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Implications of COVID-19 Mitigation Policies for National Well-Being: A Systems Perspective

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Abstract: The ongoing COVID-19 crisis and measures aimed at curbing the pandemic have a widespread impact on various aspects of well-being, such as housing, social connections, and others. Moreover, COVID-19 does not affect all population groups equally. This study analyzes the impact of major COVID-19 non-pharmaceutical interventions (NPIs) on a set of national well-being indicators from the most recent version of the OECD Well-Being Framework. Using causal loop diagrams (systems maps), we consider direct and indirect effects of these policies on various components of the national well-being system. Our results show that business closures directly and/or indirectly impact more national well-being components than any other policy. The most affected national well-being components by all policies are life satisfaction, perceived health, and prevalence of depressive symptoms. In addition, we specify how the impact of the anti-pandemic measures differs for various population strata, using the degree of income and employment loss as key stratifying variables. Our insights can be helpful to identify and promote measures that can alleviate the adverse effects of the COVID-19 crisis on the national well-being.

Keywords: COVID-19; national well-being; systems thinking; causal loop diagram

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1. Introduction

Following the rapid diffusion of COVID-19 in the early months of 2020, decision makers had to react quickly and introduce measures to curb the pandemic spread. Measures ranging from restricting the mobility of people both domestically and internationally to quarantines and temporary closures of some businesses have been widely deployed and helped mitigate public health implications [1]. A plethora of research analyzing specific impacts of COVID-19 mitigation policies on certain elements of national well-being has emerged recently [2]. Economic consequences are often the focus of attention [3]. However, other consequences such as health, happiness, psychological effects, and emotional health have also been found to be substantial [4,5].

Importantly, the impact of COVID-19 mitigation policies varies significantly across population groups. It was pointed out that COVID-19 reveals and aggravates existing economic, social, and well-being inequalities [6], and the most vulnerable population groups are being hit harder [7–9].

Tracing the multi-dimensional effects of COVID-19 mitigation policies on the national well-being is problematic because well-being itself is a multi-dimensional concept and, moreover, different dimensions of well-being are strongly interconnected. Multiple and potentially lagged interdependencies between well-being components are challenging to oversee and comprehend. A few studies have already revealed some dimensions of

well-being that have been critically affected by the COVID-19 crisis not only directly but also indirectly [10,11]. Therefore, systematic tracing of the multi-dimensional effects of policies aimed at curbing the spread of the pandemic on the national well-being is critically important—both to minimize the adverse effects [12] and to be better informed and, hence, prepared for future crises of a similar nature.

We argue that systems thinking is capable of unraveling this challenge by accounting for essential links and feedback loops between issues that both scientists and policymakers tend to consider in isolation [8]. Several recent studies highlight the importance of the systems thinking approach for dealing with the consequences of the COVID-19 crisis [13–18]. However, to date, no studies have applied systems thinking to focus on the overall impact of COVID-19 mitigation policies on the national well-being (Figure 1).

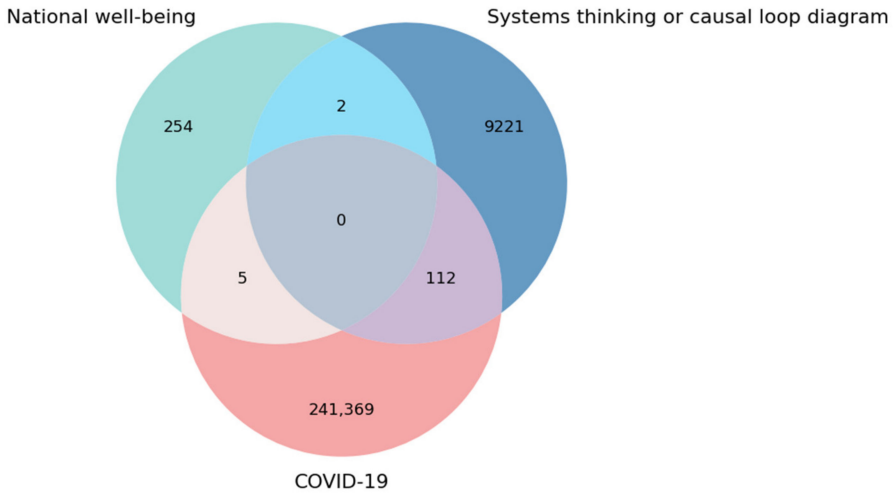


Figure 1. Venn diagram illustrating the number of papers indexed in the Scopus database involving notions "National well-being" ("National wellbeing" (without hyphen) was also included in the search), "Systems thinking" or "Causal loop diagram", and "COVID-19" separately and in various combinations. Numbers in the intersections of circles indicate the number of papers referring to the corresponding two notions from the intersecting circles. None of the papers published to date involves all three concepts.

Moreover, although there is a burgeoning body of research on the impact of the COVID-19 crisis on the well-being of people (more than 7000 papers indexed in the Scopus database as of November 2021; e.g., [19–22]), the majority of these works focus on the individual, family, or community well-being rather than on the national well-being [23]. Several studies investigate the impact of the COVID-19 crisis (both the pandemic itself and measures aimed to curb it) on well-being at the national level [23–26]. However, these studies rely on a single-dimensional notion of the Gross National Happiness Index [27], therefore omitting a multi-faceted nature of the national well-being emphasized by the OECD [28]. This drawback is addressed in [5], which reports the results of a survey on 12 national well-being indicators across a stratified national sample before and during the pandemic. However, this study does not account for interrelations among the indicators. Finally, while many studies explore the efficiency of various mitigation policies for curbing the pandemic [29–31], there is little discussion regarding the broad, systemic effect of such policies, and in particular, regarding their effect on the national well-being.

In this paper, we apply one of the systems thinking practical methods—systems mapping—and present a systems map (a causal loop diagram) of the national well-being system, and implications of the COVID-19 crisis on this system.

We rely on the most recent OECD Well-being Framework to represent national well-being [32]. This systems map is strongly informed by our pilot work [12,33]. Systems mapping allows tracing indirect effects and feedback loops between multiple factors relevant to

the national well-being in a systematic fashion, thus enabling a holistic understanding of the national well-being system. Our work therefore responds to the OECD call for multi-dimensional tools and multidisciplinary perspectives to tackle the challenges brought about by the COVID-19 crisis [34]. More broadly, systems mapping of the multi-dimensional well-being effects of COVID-19 mitigation policies work allows for " ... synthesizing the breadth of knowledge into a more comprehensive, multi-faceted, and usable understanding ... ", which the International Science Council (ISC) proclaimed to be some of the most important contributions that science has to make in the near term to support transformation to sustainability [35].

Using the systems approach, we aim at demonstrating both the complexity of the effects of the responses to COVID-19 on national well-being, as well as the ways it magnifies inequalities within society. Our insights can help policymakers reveal trade-offs and synergies, reducing the problem's "wickedness" [36], to frame the policy discourse [37].

After a brief overview of the literature on well-being and the impact of COVID-19 on well-being in the next section, we proceed to summarize the systems approach we use in Section 3. Then the generic impacts of the policies used to mitigate COVID-19's health effects on well-being are detailed in Section 4. Previous studies have shown that these impacts are highly inequitable [38,39]. Therefore, in Section 5, we analyze equity implications of policies implemented to reduce COVID-19 health effects on well-being. The final section is dedicated to the discussion and conclusions.

2. A Brief Overview of the Notion of Well-Being

Economic performance of countries as measured by the GDP has long been seen as a major determinant of a good life of its citizens [40]. Hence, policies were developed to facilitate economic growth [41]. However, while economic growth is considered a prerequisite for a good life [42], nowadays, in most developed countries, economic growth does not promote citizens' well-being as much as it used to do [43,44]. This can be explained by the fact that most of the population in such countries has already satisfied their basic needs covering the first two levels of Maslow's hierarchy of needs [45]. As high growth rates themselves do not necessarily reflect whether citizens have a good life anymore, Refs. [46,47] have persuasively argued that policymaking needs a comprehensive approach to defining, measuring, and fostering well-being at the national level.

In order to be policy-relevant, the notion of well-being needs an operationalizable and inclusive definition. There is no single commonly agreed definition of well-being in the literature. Well-being commonly refers to the "state of being happy, healthy, or prosperous" [48]. The well-being concept is close but not identical to "life satisfaction" and "quality of life" concepts [49,50]. Some authors also add autonomy and purpose in addition to happiness in their view on well-being [51]. Similarly, others emphasize that well-being goes beyond the notion of attaining pleasure (hedonic well-being) and includes "the striving for perfection that represents the realization of one's true potential" [52] (eudaimonic well-being). Along the same vein, Amartya Sen and Martha Nussbaum [53–55] advanced the capability approach, which links well-being with "how a person can 'function', taking that term in a very broad sense" [54] (p. 197). In other words, well-being can be assessed by answering the question, "What is each person able to do and to be?" [53] (p. 28).

However, to become policy-relevant, the notion of well-being needs to be measurable. While the importance of individuals' well-being is often emphasized [56], until the second half of the 20th century, there were no formal approaches to assessing well-being at the national level [57]. The first successful attempt to quantitatively evaluate national well-being was performed by the United Nations Development Program (UNDP) with the Human Development Index (HDI) in 1990. HDI was based on the capability approach by Sen and Nussbaum and included the life expectancy and education level to complement the gross national income (GNI) per capita [58]. This index is still widely used to evaluate the development of countries over time and compare their progress with each other.

In 2011, the OECD launched the Better Life Initiative [59], which aimed to advance well-being in practical terms within the policy-making field. Informed by the Commission on the Measurement of Economic Performance and Social Progress (CMEPSP) report [47], the OECD developed the Framework for Measuring Well-Being and Progress (in what follows, we will refer to it as the OECD Well-being Framework). Based on this framework, every 2–3 years since 2011, the OECD has published "How's Life?" reports presenting up-to-date countries' statistics. The latest updates of the Well-being Framework [60] and the How's Life report have been published recently [32]. Rooted in the well-established capability approach of Sen and Nussbaum [61] and covering as many as 41 OECD and partner countries, this framework can be considered the most suitable benchmark for comparing national well-being in different countries at the moment.

Several developed countries have advanced national well-being agendas or have already formulated and evaluated policies aiming to improve national well-being [62] (Table 3.1 in [62]). Even more countries monitor specific ("beyond-GDP") indicators related to national well-being [62] (Table 2.1 in [62]). As a notable example, the government of Bhutan has introduced the Gross National Happiness (GNH) index to measure national progress and developed a special screening tool to evaluate new policy proposals' impact on various domains of GNH [63].

Although the OECD Well-being Framework identifies some risk and resilience factors that might affect future well-being [32], it does not explicitly account for external risks and preparedness to deal with shocks. The fact that various systems relevant for well-being (e.g., public health, financial and economic, political, etc.) have neglected the resilience capacity against shocks constitutes a significant risk to well-being [8]. The COVID-19 pandemic is a prime example of such a shock [8].

Before the COVID-19 pandemic, only few studies applied systems thinking to analyze national well-being [64,65]. As they derived data from participatory modeling workshops, the systems well-being models that resulted were idiosyncratic to the participants of the workshops. In addition, [65] conducted a desktop-based analysis of interconnections between the OECD Better Life Index indicators. However, its scope is significantly narrower than the OECD Well-being Framework. The authors of the study [66] applied systems thinking to understand interrelations between elements of the part of the national well-being system related to human capital, also relying on the OECD Well-being framework. To our knowledge, the only full evidence-based and/or theory-based systems description of national well-being is [12]. The description presented in this working paper was a first proof-of-concept version, which we have significantly updated and used in this paper for tracing the effects of COVID-19 mitigation policies.

3. A Systems Approach to Well-Being

Our study is based on two key principles. First, we use the OECD Well-being Framework to determine the scope of analysis and define the boundaries of the analyzed system; and second, we use systems mapping (causal loop diagramming) approach as the analysis tool.

The OECD Well-being Framework addresses both current well-being, i.e., how people experience their lives "here and now" and resources for future well-being, i.e., four types of capital (economic, natural, human, and social) as well as risk and resilience factors, that will impact well-being in the future [32]. The OECD Well-being Framework also addresses both subjective, i.e., how a person self-reports their well-being, and objective, i.e., how a person's well-being can be assessed through observed indicators, aspects of well-being [57].

While the COVID-19 pandemic undoubtedly impacts future well-being [67,68], in this study, we focus only on the current well-being aspects as these are essential to inform the current policies aimed at recovering and fostering well-being during and immediately after the COVID-19 crisis. The OECD Well-being Framework contains a total of 47 indicators grouped in 11 dimensions of current well-being, categorized into material conditions (i.e., income and wealth, housing, work, and job quality) and non-material quality-of-life

factors (i.e., health, knowledge and skills, environmental quality, subjective well-being, personal safety, work-life balance, social connections, and civic engagement) [32].

