator γ_1	Indirect effect $\beta_1 - \gamma_1$	Proportion of the indirect effect on the total effect of the COVID-19 pandemic in %
− 0.249***	− 0.099***	0.063***	-0.243***	–0.006**	1.32
(0.025)	(0.028)	(0.010)	(0.025)	(0.002)	

Clustered standard errors in parentheses, † $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, standard errors clustered by individual

Table 15 Moderated mediation analyses by the relative levels of social belonging (separated by age groups). *Source:* NEPS SUF SC6 (DOI: https://doi.org/10.5157/NEPS:SC6:13.0.0)

		Total effect of COVID-19 pandemic on life satisfaction β_1	Effect of COVID-19 pandemic on social belonging δ_1	Effect of social belonging on life satisfaction γ_2	Effect of COVID-19 pandemic on life satisfaction net of the mediator γ_1	Indirect effect $\beta_1 - \gamma_1$	Proportion of the indirect effect on the total effect of the COVID-19 pandemic
30 up to 40	*Interaction between COVID-19 pandemic and levels of social belonging*						
(N = 2103; n = 583)	Low level of social belonging	−0.028	0.656**	0.208***	−0.099	−0.071	–
		(0.2502)	(0.2950)	(0.0703)	(0.2240)	(0.108)	
	Average level of social belonging	−0.238**	−0.049	0.143***	−0.229**	0.009	3.78
		(0.0964)	(0.0980)	(0.0417)	(0.0956)	(0.015)	
	High level of social belonging	−0.315	−0.932***	0.143**	−0.181	0.134**	42.54
		(0.1966)	(0.2664)	(0.0681)	(0.2044)	(0.056)	
40 up to 50	*Interaction between Begin of COVID-19 pandemic (3/2020) and levels of social belonging*						
(N = 3,963; n = 1,063)	Low level of social belonging	−0.061	1.196***	0.069	−0.096	0.035	–
		(0.1808)	(0.2458)	(0.0583)	(0.1842)	(0.036)	
	Average level of social belonging	−0.276***	−0.237***	0.030	−0.265***	−0.011	3.99
		(0.0688)	(0.0709)	(0.0255)	(0.0690)	(0.008)	
	High level of social belonging	−0.602***	−0.797***	−0.031	−0.592***	−0.011	1.83
		(0.1110)	(0.1150)	(0.0420)	(0.1132)	(0.020)	
50 up to 65	*Interaction between Begin of COVID-19 pandemic (3/2020) and levels of social belonging*						
(N = 13,386; n = 3,614)	Low level of social belonging	−0.105	0.690***	0.054*	−0.146	0.041**	-
		(0.1355)	(0.1390)	(0.0294)	(0.1357)	(0.006)	
	Average level of social belonging	−0.214***	−0.188***	0.069***	−0.200***	−0.014***	6.54
		(0.0386)	(0.0416)	(0.0160)	(0.0386)	(0.004)	
	High level of social belonging	−0.373***	−0.816***	0.022	−0.336***	−0.037*	9.92
		(0.0710)	(0.0745)	(0.0300)	(0.0726)	(0.,15)	
65 and older	*Interaction between Begin of COVID-19 pandemic (3/2020) and levels of social belonging*						

Table 15 (continued)

		Total effect of COVID-19 pandemic on life satisfaction β_1	Effect of COVID-19 pandemic on social belonging δ_1	Effect of social belonging on life satisfaction γ_2	Effect of COVID-19 pandemic on life satisfaction net of the mediator γ_1	Indirect effect $\beta_1 - \gamma_1$	Proportion of the indirect effect on the total effect of the COVID-19 pandemic
(N = 5,983; n = 1,630)	Low level of social belonging	0.065	1.204***	0.040	−0.022	0.087*	-
		(0.2220)	(0.2524)	(0.0390)	(0.2190)	(0.038)	
	Average level of social belonging	−0.245***	−0.253***	0.076***	−0.227***	−0.018*	7.34
		(0.0648)	(0.0702)	(0.0262)	(0.0652)	(0.009)	
	High level of social belonging	−0.424***	−0.761***	0.060	−0.371***	−0.054*	12.74
		(0.1167)	(0.0935)	(0.0558)	(0.1183)	(0.024)	