For the purposes of this paper, we took the 47 original OECD indicators as a basis and transformed them into 31 indicators to reduce the complexity. In this transformation, 26 indicators remained unchanged. Some of the indicators we removed are highly correlated with another indicator from the set of 31, while in other cases, we merged several indicators where the original indicators described too narrow aspects of well-being for the scope of our study. This mapping is described in detail in Supplementary Materials, Table S1.

Systems mapping is a principal system thinking tool. A systems map is a visualization of the considered system, that is, it displays the system's components and interconnections between them. The components are connected by directed links. Each link represents an impact (causal influence) that one component makes on another. The impact can be positive, which is the case when an increase/decrease in the state of the impacting component correspondingly leads to an increase/decrease in the impacted component, or negative, which is the case when an increase/decrease in the state of the impacting component, on the contrary, leads to a decrease/increase in the state of the impacted component [69].

Being a qualitative method, systems mapping is often used to analyze "wicked" policy planning problems in case no quantitative data are available [70]. Typically, this method is useful when the considered problem is new (and no prior experience exists on how it can be addressed) or the examined system is so complex that not all interdependencies between its components are fully known to researchers. The COVID-19 crisis entails both of these features [17]. Systems mapping can help building a shared perception of the considered problem [71], collecting insight about the dynamics of the studied system [72], and identification of the key system components for policy planning (so-called leverage points) [73].

Systems mapping has been used in several studies that assessed the impact of the COVID-19 pandemic and its mitigation policies on various components of a broader socio-economic system [13,15–18,74,75] (for a review, see [76]). However, no study dealt with their impact on the national well-being indicators.

Our paper fills in this gap and provides a tool for a holistic qualitative assessment of the impact of COVID-19 mitigation policies on the national well-being. Our methodology consists in several major steps. First, based on synthesizing knowledge from 85 literature sources, we produced a systems map of the current national well-being system (NWS) that includes 31 well-being indicators connected by a total of 134 causal relations.

To introduce COVID-19 mitigation policies into the well-being system, we took the list of 48 non-pharmaceutical interventions (NPIs) identified in the Complexity Science Hub Vienna COVID-19 Control Strategies List (CCCSL), level 2 [31,77] and clustered them into ten groups (Table 1; for the mapping see Supplementary Materials, Table S2). We further discarded from further analysis "Raising awareness" as it has a highly ambiguous and yet-to-be-better-understood impact (for example, its impact on "Depressive symptoms" and "Perceived health" is likely to have both a positive or negative component, and it is not clear which one determines the net result). Based on the intended scope of our study, we also discarded "Government support" as these measures rather deal with the effects of other COVID-19 policies and not with COVID-19 itself, thus being second-order measures rather than primary measures [78].

Table 1. COVID-19 mitigation policy groups.

Policy Groups	Included in Analysis (+)
State of emergency	+
Medical capacity enhancement	+
International travel restrictions	+
Quarantines	+
Restrictions on population mobility	+
Enhancement of physical barriers	+
Gatherings restriction	+
Closures	+
Raising awareness	-
Government support	-

We identified the presence of a direct impact of the considered COVID-19 mitigation policies on the components of the national well-being system based on the collective assessment of this paper's co-authors supported by the literature review. In this exercise, each of us first independently assessed the impact of each policy on each national well-being indicator. Only links that were agreed on by at least five out of six co-authors were suggested as candidate links. Then, for each candidate link, we looked for evidence from the existing literature. A total of 35 links was identified relying on 33 literature sources (Table A2 in Appendix A).

Despite the fact that in the spirit of Occam's razor principle, we strived to create an as-simple-as-possible NWS systems map [79], the resultant map appears to be too complex to comprehend by an optical observation [80]. In order to unravel the complexity, we employed several methods, including (i) analysis of *in- and out-degrees* to determine the most impacting (drivers) and most impacted components [81]; (ii) *uses trees* to trace impact pathways of policy interventions [82], and (iii) *loops* to analyze feedback loops emerging in the systems map [69,83].

The entire process of data collection, processing, and analysis is depicted in Figure 2. A similar procedure was used in [65] for the analysis of interconnections between high-level national well-being indicators.

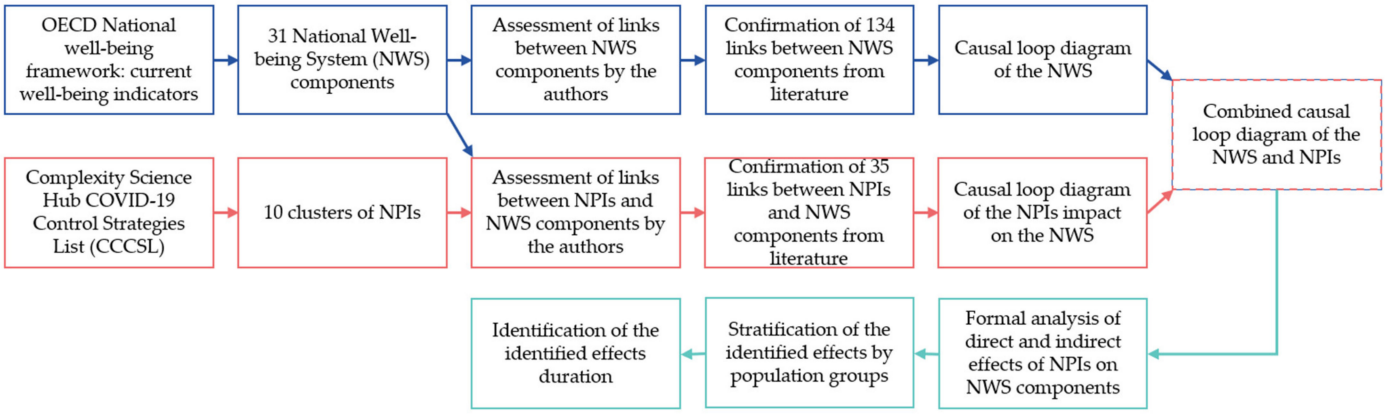


Figure 2. Data collection, processing, and analysis steps. The blue rectangles denote data collection and processing steps on the National Well-being System (NWS), the red rectangles denote data collection and processing steps on the non-pharmaceutical interventions (NPIs), and the green rectangles denote the causal loop diagram (CLD) analysis steps.

On the practical side, we implemented the developed NWS systems map in Vensim software, the most commonly used tool for developing and analyzing CLDs. It allows easy identification of indirect causal effects of higher orders and feedback loops in the NWS.

4. Impacts of COVID-19 Mitigation Policies on National Well-Being

4.1. Causal Loop Diagram of the National Well-Being System

First, we develop a causal loop diagram (CLD) depicting relationships among the indicators from the OECD Well-being Framework 2020. The resultant CLD can be found in Appendix A (Figure A1). The vast majority of the links in this map are supported with evidence from literature, see Table A1 in Appendix A.

This map reflects a high complexity of the national well-being system indeed. As one measure of complexity, we used the pathway proliferation rate, which is the spectral radius of the adjacency matrix reflecting information about all links in a CLD (this matrix is available in Supplementary Materials, Table S3). The pathway proliferation rate indicates how much the number of indirect pathways increases with the increase in their length. This metric is often used for assessing the complexity of ecological networks [84] (where typical numbers vary between 0 and 10.25 with the mean value of 3.09 across 17 reviewed networks). The pathway proliferation rate of our national well-being map is 4.46. This rather high value suggests a strong power of indirect effects in this system.

To identify the most impacted indicators, we estimated the in-degree (the number of incoming links) of all indicators (Figure 3). The most impacted indicators are "Life satisfaction" (in-degree 20), "Perceived health" (in-degree 17), and "Depressive symptoms" (in-degree 16). They can be considered as ultimate determinants of well-being.

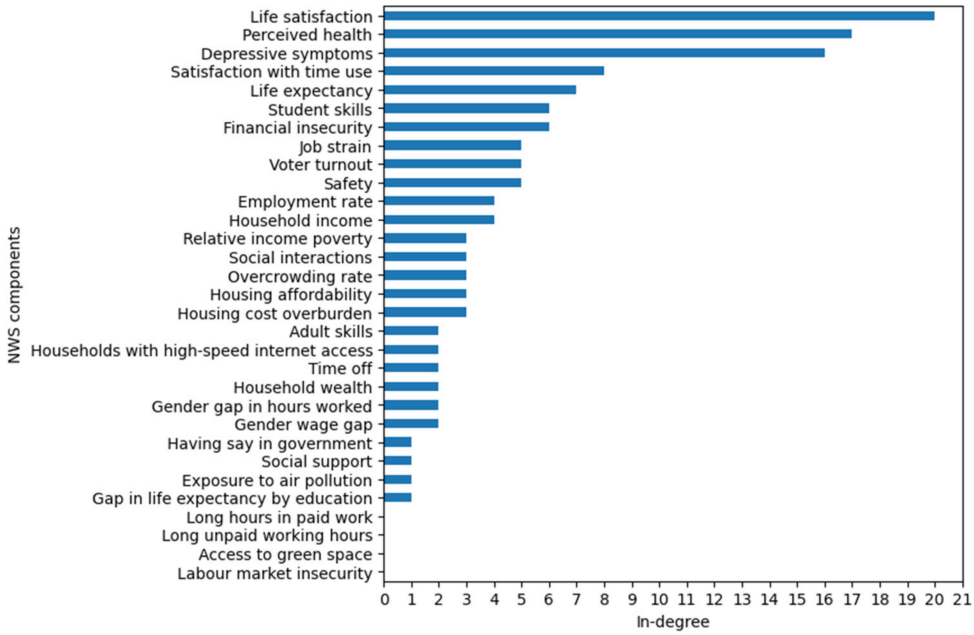


Figure 3. In-degrees of the National Well-being System components.

4.2. Identifying the Impact of COVID-19 Mitigation Policies on the National Well-Being System

Based on the links illustrating NPIs effects on the National Well-being System identified by the authors and confirmed with literature evidence, we designed a causal loop diagram which is depicted in Figure 4.

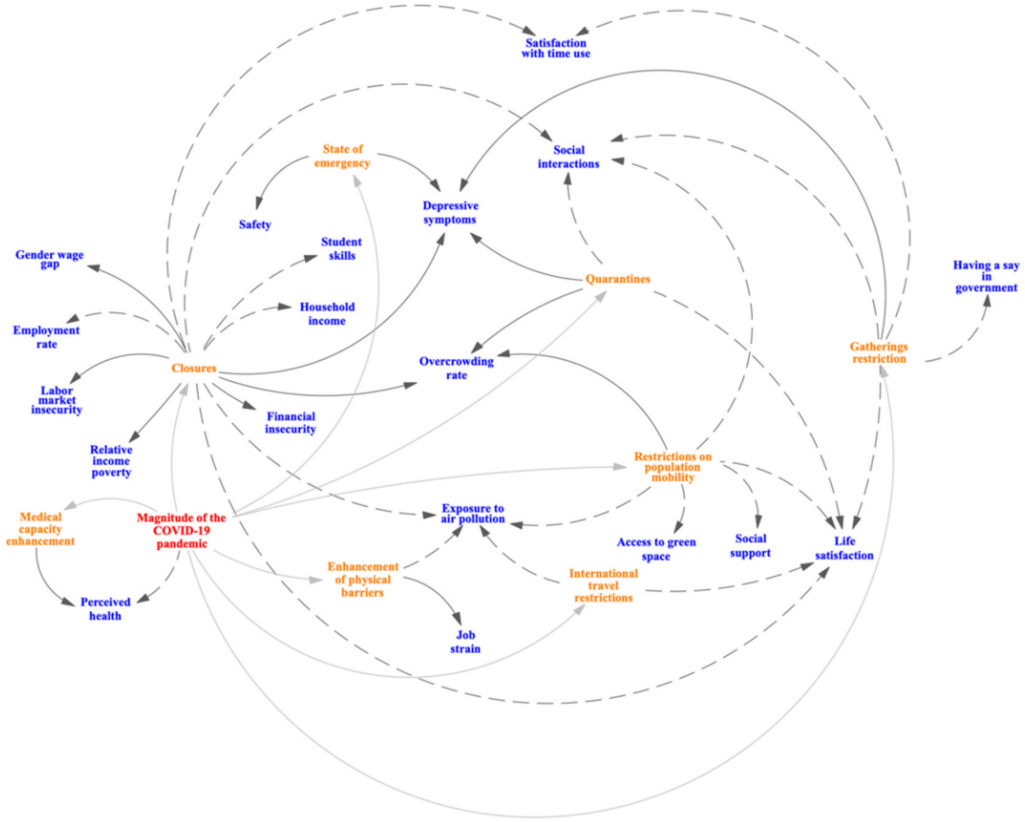


Figure 4. Direct impact of the COVID-19 pandemic (red) and selected mitigation policies (orange) onto national well-being components (blue). Light-grey links illustrate connections between the magnitude of the COVID-19 pandemic and the mitigation policies.

To identify which policies have the strongest direct effect, we estimated the out-degree (number of outgoing links) for each policy (Figure 5). The "Closures" policy has the largest out-degree—13, thereby directly affecting 13 national well-being components.

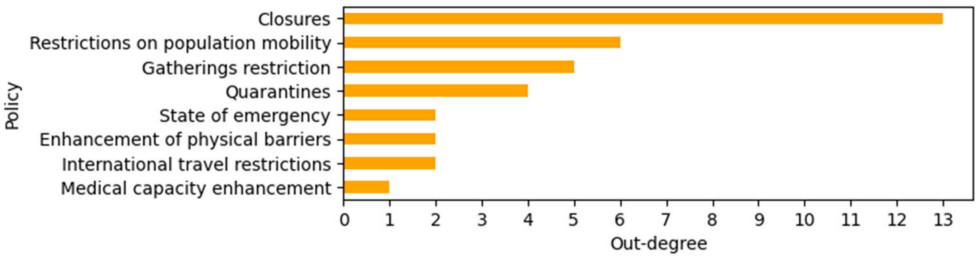


Figure 5. Out-degrees of the selected COVID-19 mitigation policies. The numbers on the x-axis indicate the number of national well-being components affected by a policy.

In addition to direct effects, we also analyzed the first-order indirect effects of the COVID-19 mitigation policies; that is, how the national well-being components are affected by the policies through other national well-being and intervening components (see Figure 6 for an illustrative example).

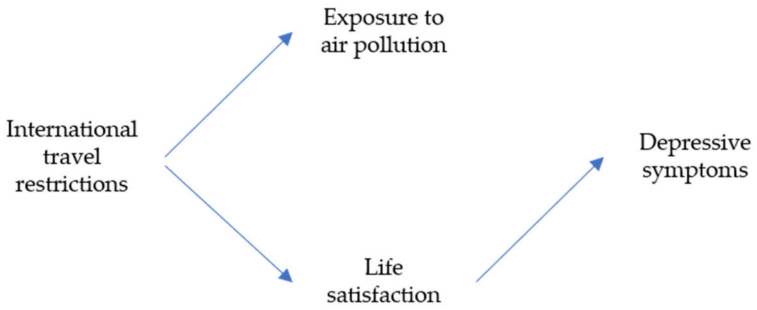
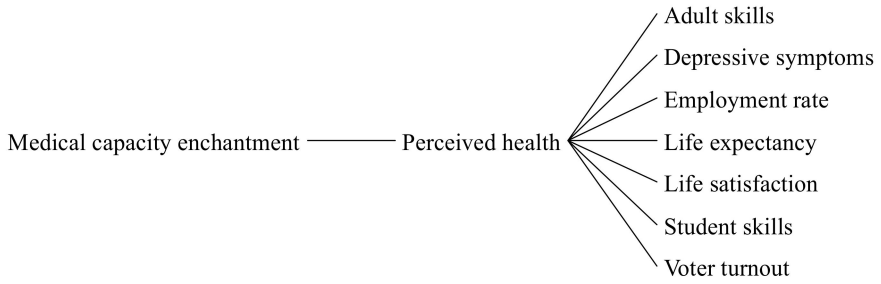


Figure 6. An illustrative example of direct and first-order indirect effects of COVID-19 mitigation policies. The policy "International travel restrictions" affects national well-being systems components "Exposure to air pollution" and "Life satisfaction" directly while it affects "Depressive symptoms" component indirectly, i.e., through the "Life satisfaction" component.

For this purpose, we combined the CLD of the NWS (Figure A1) and the CLD illustrating the direct effects of the COVID-19 mitigation policies on the NWS (Figure 4). The resultant CLD is depicted in Figure A2 (see Appendix A). To formally analyze it, we applied the Uses Tree tool in Vensim to the resultant extended CLD (Figure 7).



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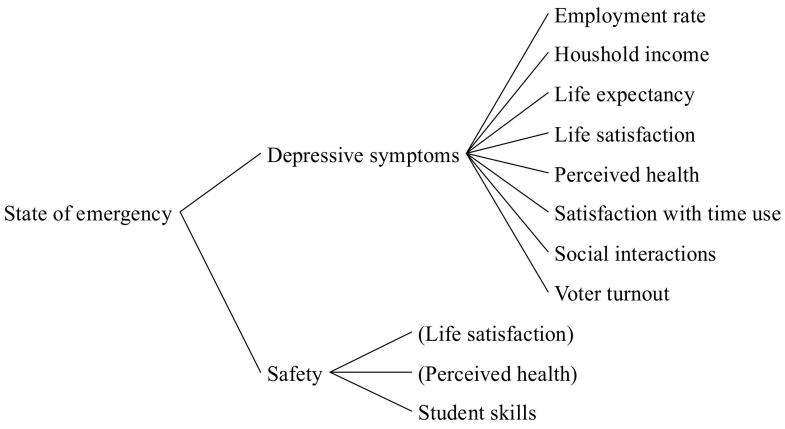

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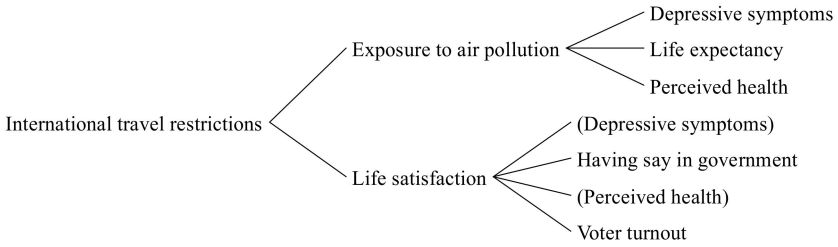

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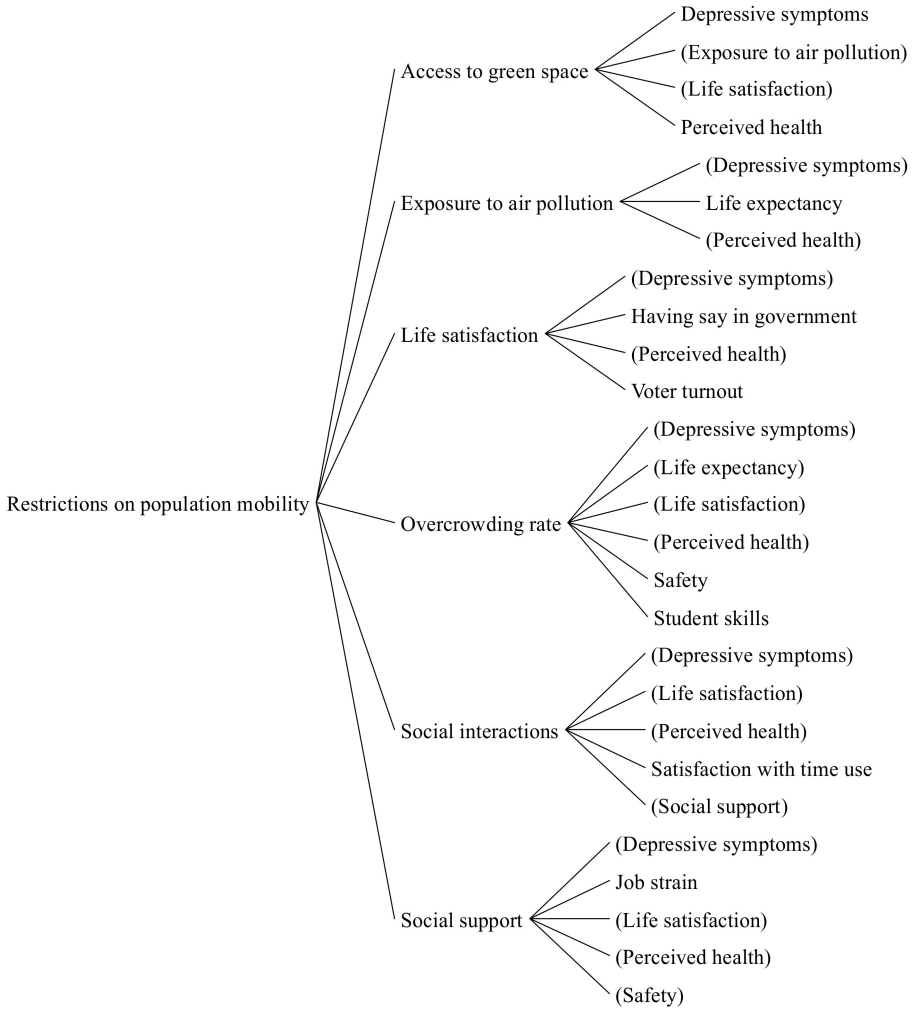

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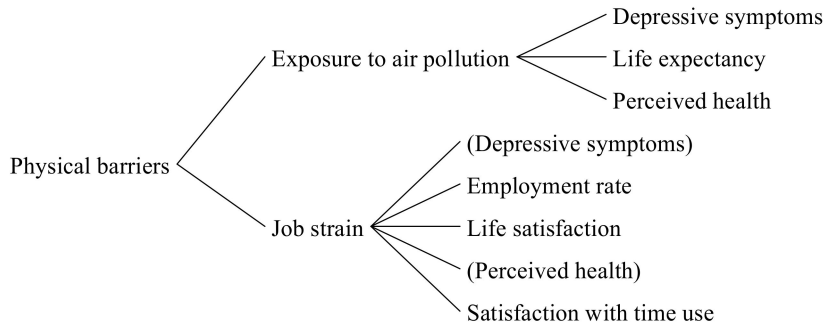

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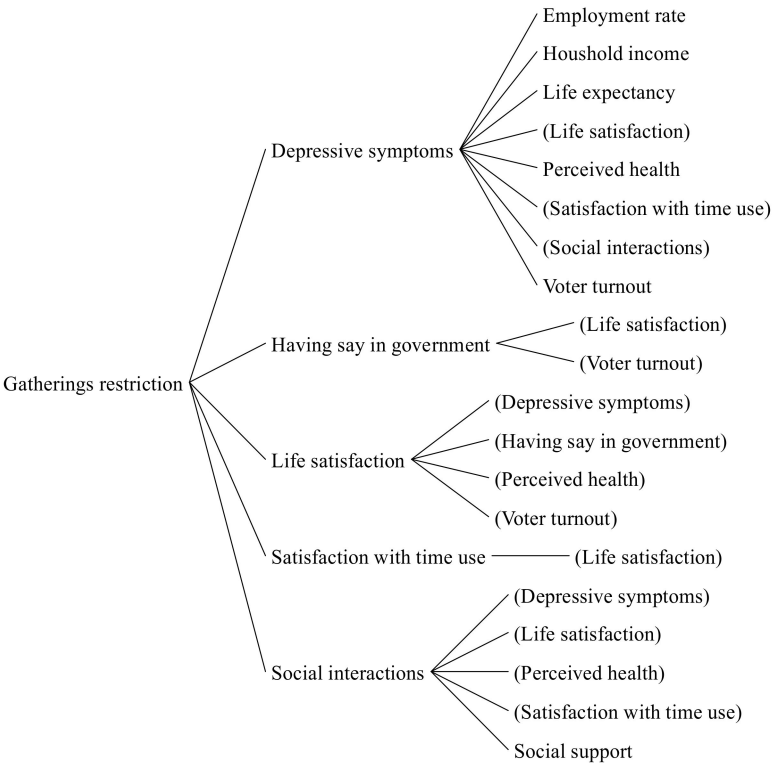

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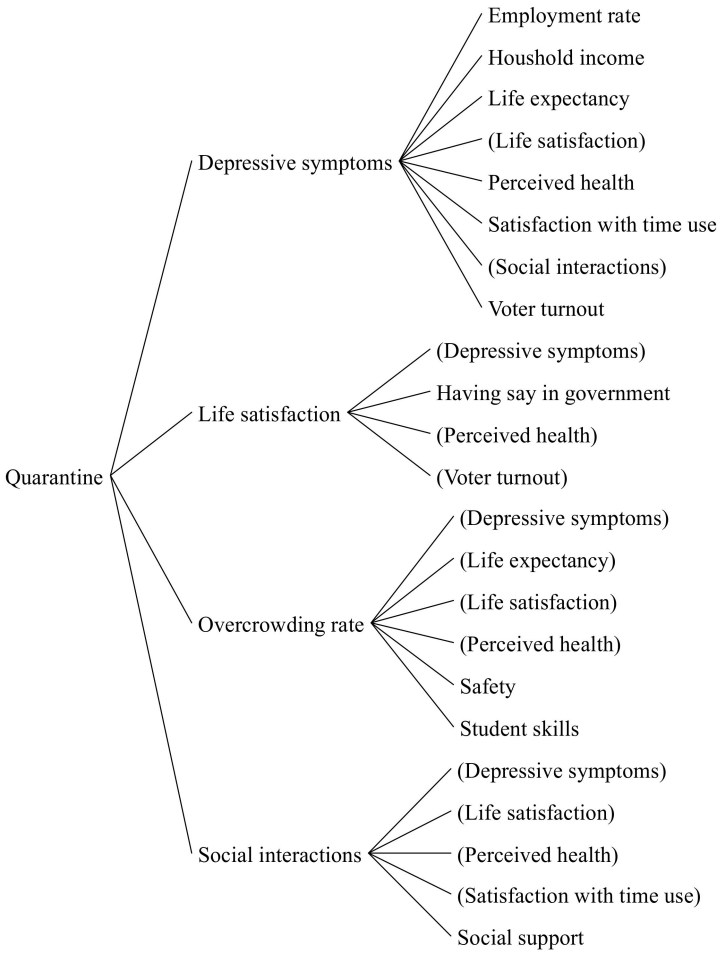