Clustered standard errors in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, standard errors clustered by individual. Full regression models are available upon request

Appendix 2

See Tables 16

Table 16 FE-regression results for the mediation of the effect of the COVID-19 pandemic on life satisfaction via social belonging moderated by relative level of social belonging (including all control variables). *Source:* NEPS SUF SC6 (DOI: https://doi.org/10.5157/NEPS:SC6:13.0.0)

	Life satisfaction (Eq. 3)	Social belonging (Eq. 4)	Life satisfaction (Eq. 5)
Interaction of COVID-19 pandemic and levels of social belonging			
Low level of social belonging	−0.064	0.863***	−0.118
	(0.0933)	(0.1050)	(0.0930)
Average level of social belonging	−0.237***	−0.207***	−0.221***
	(0.0284)	(0.0303)	(0.0284)
High level of social belonging	−0.416***	−0.809***	−0.372***
	(0.0515)	(0.0524)	(0.0527)
Interaction of social belonging and levels of social belonging			
Low level of social belonging			0.066**
			(0.0206)
Average level of social belonging			0.070***
			(0.0117)
High level of social belonging			0.036
			(0.0238)
Interaction of married and levels of social belonging			
Low level of social belonging	0.195	−0.025	0.199
	(0.1560)	(0.1490)	(0.1554)
Average level of social belonging	0.005	0.107	−0.002
	(0.1308)	(0.1183)	(0.1302)
High level of social belonging	0.020	0.109	0.012
	(0.1398)	(0.1237)	(0.1393)
Interaction of household size and levels of social belonging			
Low level of social belonging	−0.063	0.008	−0.064
	(0.0494)	(0.0614)	(0.0496)
Average level of social belonging	0.002	0.073*	−0.003
	(0.0292)	(0.0297)	(0.0293)
High level of social belonging	0.021	0.136***	0.014
	(0.0347)	(0.0340)	(0.0348)
Interaction of number of minor children in the household and levels of social belonging			
Low level of social belonging	0.261**	−0.001	0.260**
	(0.0850)	(0.0928)	(0.0841)
Average level of social belonging	0.217***	0.072	0.213***
	(0.0610)	(0.0564)	(0.0606)
High level of social belonging	0.171*	0.042	0.168*
	(0.0691)	(0.0682)	(0.0688)
Observations	25,435	25,435	25,435
N	6,890	6,890	6,890

Clustered standard errors in parentheses, * $p<0.05$, ** $p<0.01$, *** $p<0.001$, standard errors clustered by individual. Modell also controls for month. However, these are not reported in order to save space. Full regression models including month are available upon request

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Author Contribution All authors contributed to the study conception and design. Philipp Handschuh is responsible for the initial idea and project lead. The methodological approach and data analyses were conducted by Jacqueline Kroh and the theoretical concept was framed by Philipp Handschuh und Markus Nester. Manuscript preparation was performed by all authors. All authors read and approved the final manuscript.

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Data Availability For more information on access to NEPS Data see https://www.neps-data.de/Data-Center/Data-Access.

Declarations

Conflict of interest The authors have no relevant financial or non-financial interests to disclose.

Ethical Approval This paper uses data from the National Educational Panel Study (NEPS; see Blossfeld & Roßbach, 2019): Starting cohort SC6, DOI: https://doi.org/10.5157/NEPS:SC6:13.0.0 (NEPS Network, 2022). The NEPS study is conducted under the supervision of the German Federal Commissioner for Data Protection and Freedom of Information (BfDI) and in coordination with the German Standing Conference of the Ministers of Education and Cultural Affairs (KMK). All data collection procedures, instruments and documents were checked by the data protection unit of the Leibniz Institute for Educational Trajectories (LIfBi). The necessary steps are taken to protect participants' confidentiality according to national and international regulations of data security. Participation in the NEPS study is voluntary and based on the informed consent of participants. This consent to participate in the NEPS study can be revoked at any time.

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