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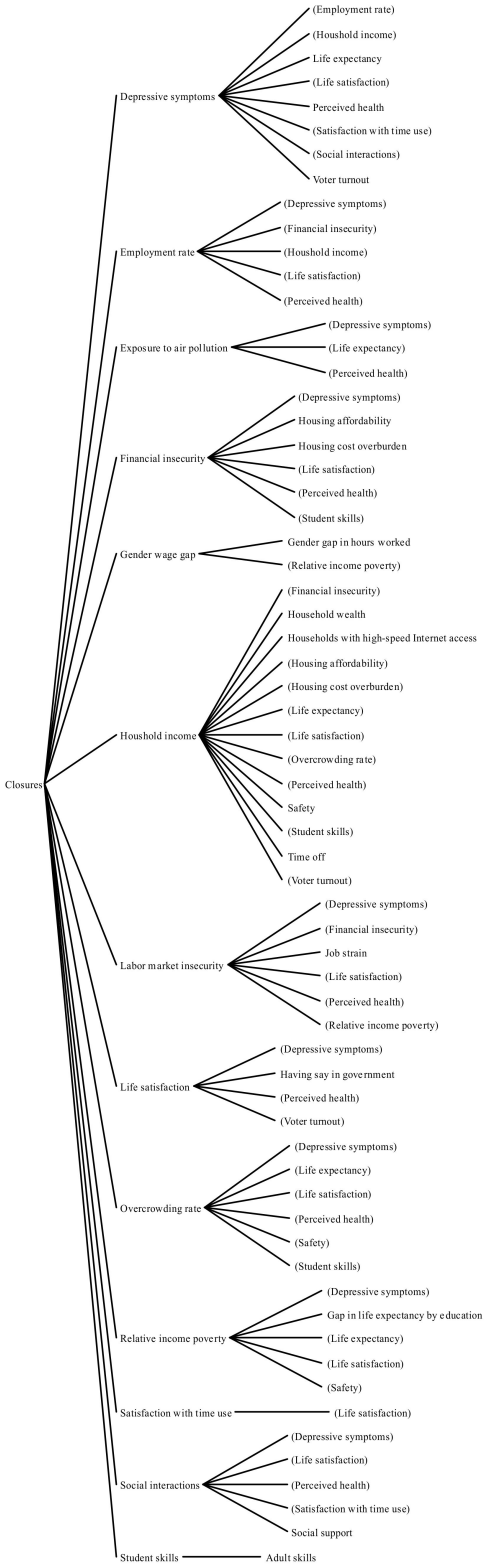

(**h**)

Figure 7. Direct and first-order indirect effects (listed in alphabetical order) of various COVID-19 mitigation policies on the of the National Well-being System components: (**a**) Medical capacity enhancement, (**b**) State of emergency, (**c**) International travel restrictions, (**d**) Restrictions on population mobility, (**e**) Enhancement of physical barriers, (**f**) Gatherings restriction, (**g**) Quarantines, (**h**) Closures.

To estimate the indirect effects of COVID-19 mitigation policies, we count how many national well-being indicators are affected by each policy indirectly through the first-order indirect effects and compute the ratio of indirect to direct effects (Table 2).

Table 2. Direct and indirect effects of COVID-19 mitigation policies. For policies indirectly affecting a national well-being component through different paths (see Figure 7), each such effect is counted separately.

Mitigation Policy	Direct Effects	Indirect Effects	Total Effects	Indirect/Direct Ratio
State of emergency	2	11	13	5.5
Medical capacity enhancement	1	7	8	7
International travel restrictions	2	7	9	3.5
Quarantines	4	23	27	5.75
Restrictions on population mobility	6	27	33	4.5
Enhancement of physical barriers	2	8	10	4
Gatherings restriction	5	20	22	4
Closures	13	65	78	5

We observe that naturally, all considered policies have more indirect than direct effects. "Closures" has not only the highest number of direct but also the highest number of first-order indirect effects. This policy impacts virtually all aspects of the national well-being system only through direct and first-order indirect links (28 of 31).

The ratio between indirect and direct effects varies significantly across policies ranging from 3.5 in the case of "International travel restrictions" to 7 in the case of "Medical capacity enhancement". A high indirect/direct ratio reveals the situation when a policy affects an indicator that strongly influences the system. This can help detect policies whose impact may be overlooked if one focuses only on the direct effects.

Finally, using the paths identified in Figure 7, we summarized how each COVID-19 mitigation policy impacts each national well-being indicator both directly and indirectly through the first-order effects. Where possible, we also provide the direction of the total impact (Table 3). We observe that the most severely impacted components are "Life expectancy", "Perceived health", "Depressive symptoms", and "Life satisfaction"—they are impacted directly or indirectly by all COVID-19 mitigation policies. While some policies have a definite (positive or negative) effect on these national well-being components, others have an ambiguous effect.

Figure 8 further illustrates the total numbers of direct and indirect paths connecting COVID-19 mitigation policies and well-being indicators. A higher number of paths from a policy to an indicator suggests a stronger impact. Thus, the impact of "Closures" on "Life satisfaction" (10 paths) and on "Perceived health" and "Depressive symptoms" is the strongest (9 paths each) among all $8 \times 31 = 248$ policy->indicator pairs. This is followed by the impact of "Restriction on population mobility" on the same three well-being indicators (six paths to "Perceived health" and "Depressive symptoms" and five paths to "Life satisfaction"). These three well-being indicators emerge as the most impacted by all policies, as can be seen by the total number of paths coming into each of them.

Table 3. Summary of the COVID-19 mitigation policies (columns) impact on the national well-being system components (rows); both are listed in alphabetical order. If a direct and one or more indirect effects of a COVID-19 mitigation policy on a national well-being component has the same polarity (either positive or negative), then we assume that the direct effect absorbs the indirect effects. If the polarity of at least one indirect effect is different from the polarity of the direct effect, then the total effect is ambiguous. A total effect is also ambiguous if there are no direct effects but several indirect effects with different polarities.

	Closures	Enhancement of Physical Barriers	Gatherings Restriction	International Travel Restrictions	Medical Capacity Enhancement	Quarantines	Restrictions on Population Mobility	State of Emergency
Access to green space	0	0	0	0	0	0	−1	0
Adult skills	−1	0	0	0	1	0	0	0
Depressive symptoms	?	?	1	?	−1	1	?	1
Employment rate	−1	−1	−1	0	1	−1	0	−1
Exposure to air pollution	−1	−1	0	−1	0	0	?	0
Financial insecurity	1	0	0	0	0	0	0	0
Gap in life expectancy by education	1	0	0	0	0	0	0	0
Gender gap in hours worked	−1	0	0	0	0	0	0	0
Gender wage gap	1	0	0	0	0	0	0	0
Having say in government	−1	0	−1	−1	0	−1	−1	0
Household income	−1	0	−1	0	0	−1	0	−1
Household wealth	−1	0	0	0	0	0	0	0
Households with high-speed internet access	−1	0	0	0	0	0	0	0
Housing affordability	−1	0	0	0	0	0	0	0
Housing cost overburden	1	0	0	0	0	0	0	0
Job strain	1	1	0	0	0	0	1	0
Labor market insecurity	1	0	0	0	0	0	0	0
Life expectancy	?	1	−1	1	1	−1	?	?
Life satisfaction	−1	−1	−1	−1	1	−1	−1	?
Long hours in paid work	0	0	0	0	0	0	0	0
Long unpaid working hours	0	0	0	0	0	0	0	0
Overcrowding rate	1	0	0	0	0	1	1	0
Perceived health	?	?	−1	?	1	−1	?	−1
Relative income poverty	1	0	0	0	0	0	0	0
Safety	−1	0	0	0	0	−1	−1	1
Satisfaction with time use	−1	−1	−1	0	0	−1	−1	−1
Social interactions	−1	0	−1	0	0	−1	−1	−1
Social support	−1	0	−1	0	0	−1	−1	0

Table 3. *Cont.*

	Closures	Enhancement of Physical Barriers	Gatherings Restriction	International Travel Restrictions	Medical Capacity Enhancement	Quarantines	Restrictions on Population Mobility	State of Emergency
Student skills	−1	0	0	0	1	−1	−1	1
Time off	−1	0	0	0	0	0	0	0
Voter turnout	−1	0	−1	−1	1	−1	−1	−1

1	Direct positive effect	−1	Direct negative effect	?	Ambiguous effects (direct + indirect)
1	Indirect positive effect(s)	−1	Indirect negative effect(s)	?	Ambiguous effects (only indirect)

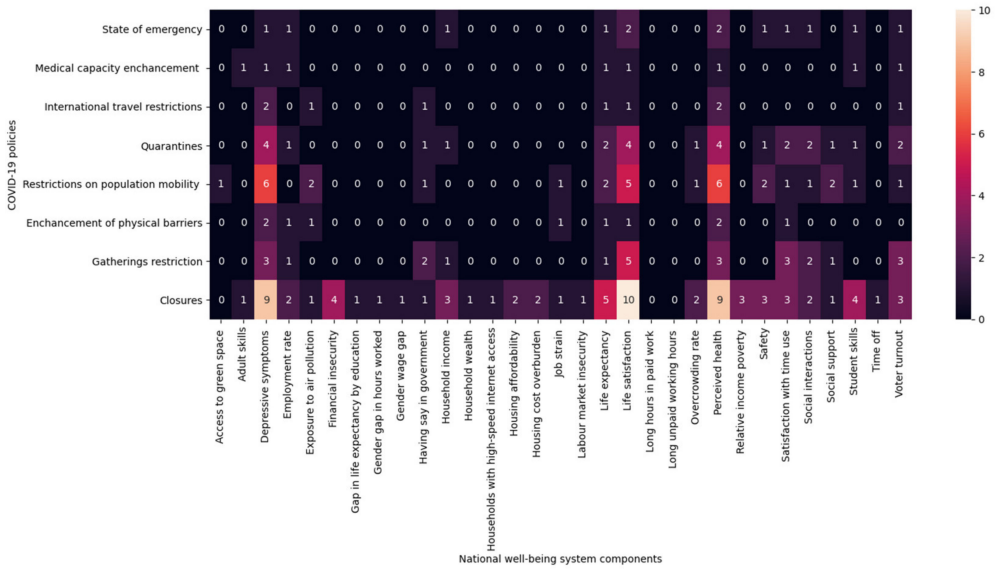

Figure 8. Total number of paths of length not greater than 2 (i.e., direct and first-order indirect effects) between COVID-19 mitigation policies and national well-being systems components.

4.3. Feedback Loops

We complement the analysis of directional indirect effects of COVID-19 mitigation policies on the national well-being components discussed in Section 4.2 by analyses of feedback loops that constitute cycles of indirect effects. Feedback loops can greatly amplify or balance direct effects [69].

Our CLD of the national well-being system contains a total of 48,208 feedback loops (without repetitions of components or links other than the starting and ending components). These loops contain 2 to 20 components, with the largest number of loops containing 12 components. The full distribution of the number of loops according to their length (measured by the number of nodes a loop contains) is depicted in Figure 9.

This result underscores a high complexity of the national well-being system and the prevalence of long indirect cycled effects. As long indirect effects are typically weaker than shorter ones [65], we analyzed only feedback loops containing four nodes. As an important example, we focus on feedback loops that involve "Life satisfaction" as the most impacted component of the national well-being system. There is a total of 33 such loops. Of these, we select those whose elements are directly affected by "Closures", as this was found to be the most impactful policy (Table 2). We present here two distinct sets of such feedback loops, which have important implications for various aspects of the national well-being system (Figure 10). Individual feedback loops in both sets are listed in Table 4.

Panel (a) in Figure 10 illustrates the feedback loop from "Social interactions" to "Social support" to "Life satisfaction" to "Depressive symptoms" and back to "Social interactions". This loop can be referred to as a "social driver of life satisfaction". Through this loop, increased depression and reduced social interaction and support can amplify a fall in life satisfaction. This four-element feedback loop (R1) is further amplified by the presence of four smaller (two- and three-element) reinforcing feedback loops (depicted as R2–R5). "Closures" has a direct effect on three elements in this four-element feedback loop and is likely to aggravate the negative dynamics described above even more.

Panel (b) in Figure 10 illustrates the feedback loop from "Employment" to "Financial insecurity" to "Life satisfaction" to "Depressive symptoms" to and back to "Employment". This loop can be referred to as an "economic driver of life satisfaction". Through this loop, increased depression because of low life satisfaction increases the chances for unemployment which increases financial insecurity, thus decreasing life satisfaction even further. Again, this four-element feedback loop (R6) is amplified by the presence of four smaller

ones (R7–R10). "Closures" directly affect all four elements in this feedback loop and are likely to aggravate the negative dynamics described above even more.

Overall, we can conclude that synergistic effects between the well-being indicators involved in two loops in Figure 10 increase the overall adverse effects of "Closures" on life satisfaction beyond the direct effect of each variable.

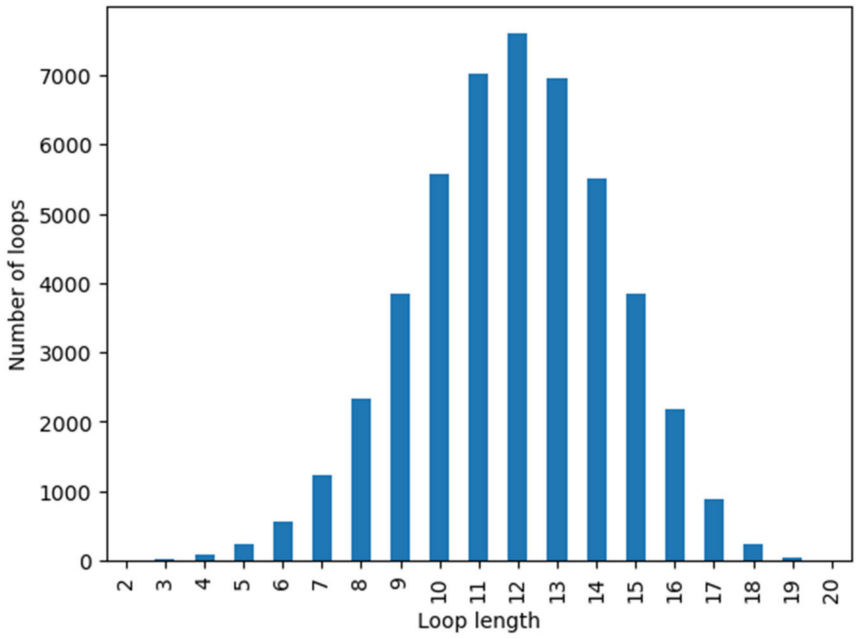

Figure 9. Number of feedback loops of different lengths in the National Well-being System. Loop length is the number of links it contains.

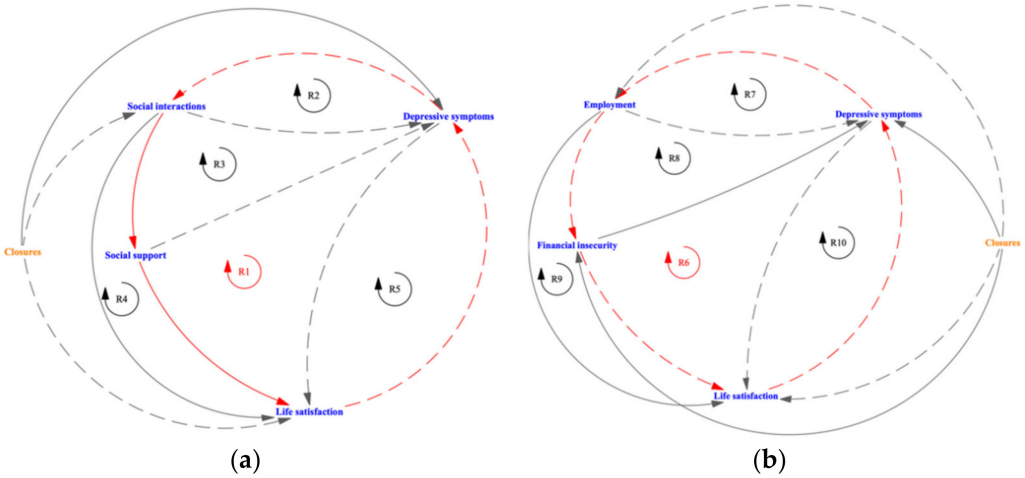

Figure 10. Exemplary feedback loops illustrating effects of the "Closures" policy on various aspects of the National Well-being System: (**a**) "social driver of life satisfaction", (**b**) "economic driver of life satisfaction".

Table 4. Exemplary feedback loops.

Loop Code	Description
R1	Social interactions—Social support—Life satisfaction—Depressive symptoms—Social interactions
R2	Social interactions—Depressive symptoms—Social interactions
R3	Social interactions—Social support—Depressive symptoms—Social interactions
R4	Social interactions—Life satisfaction—Depressive symptoms—Social interactions
R5	Life satisfaction—Depressive symptoms—Life satisfaction
R6	Employment—Financial insecurity—Life satisfaction—Depressive symptoms—Employment
R7	Employment—Depressive symptoms—Employment
R8	Employment—Financial insecurity—Depressive symptoms—Employment
R9	Employment—Life satisfaction—Depressive symptoms—Employment
R10	Depressive symptoms—Life satisfaction—Depressive symptoms

5. The Equity Effects of COVID-19 on Well-Being

5.1. The Process of Analysis

The effects of COVID-19 on current well-being differ across different population groups [4]. There is evidence that suggests that one of the major effects of COVID-19 is increasing inequities [39]. These inequities are not along the commonly analyzed lines, such as the differentiation and socio-economic stratification, lifestyle choice, or belonging (ethnic, racial, religious, etc.).

As can be seen in Figure 4 and Table 3, the main short-term effects of COVID-19 pertain to economic facets. Across eight analyzed policies, "Employment rate" and "Household income" appear most frequently as directly affected variables or are subject to first-order indirect effects. Therefore, we suggest using employment and income as the main stratifying variables concerning the sensitivity of the population to COVID-19 mitigation policies. Thus, we stratify the population to those whose employment is affected and those that are largely unaffected, at least in the short run. However, the effect on employment is not limited to the loss of employment, as in many cases, particularly in the private sector, the implication is an increase in financial insecurity and labor market insecurity (the corresponding components are directly affected by "Closures" policy, see Table 3). Further stratification is based on the effect on mobility, which also pertains to the short term. As public transport use was limited, those dependent on it were affected, while owners of private vehicles were not.

Based on these observations, we stratify the population into three main groups, each sub-stratified by the mobility effects. Income and employment stratify the population into those that (i) were unaffected, those (ii) whose income and job security were affected but retained their workplace, and those (iii) who lost their workplace (temporarily or permanently). These groups serve as a basis for the equity analysis. The mobility effect essentially differentiates car-owners from those that depend on public transport to reach workplaces and health facilities and is used as an additional stratifying variable for each of the three groups where applicable. COVID-19 impacts different groups differently, but some groups are affected almost equally (e.g., people who have lost their jobs) regardless of having a car. Below we discuss each group and how it is affected.

5.1.1. Group 1: Income and Employment Unaffected

This group is typified by people whose income and job security were not affected and who own private cars, and thus their mobility options were unaffected too (except during lockdowns, which affect the whole population and thus do not stratify in terms of mobility). Many of these are people who can work remotely and whose workplaces were not adversely affected. This group includes thus business owners and employees of sectors that were not affected (such as pharmacists and health professionals), businesses and employees who could switch easily to remote work such as academics and many high-tech businesses and people who are in the public sector and deemed as essential personnel and thus continued to work as usual (such as policemen and military personnel).

5.1.2. Groups 2: Loss of Job Security and Possibly Some Income

This group includes people whose workplaces are affected by COVID-19 but who did not lose their jobs. Hence, while they continue to work, they face uncertainty regarding their future employment and may face redundancy. In some cases, their income has also reduced. In the case of salaried employees, this group includes those whose wages were reduced, while in the case of business owners, this group includes owners (including self-employed workers) whose revenues fell but whose enterprises did not close. These include owners and employees in many retail sectors, as well as in industries that continued to operate but faced greater uncertainty or losses due to the general downturn in the economy.

5.1.3. Groups 3: Loss of Jobs

The third group includes all those whose workplaces have been forced to shut down or employees laid off due to losses suffered by their workplaces. This group also includes business owners (and self-employed) whose businesses went out of business, temporarily or permanently. They may also include people who previously were in high-income brackets, such as airline pilots. However, the majority of people in this group are in the low-income brackets [85]. As they become job seekers, those who depend on public transport are further constrained in their job search by limitations on public transport. This group is likely to include also people who were not employed when the pandemic began and whose prospects of finding employment were vastly reduced due to the pandemic. This group includes, for example, recent graduates from high schools, colleges, or universities.

The effects of COVID-19 on the current well-being of the three groups were analyzed in three timeframes—short, medium, and long. The short timeframe is within the first three months after the first case was identified, or a new (second, third, or fourth) wave due to a new variant is declared. This is usually the period in which governments enacted lockdowns to overcome the first waves of COVID-19. The medium period is the period in which some exit from the first measures is enacted after infection rates have declined. Finally, the third, long period, pertains to the period (2–3 years, perhaps more) during which COVID-19 persists while the economy is at least partially operational. It is expected that during this period, international travel will continue to be constrained, and the world economy will continue to be affected. Hence, open economies will continue to be adversely affected.

In Table 5, the effects of COVID-19 mitigation policies on various well-being variables are noted by the group as positive (+), negative (−), or absent (0). It indicates whether that well-being variable was or was not affected by COVID-19 mitigation measures for the specific group, given the different economic effects. To categorize these effects, the impacts identified in Figure 7 were used. Namely, to assess the implications for those whose income and jobs were unaffected, this figure was redrafted with the income and labor-related variables not directly affected by any of the COVID-19 mitigation policies, i.e., "Household income", "Relative income poverty", "Employment rate" (not affected for Groups 1 and 2), "Labor market security", and "Financial insecurity" (not affected for Group 1 only). In this analysis, we consider only restrictive measures, i.e., all listed in Table 1 except for "Medical capacity enchantment".

Using systems mapping, we can identify potential effects even if they have not materialized yet. The short- and mid-term effects are those which are caused directly by the COVID-19 mitigation policies (Figure 4; see Table A2 in Appendix A for the evidence). The long-term effects are those that can be traced through the systems map but have not materialized yet (such as effects on student skills due to interruption of education or sub-optimal distance learning), and those with long-term effects such as loss of household wealth, i.e., savings or loans. As we are still not in the long term (or just entering it), there is no empirical evidence yet. Therefore, the possible duration of such effects, as well as persistence of short- and mid-term effects in a longer term, was assessed by the authors' collective judgment.

Table 5. The well-being effects stratified by groups (+ positively affected; 0 unaffected; − negatively affected). Duration of effect: s—short-term, m—medium-term, l—long-term, 0—no effect.

Well-Being Component	Duration of Effect	Group 1	Group 2	Group 3
Access to green space	s/m	−	−	−
Adult skills	l	0	0	(−) ***
Depressive symptoms	s/m/l	+	+	+
Employment rate	s	0	0	(−) ***
Exposure to air pollution	s/m/l	−	−	−
Financial insecurity	m/l	0	0/−	−
Gap in life expectancy by education	0	0	0	0
Gender gap in hours worked	s/m	(+) *	+	+
Gender wage gap	s/m	0	0	+
Having say in government	m/l	−	−	−
Household income	s	0	0/(−) **	−
Household wealth	m/l	0	0/−	−
Households with high−speed internet access	s	0 ****	0	0
Housing affordability	l	0	0	−
Housing cost overburden	l	0	0	+
Job strain	m/l	0	+	+
Labor market insecurity	s	0	+	+
Life expectancy	0	0	0	0
Life satisfaction	m/l	0	−	−
Long hours in paid work	0	0	0	0
Long unpaid working hours	s/m	(+) *	+	+
Overcrowding rate	s	+	+	+
Perceived health	s/m/l	−	−	−
Relative income poverty	s/m/l	0	0	+
Safety	s	0	0	−
Satisfaction with time use	s	−	−	−
Social interactions	s	−	−	−
Social support	s/m	−	−	−
Student skills	m/l	0	0	(−) ***
Time off	0	0	0	0
Voter turnout	m/l	−	−	−

* In cases where needed childcare was affected; ** Depending on the extent to which income affected; *** Affecting mainly those who are dependent on public transport; **** While this well-being component is not affected by the COVID-19 mitigation policies, it has been observed that the number of households with high-speed Internet access has increased to facilitate, among other things, remote work.

5.2. Summary of Effects by Group and Timescale

5.2.1. Group 1: Employment and Income Unaffected

The main short-term effect on the well-being of this group is the loss of recreation opportunities. These were curtailed in the short term due to lockdowns and the closing of parks, beaches, etc. (measured by "Access to green space"). However, these were largely re-opened in the medium term, though with some restrictions. Still, the options for recreation abroad remain limited, resulting in potential congestion in many domestic sites. Another short-term effect may be the effect on work-life balance for households with small children who were left without educational facilities (measured by "Long unpaid working hours" and "Gender gap in hours worked"). A third short-term effect may be on health, particularly if positively tested for COVID-19 (measured by "Perceived health"). This effect is not limited to the short-term as additional infection waves arise. Thus, the effect is likely to amplify over time.

Like other groups, this group was adversely affected already in the short term by the effects of restrictions on social interactions (measured by "Social interactions"). The severance of social interactions has possible medium and long-term implications for life satisfaction and social support. As noted above, these are amplified due to the cyclical relations between them, and thus may have long-term implications beyond the period in which the pandemic ranges. Lower likelihood implications may pertain to engagement

in politics (measured by "Having say in government"). Those without a private vehicle may also be affected by more limited mobility due to the limitations on public transport, particularly in the short run.

Overall, the effects on this group are limited in the short term, with the most important effects being related to the limitations on social interactions. The long-term implications of these limitations may be perceptible but are uncertain. Well-being components such as housing (measured by "Housing affordability" and "Housing cost overburden") and education (measured by "Student skills" and "Human skills") are not likely to be affected for this group. If the possibilities for spending money are curtailed due to limitations on international flights and closure of shops, cultural activities, nightlife, etc., which are primarily luxury goods, expenditures of such households may actually decline.

5.2.2. Group 2: Loss of Job Security and Possibly Some Income

Even though members of this group continue to be employed, their continued employment is threatened, and/or their income falls (due to lower revenues or wages) (measured by "Household income"). The loss of job security and/or income occurs already in the short run. These have implications for job strain as well as work-life balance (measured by "Long unpaid working hours", "Gender gap in hours worked", and "Satisfaction with time use"). This is true for salaried employees, independent workers, and business owners. Moreover, increased job strain and disruption of work-life balance affect life satisfaction and health, and further limit social contacts, thereby aggravating the social well-being implications. Losses of job security and/or income have implications for consumption, as households rein in their outlays given the uncertainty regarding future earnings. Increasing labor market insecurity and income uncertainty (measured by "Financial insecurity") incentivize contraction of expenditures, leading to retailing and production contraction, worsening the economic downturn. Thereby they have macro-economic implications.

In addition, this group suffers from loss of social capital due to reduced social contacts, like group 1, with implications for life satisfaction and social support. This group is also likely to have reduced health, similarly to group 1, as well as have lesser recreational opportunities. However, while domestic recreational opportunities open up for group 1, this group may not utilize them due to the fiscal contraction. In this case, too, those without a private car will face limited mobility options due to the limitations on public transport.

5.2.3. Group 3: Loss of Employment (Unemployed or on Extended Unpaid Leave)

This group is the group most adversely affected. The loss of jobs, extended unpaid leave, and business closures have immediate drastic effects on income. If a household has monetary reserves, it may draw on them, thereby reducing its wealth. Otherwise, it may increase debt (which will need to be repaid, even if the government supports such households). In both cases, the loss of income will lead to drastic change (reduction) in expenditures, with multiplier effects on the economy. This may lead to reduced production and labor demand, thereby widening the circle of those affected. This downturn has immediate effects on labor market insecurity and increasing job strain (even if the household members find an alternative, often lesser paying, job), as well as on work–life balance. The loss of wealth is likely to have adverse implications for housing affordability and possibly student skills as teenagers and student-aged youngsters need to seek an additional income and cannot rely on their parents. However, data suggest that the jobs available to these age groups are among those most adversely affected [84]. Thus, the skills of such young people may suffer, thereby adversely affecting their long-term opportunity (measured by "Adult skills") and raising the specter of a "lost generation". This outlook is worse for those without private means of transport, as their accessibility to jobs and opportunities is constrained by the limitations imposed on public transport.

The health implications for this group may be worse than for other groups as the loss of income may lead to reduced access to health professionals. In addition to the loss of social capital due to the reduced social contacts, this group may suffer psychological impacts,

which will be seen in life satisfaction and the increased onset of depressive symptoms. Thus, while all groups will suffer a loss of social capital, the implications and extent of loss for this group are likely to be much more significant.

6. Discussion and Conclusions

The COVID-19 pandemic has widespread implications. Measures that were implemented by different countries to reduce its direct health effects are largely similar [31]. Nevertheless, the stringency, duration, and specifics of how these measures were implemented vary between countries [77]. Hence, the actual effects are likely to vary too. The generic framework advanced in this paper can serve as a basis for comprehensive analyses of the effects of the sets of measures implemented on well-being. Yet, clearly, it should be adapted to local circumstances when applied to specific countries or societies.

While the initial set of measures implemented to reduce the direct health effects of COVID-19 were quite similar across countries, different countries used different measures to mitigate the adverse effects of these initial effects. These secondary mitigating measures are not included in the generic framework presented here, but they can be added when analyzing specific countries.

While the actual impacts of the measures taken to reduce COVID-19's health effects will vary across settings, as noted above, some insights can be gained already from this generic framework. The first one is that closures (lockdowns) have the most widespread adverse effects on well-being. Hence, they should be considered measures of the last resort, to be avoided if at all possible. With the widening availability of vaccinations, they increasingly can be avoided [86], and indeed should be deferred. A second insight is the importance of maintaining employment to the extent possible, as employment is seen to be a major stratifying variable in the equity analysis. Most adversely affected population groups (other than those who are severely affected health-wise) are those that lose employment [87]. In many cases, they are those that are already less well-off and thus more vulnerable to economic downturns. Moreover, employment may affect the degree of trust in government [88]. Maintaining such trust is critical as a third and fourth wave of various COVID-19 variants arise, thereby straining public acceptance of the COVID-mitigation measures [89].

At present, it seems that COVID-19 will continue to have periodic outbreaks for some time, perhaps several years. Therefore, it is necessary to address also long-term well-being effects even if they have hardly materialized so far [28]. As most feedback loops amplify over time and some of the variables are affected only in the long term (Table 5), these long-term effects might not attenuate quickly, even after the lockdowns are lifted [90]. Rather, the effects might reverberate through the socio-economic system over an extended period of time with long-term consequences. Of particular importance in this sense are educational attainment and student skills. If educational attainment is compromised, households and societies may suffer long-term adverse effects [91]. Such effects may have long-term macro implications if skill levels deteriorate. This may happen if enrollment in higher education is reduced, particularly of young adults whose incomes and job prospects were adversely affected in the critical age when they graduate from high school. Other long-term effects are on perceived health (including mental health) [92] and social support [93]. Both of these well-being indicators have widespread implications for other well-being variables (Figure A1). Thus, action should be taken to mitigate these effects.

Despite recent calls to use systems thinking for addressing the complexity of the COVID-19 crisis, its practical applications are still currently scarce [18]. To the best of the authors' knowledge, there have been no published studies applying systems thinking to investigate the impacts of COVID-19 and the corresponding mitigation policies on the national well-being. Compared to the previous research on systems analysis of the national well-being [12,65], our approach has a broader scope (reflected by a more complex CLD with more components) and relies on a formal well-being framework, i.e., the most recent OECD National Well-being framework. At the same time, compared to existing CLD

applications to examine COVID-19 impact on a wider socio-economic system, our study has a more specific focus, i.e., national well-being, reflected in the choice of system components. Our study accounts for the mitigation policies that are also addressed in other studies, such as business closures, travel restrictions, and social distancing [76]. We also address the underrepresentation of inequality concerns observed in the CLDs analyzing COVID-19 impacts on a broader socio-economic system [76]. As for the system driver, our CLD considers "Magnitude of the COVID-19 crisis", which aggregates typically used concepts such as number of infected people, number of deaths, and pressure on the healthcare system in one variable; a similar approach is also used in [18] to keep the number of the CLD components manageable.

While various CLD studies employ similar concepts, they are often formulated somewhat differently by different authors and, thus, are not entirely identical and directly comparable [76]. Following a call for standardization of concepts used in CLDs for COVID-19 assessment, we grounded our study in the existing frameworks, such as the OECD Well-being Framework and the Complexity Science Hub Vienna COVID-19 Control Strategies List (CCCSL). This can enable further development of the CLD presented in this study by other researchers who are familiar with and want to rely on these popular frameworks.

Our approach should be interpreted in light of certain limitations. As any model, the developed CLD constitutes a simplification of the real national well-being system. Our CLD is not capable of distinguishing stocks and flows, which along with feedback structures, are important in modeling systems behavior [69,94]. Furthermore, it is static in the sense that it cannot account for dynamics of the modeled system, such as changes in behavior over time [94].

As it is quite common in studies involving CLDs, our study does not rely on quantitative data but rather on the mental models of its authors [95]. The inclusion and omission of certain links between the COVID-19 mitigation policies and the national well-being components, as well as links between the national well-being components themselves, can be biased by the subjectivity of the authors' mental models [96]. It is partially mitigated by relying on a collective, almost-consensus-based assessment of links and the diversity of the participants' expertise [97] and by supporting the identified links by evidence from the existing literature (see Tables A1 and A2 in Appendix A for such evidence). According to the authors' knowledge, all recent state-of-the-art studies applying CLDs to examine socio-economic effects of COVID-19 follow a similar approach, i.e., CLDs are designed based on the authors' expertise or, in one case, involving an expert workshop in addition [17]. Using such qualitative assessment is often helpful in case of novel challenges such as COVID-19 to rapidly develop an understanding of its implications [76]. Moreover, it enables including factors that are inherently difficult to quantify [98].

Despite the attempts to reduce complexity (for example, excluding highly correlated well-being indicators from the analysis), the final full CLDs are quite complex to oversee and analyze visually by humans [80]. We addressed this limitation by using some commonly applied CLD analysis methods, such as uses trees and feedback loops.

We believe that our approach reflects the power of systems thinking in identifying connections between the COVID-19 crisis, the measures implemented to mitigate its health impacts, and various well-being components affected. In this way, it assists in presenting a holistic picture of the entire system affected by the pandemic. Indeed, the developed CLDs help expose the complexities brought about by the COVID-19 pandemic mitigation measures to policymakers and the general public. They promote critical thinking [99] and show how deeply the pandemic and the measures enacted in response to it affect all areas of well-being. Moreover, the systems approach shows that there are no easy solutions for this wicked problem [31,100], articulating a need for a transdisciplinary approach [15].

The analysis of indirect effects of COVID-19 mitigation policies on the national well-being could also be further informed by data describing NPIs and national well-being indicators. Such data are becoming increasingly available, for example, see the OECD COVID-19 Recovery Dashboard [101]. Multiple national-level observational studies report

negative consequences of the pandemic on the subjective well-being and other national well-being dimensions, such as trust in government [5,23,24,88,102–104]. However, these studies do not account for causal mechanisms of such effects [102]. Our analysis relying on a CLD highlights specific paths of how these effects propagate. Quantitative data coupled with an CLD can be used to inform econometric or simulation models, for example, systems dynamics models [17].

The framework that we presented here comes to identify the issues that should be addressed to mitigate the adverse effects of the policies undertaken to limit the health effects of COVID-19 on well-being. What it shows is that there is a need to address an extensive set of impacts. It can enable policymakers to "select points of intervention in a selective, adaptive way" [105]. At the same time, the developed framework supports tackling the consequences of the COVID-19 crisis holistically and facilitates development of policies for a sustainable improvement of various dimensions of national well-being—economic, social, and environmental [106]. Not only governmental structures but also other agents such as NGOs and private companies should be involved in this process [107]. Hence, a broad set of policies will be needed to address these multiple effects. To this end, policy packages will be needed [108]. These will have to be tailored to local circumstances. Hence the next step should be tailoring the generic framework presented in this paper to specific national settings as a basis for formulating such policy packages.

Finally, the developed framework can be useful for improving resilience of the national well-being system against further crises of various nature through identifying its critical components and developing policies aiming at decreasing their vulnerability [105].

Supplementary Materials: The following are available online at https://www.mdpi.com/article/10.3390/su14010433/s1, Table S1: CCCSL L2 NPIs Clustering, Table S2: OECD National Well-being Indicators 2020, Table S3: CLD Adjacency Matrix.

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Appendix A

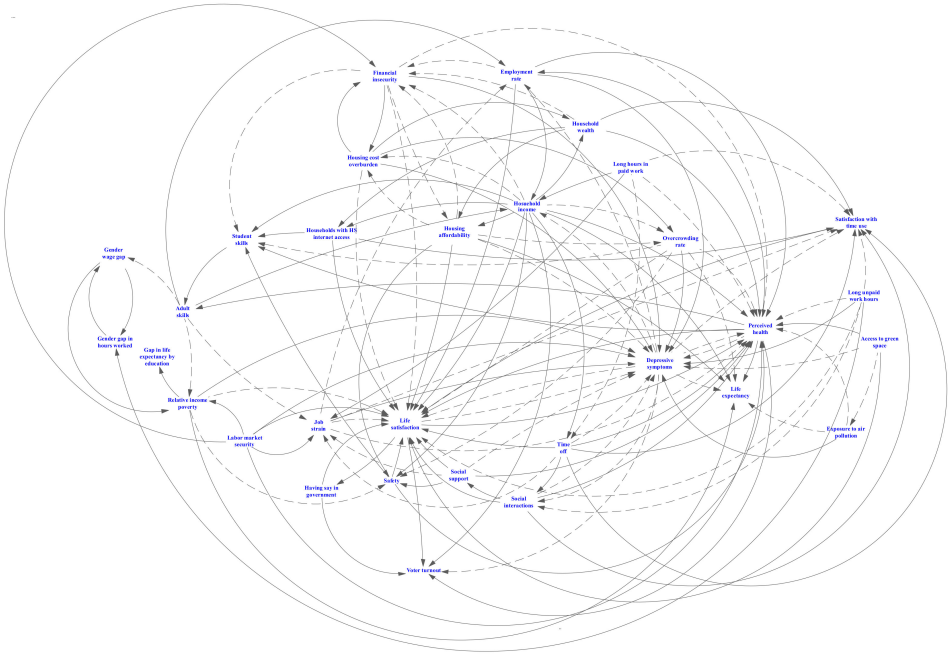

Figure A1. Causal loop diagram of the national well-being system.

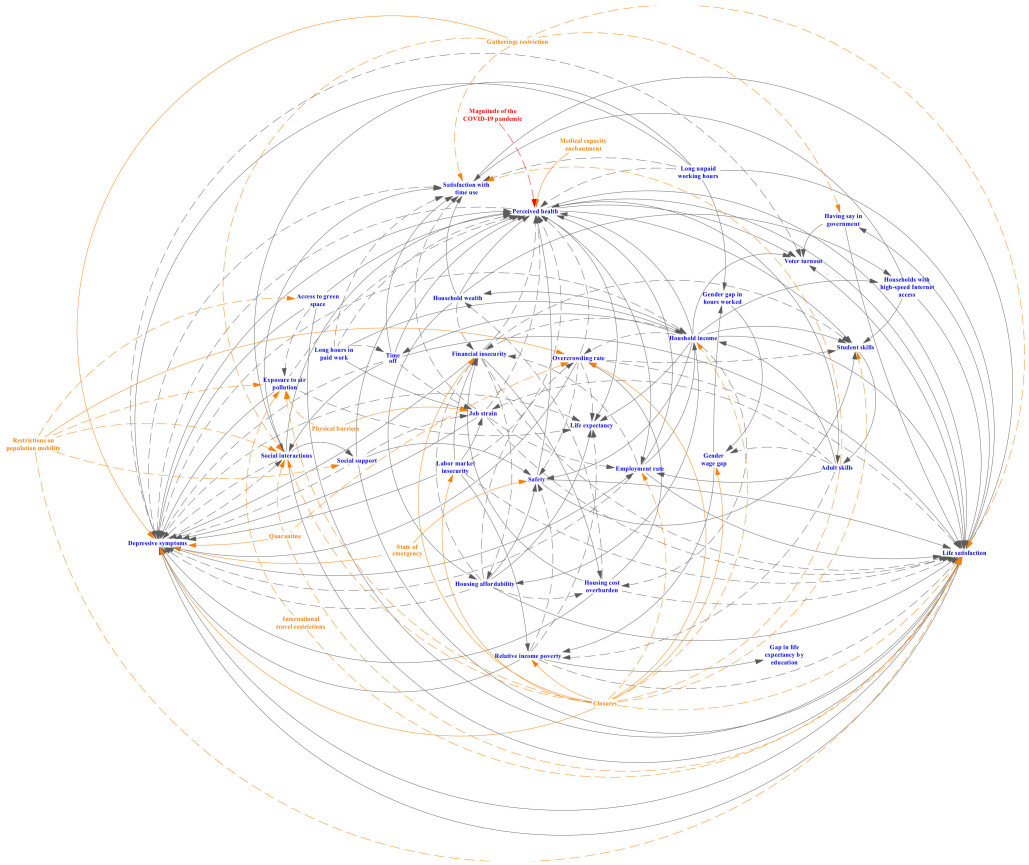

Figure A2. Causal loop diagram of the national well-being system (blue components) with direct effects of the COVID-19 pandemic (red component) and selected mitigation policies (orange components) included.

Table A1. Literature-based evidence for the links between components of the National Well-being System (Figure A1). Some trivial effects are added based on the authors' own judgment, therein no reference is provided. Numbers in the "Value" column denote the polarity of the links, i.e., "1" stands for a positive relationship while "−1" stands for a negative relationship.

Link ID	From	To	Value	Justification	Reference
1	Access to green space	Perceived health	1	Greenspace exposure is associated with numerous health benefits in intervention and observational studies. These results are indicative of a beneficial influence of greenspace on a wide range of health outcomes.	[109]
2	Access to green space	Depressive symptoms	−1	Higher residential greenness was associated with a reduced likelihood of depressive symptoms. Associations may be stronger for more disadvantaged groups and for those who are already physically active. Improving green space is a promising intervention to reduce risk of depression in disadvantaged groups.	[110]
3	Access to green space	Exposure to air pollution	−1	Forests and green spaces help improve air quality in urban and rural areas. They extract a wide range of air pollutants from the air such as particles and carbon oxides, emitted, for example, by traffic and industry.	[111]
4	Access to green space	Life satisfaction	1	An unspoiled environment is a source of satisfaction, improves mental well-being, allows people to recover from the stress of everyday life and to perform physical activity.	[65]
5	Adult skills	Household income	1	Good education greatly improves the likelihood of earning enough money to satisfy needs.	[65]
6	Adult skills	Relative income poverty	−1	Policies to improve UK skills levels particularly those that meet or exceed the projected improvement in skills levels by 2020 could improve the absolute quality of life of large groups of people currently in poverty.	[112]
7	Adult skills	Employment rate	1	The skills needed in the labor market are becoming more knowledge-based. This shift in demand has made an upper secondary degree, or high-school degree, the minimum credential for finding a job in almost all OECD countries.	[113]
8	Adult skills	Gender wage gap	−1	The gender wage gap narrows as women move into high-skill jobs and acquire more education.	[114]
9	Adult skills	Job strain	−1	People working in lower-skilled occupations had generally higher levels of job strain and effort–reward imbalance, as well as they tend to have a steeper increase in job strain than people working in higher-skilled occupations.	[115]
10	Depressive symptoms	Household income	−1	People suffering from mental health problems such as depression and panic attacks earn up to 42% less than their peers.	[116]
11	Depressive symptoms	Employment rate	−1	We also find that severe depressive symptoms, in turn, lead to economic inactivity. Individuals are less likely to be labor force participants or employed if they experience severe depressive symptoms.	[117]
12	Depressive symptoms	Life expectancy	−1	The impact of serious mental illness on life expectancy is marked and generally higher than similarly calculated impacts of well-recognized adverse exposures such as smoking, diabetes and obesity.	[118]

Table A1. *Cont.*

Link ID	From	To	Value	Justification	Reference
13	Depressive symptoms	Perceived health	−1	Depressed people are substantially more likely to have cardiovascular problems such as heart disease and strokes.	[119]
14	Depressive symptoms	Life satisfaction	−1	Depression has a negative impact on life satisfaction.	[120]
15	Depressive symptoms	Satisfaction with time use	−1	Depressive symptoms represent a serious and distinct threat to independent functioning in older adults. Whether experienced alone, or in combination with chronic diseases, depressive symptoms shorten ALE substantially. Timely diagnosis and treatment of depressive symptoms in older adults may delay the onset of disability and improve the quality of life.	[121]
16	Depressive symptoms	Social interactions	−1	Our results indicate that depressive symptoms are associated with spending less time in social interaction.	[122]
17	Depressive symptoms	Voter turnout	−1	Reporting increased depressive symptoms was associated with a lower probability of voting across electoral contexts for all respondents, and few factors mitigated this negative effect.	[123]
18	Employment rate	Household income	1	Jobs and the type of jobs people do (or do not do) are the main determinant of income level and distribution of income. Jobs provide people with incomes to enable them to meet their basic needs and to contribute to their material comfort.	[65]
19	Employment rate	Financial insecurity	−1	The work and job quality of the individuals within a household contributes directly to household income and economic security.	[124]
20	Employment rate	Perceived health	1	Research shows that losing your job has the next highest impact on health after divorce and death.	[65]
21	Employment rate	Depressive symptoms	−1	We find that severe depressive symptoms are partially a consequence of economic inactivity. The incidence of depressive symptoms is higher if individuals have been out of a job for an extended period.	[117]
22	Employment rate	Life satisfaction	1	Evidence from the literature shows that unemployment has a strong negative effect on life satisfaction, after controlling for other factors associated with employment. The impact of unemployment on life satisfaction is one of the strongest findings from the literature.	[65]
23	Exposure to air pollution	Life expectancy	−1	Globally the health impacts of urban air pollution continue to worsen, with air pollution set to become the top environmental cause of premature mortality by 2050.	[125]
24	Exposure to air pollution	Perceived health	−1	Globally the health impacts of urban air pollution continue to worsen, with air pollution set to become the top environmental cause of premature mortality by 2050.	[125]
25	Exposure to air pollution	Depressive symptoms	1	Short-term exposure to NO_2 was associated with increased odds of depression.	[126]
26	Financial insecurity	Housing affordability	−1	Housing is both a contributor to wealth (as an asset or as outstanding debt through a mortgage) and a function of economic security.	[124]

Table A1. *Cont.*

Link ID	From	To	Value	Justification	Reference
27	Financial insecurity	Housing cost overburden	1	Results showed that housing costs represent a non-negligible burden in all the five European countries. Moreover, home ownership was found to significantly reduce household hardship status.	[127]
28	Financial insecurity	Perceived health	−1	Results across our studies provided support for the direct effects of financial insecurity on WFC and stress. In addition, appraisals of WFC and stress serve as significant mediators of the relationship between financial insecurity and health outcomes, including a significant overall lagged effect across time.	[128]
29	Financial insecurity	Depressive symptoms	1	Our preferred estimates indicate that a standard deviation shock to economic insecurity lowers an individual's mental health score by about 1.4 percentage points. If applied uniformly across the Australian population such a shock would increase the morbidity rate of mental disorders by about 1.7%.	[129]
30	Financial insecurity	Student skills	−1	We show that being brought up in a family whose mother has at least one major financial problem has negative consequences on both cognitive and non-cognitive achievements in adolescence even after controlling for income and a set of standard variables.	[130]
31	Financial insecurity	Life satisfaction	−1	Evidence suggests that experiencing financial insecurity lowers well-being and increases problematic financial behaviors.	[131]
32	Gender gap in hours worked	Gender wage gap	1	Our results suggest that high returns to overwork, coupled with the persistent gap in the propensity to work overtime across genders, is an important factor that limits the convergence in gender pay gaps in many highly-skilled occupations.	[132]
33	Gender wage gap	Relative income poverty	1	Equal Pay Would Reduce Poverty by Half for Families with a Working Woman.	[133]
34	Gender wage gap	Gender gap in hours worked	1	Women often choose to move to part-time employment or to step out of a career promotion pathway in order to have more time for motherhood and childcare when their children are young. If they return to work full-time, they are often forced to accept a lower wage compared to the wage they would have earned had they stayed in their original job.	[134]
35	Having say in government	Life satisfaction	1	Analyses reveal that policy outcomes, especially microlevel ones, significantly influence life satisfaction.	[135]
36	Having say in government	Voter turnout	1	Our analysis confirms that trust in parliament has a positive impact on turnout, and also satisfaction with democracy increases it. These effects are especially high when aggregated at a country level and when hard data on turnout are used. At the individual level, in particular trust in parliament increases the likelihood of voting.	[136]
37	Household income	Household wealth	1	Earning a higher income makes saving easier, and saving is necessary to build wealth.	[137]

Table A1. *Cont.*

Link ID	From	To	Value	Justification	Reference
38	Household income	Financial insecurity	−1	Results showed that a household's liquidity constraint and asset inadequacy were linked with increased risk of food insecurity at all income levels; although, the association was strongest among poor households and those with incomes slightly above the federal food assistance eligibility threshold.	[138]
39	Household income	Overcrowding rate	−1	People in lower income households are more likely to be in overcrowded accommodation than those in higher income households.	[139]
40	Household income	Housing affordability	1	Income determines the quality, location, and size of housing that is affordable. Higher income increases house affordability.	[65]
41	Household income	Housing cost overburden	−1	Low-income households are particularly vulnerable when a high share of their income is devoted to housing costs, since this limits spending on other basic essentials, such as food, health care, and education.	[32]
42	Household income	Households with high-speed internet access	1	There is a strong relationship between median income and internet adoption.	[140]
43	Household income	Life expectancy	1	Life expectancy increases continuously with income.	[141]
44	Household income	Perceived health	1	Both individual income (material circumstances) and income inequality (relative income) make a difference to health. Therefore, there is a 'social gradient' in health, which means that every step up the socio-economic ladder leads to an increase in health.	[65]
45	Household income	Student skills	1	Family income levels impact on the achievement level of students. Higher socio-economic groups provide more financial support for schools, pay school fees, etc. Students' socioeconomic background tends to have an impact on their education. People who are successful as a result of their education are role models for others. They are also more likely to encourage and financially support their children to achieve high levels of education.	[65]
46	Household income	Life satisfaction	1	Adequacy of income has an impact on life satisfaction. Wealthier people are happier than those on lower incomes; however, life satisfaction does not increase proportionally as income increases.	[65]
47	Household income	Safety	1	People with higher incomes can afford to live in safer areas and afford more security (e.g., burglar alarms).	[65]
48	Household income	Time off	1	Higher incomes allow people to increase their work–life balance by working less hours.	[65]
49	Household income	Voter turnout	1	Voter turnout generally increases with individual income.	[65]
50	Household wealth	Financial insecurity	−1	Wealth allows households to weather a financial emergency such as a layoff or a family member's illness.	[142]

Table A1. *Cont.*

Link ID	From	To	Value	Justification	Reference
51	Household wealth	Housing affordability	1	Housing assets, which accounted for over 70 percent, were the largest component of household wealth.	[143]
52	Household wealth	Households with high-speed internet access	1	Wealth is an important driver of access to digital technology at home.	[144]
53	Household wealth	Perceived health	1	Furthermore, in all countries the positive association between wealth and health holds even after controlling for socio-demographic attributes and household income.	[145]
54	Household wealth	Satisfaction with time use	1	We find that both permanent income and wealth are better predictors of life satisfaction than current income and wealth.	[146]
55	Households with high-speed internet access	Student skills	1	We find that students who do not have access to the Internet from home or are dependent on a cell phone only for access, perform lower on a range of metrics, including digital skills, homework completion, and grades. Students lacking home Internet, and those dependent on a cell phone, are also less likely to consider post-secondary education. A deficit in digital skills compounds inequalities in access, contributing to lower standardized test scores and less interest in STEM careers. Consequently, lack of broadband access not only impacts school performance, but also has broader repercussions for career choice, life income, and the ability to adapt to emerging demands of the workforce. We believe the findings are generalizable to rural America.	[147]
56	Households with high-speed internet access	Life satisfaction	1	The empirical evidence suggests that people with access to the Internet enjoy a higher life satisfaction than people without access to the Internet, even when controlling for income and education.	[148]
57	Households with high-speed internet access	Satisfaction with time use	1	Evidence from the American Time Use Survey shows that reductions in the time spent commuting and in home production due to Internet increase labor force participation, in particular among married women.	[148]
58	Housing affordability	Financial insecurity	−1	In recent decades, housing affordability has been increasingly linked to household financial outcomes where high housing costs relative to income are perceived to negatively affect financial well-being.	[149]
59	Housing affordability	Overcrowding rate	−1	The combination of high rents and low incomes drives households into overcrowding. Overcrowding is more prevalent in locations of housing affordability stress (households on low incomes that face higher housing costs) and tight housing markets (low rates of rental vacancy).	[150]
60	Housing affordability	Housing cost overburden	−1	The immediately visible consequences of worsening affordability are to be found in the high level of indebtedness over housing mortgages in a number of countries as well as an increase in the number of households reporting arrears on rents and mortgage payments, as well as on utilities bills.	[151]
61	Housing affordability	Life expectancy	1	Surveys of hospital admissions demonstrate a strong association between poor housing and poor health, especially for children.	[65]

Table A1. *Cont.*

Link ID	From	To	Value	Justification	Reference
62	Housing affordability	Depressive symptoms	−1	Housing affordability was the most frequently referenced issue by those who saw housing pressures having had a negative impact upon their mental health.	[152]
63	Housing affordability	Life satisfaction	1	Having adequate housing improves life satisfaction.	[65]
64	Housing affordability	Safety	1	The location of a person's home can impact their feelings of security and the likelihood of crime.	[124]
65	Housing cost overburden	Household wealth	−1	Housing is both a contributor to wealth (as an asset or as outstanding debt through a mortgage) and a function of economic security.	[124]
66	Housing cost overburden	Financial insecurity	1	In recent decades, housing affordability has been increasingly linked to household financial outcomes where high housing costs relative to income are perceived to negatively affect financial well-being.	[149]
67	Housing cost overburden	Overcrowding rate	1	Similarly, many studies demonstrate that low-income households that had to rent in the private market, compared to similar households residing in public housing or receiving housing vouchers, were more likely to suffer from overcrowding and financial stress and their children were more likely to be held back a year in school.	[153]
68	Housing cost overburden	Depressive symptoms	1	Homeowners in default or foreclosure exhibited poorer mental health and more physical symptoms than renters, homeowners with moderate strain, and homeowners with no strain following a gradient that was consistent across multiple health indicators.	[154]
69	Housing cost overburden	Life satisfaction	−1	The housing dimension is one of the major issues affecting the quality of life. The housing indicators reflecting the quality of life can be assessed by applying quality of housing, quality of housing environment and housing cost burdens indicators.	[155]
70	Job strain	Employment rate	−1	There is consistent support for the proposition that employees with elevated job strain are more likely to voluntarily resign from their organizations than employees with low strain.	[156]
71	Job strain	Perceived health	−1	Workers in high-strain jobs, who do not receive adequate support to cope with difficult work demands, are more likely to suffer from job burnout, to develop musculoskeletal disorders, hypertension, and cardiovascular disease.	[65]
72	Job strain	Depressive symptoms	1	While workers with high job strain were more likely to have adverse workplace conditions (competition with coworkers, job dissatisfaction and insecurity), sleeping problems, depressive symptoms, a Type A personality, and be physically inactive, no differences in cardiometabolic risk factors were detected.	[157]
73	Job strain	Life satisfaction	−1	Workers in high-strain jobs, who do not receive adequate support to cope with difficult work demands, are more likely to suffer from job burnout.	[65]
74	Job strain	Satisfaction with time use	−1	Time use is connected to work and job quality, as access to flexible working and job strain impacts the time available for caring duties and leisure time outside of paid work.	[124]

Table A1. *Cont.*

Link ID	From	To	Value	Justification	Reference
75	Labor market insecurity	Relative income poverty	1	It seems sensible on the face of it to assume that recurrent poverty could be related to patterns of repeated, low-paid insecure employment (cycles of poverty caused by cycles of worklessness).	[158]
76	Labor market insecurity	Financial insecurity	1	Alongside remuneration, job security and hours worked can also impact economic insecurity, such as access to social protection based on the type of job, contract type or PRSI payments.	[124]
77	Labor market insecurity	Job strain	1	Survey data from four European countries show that the effect of job insecurity on turnover intention is mediated by organizational commitment and job satisfaction. In contrast, it appears that work attitudes partially mediate the effect of job insecurity on mental health complaints.	[159]
78	Labor market insecurity	Perceived health	−1	Research has shown that job insecurity affects both mental and physical health, though the effects are lower when employees are easily re-employable.	[160]
79	Labor market insecurity	Depressive symptoms	1	The results indicate the validity of using this concept in order to better understand how insecurity relates to mental well-being by affecting both the manifest and latent functions of work.	[161]
80	Labor market insecurity	Life satisfaction	−1	People who feel their employment is insecure are more likely than other employed people to rate their overall life satisfaction poorly.	[162]
81	Life satisfaction	Perceived health	1	Life satisfaction is the strongest predictor of poor perceived health in addition to country of birth, number of symptoms and depression.	[163]
82	Life satisfaction	Depressive symptoms	−1	A strong linear association was found between concurrent Life Satisfaction and Beck Depression Inventory scales (r = 0.6). With an LS cut-off point of 11/12, moderate/severe depression (BDI $\geq$ 19) was detected with 87% sensitivity, 88% specificity, and a 94% area under the ROC curve. Longitudinally, a strongly increased risk of moderate/severe depression in 1990 was observed among the dissatisfied (LS 12–20) compared with the satisfied (LS 4–6) in 1975 (OR = 6.7; 95% CI 4.2–10.9) and in 1981 (OR = 10.4; 6.1–17.6).	[164]
83	Life satisfaction	Voter turnout	1	People satisfied with life are more inclined to be trusting of public service and participate in civil duties such as voting and submission making.	[65]
84	Life satisfaction	Having say in government	1	People satisfied with life are more inclined to be trusting of public service and participate in civil duties such as voting and submission making. Dissatisfaction in life breeds apathy, resulting in poor civic engagement from these individuals.	[65]
85	Long hours in paid work	Household income	1	For most managerial and sales occupations, there is a large difference between weekly earnings of standard and extended-week workers. Workers with a standard workweek appear to pay a large financial "penalty" for their shorter hours, while those with an extended week appear to receive a large "payoff" for their longer hours. In contrast, differences between earnings of standard and extended-week workers are small among engineers, computer scientists, and teachers. Workers in these occupations appear to suffer very little financially from having a standard workweek, but to gain little from an extended week.	[165]

Table A1. *Cont.*

Link ID	From	To	Value	Justification	Reference
86	Long hours in paid work	Job strain	1	High job strain among shift workers is associated with higher perceived work load, poorer ergonomics in work schedules and low control over shift scheduling. Ergonomics in shift planning and better opportunities to influence working hours and workload should be implemented to reduce work strain.	[166]
87	Long hours in paid work	Perceived health	1	Working shorter hours may be good for your health. Longer working hours seem to lead to higher premature mortality. Stress, for example, can contribute to range of problems like heart disease and depression.	[65]
88	Long hours in paid work	Time off	−1	Long workdays make it harder for people to balance work with private life. People are multi-dimensional beings who seek to develop in a range of areas, and to live not only as workers but also as family members, caregivers, and more. Given that time is a limited resource, allocating too much time to work would lead	[167]
89	Long hours in paid work	Satisfaction with time use	−1	Working 8 h a week is sufficient to gain the wellbeing benefits of employment. The wellbeing of employees is similar regardless of the length of the working week up to 48.	[168]
90	Long unpaid working hours	Perceived health	−1	Longer working hours seem to lead to higher premature mortality. Stress, for example, can contribute to range of problems like heart disease and depression.	[65]
91	Long unpaid working hours	Depressive symptoms	1	This study supported heterogeneous individual patterns of depressive symptoms over time among the Swedish working population. The results also indicate that a higher burden of unpaid work and longer total working hours, which indicate a double burden from paid and unpaid work, may be associated with higher depressive symptom trajectories, especially among women.	[169]
92	Long unpaid working hours	Life satisfaction	−1	Results imply that state and organizational policies that reduce the incidence of long hours working are likely to enhance aggregate well-being levels.	[170]
93	Long unpaid working hours	Gender gap in hours worked	1	Although it is mothers who have increased the time they spend working for pay, they also continue to spend more time than fathers caring for children and doing domestic work.	[171]
94	Long unpaid working hours	Satisfaction with time use	−1	< . . . > unpaid work can leave individuals with little time for themselves, their family, and their friends.	[32]
95	Long unpaid working hours	Social interactions	−1	If a person does not have time (due to paid or unpaid work), it is more challenging to build and maintain social connections.	[124]
96	Overcrowding rate	Life expectancy	−1	The study demonstrates that household crowding at levels that are common in the United States can have a substantial negative impact on mental health physical health and childcare.	[172]
97	Overcrowding rate	Perceived health	−1	Surveys of hospital admissions demonstrate a strong association between poor housing and poor health, especially for children.	[65]
98	Overcrowding rate	Depressive symptoms	1	. . . overcrowded housing which impacts on mental health and social wellbeing.	[65]

Table A1. *Cont.*

Link ID	From	To	Value	Justification	Reference
99	Overcrowding rate	Student skills	−1	The results show that overcrowding has a negative effect that even exceeds the impact of certain maternal education level on a child's academic performance.	[173]
100	Overcrowding rate	Life satisfaction	−1	Surveys of hospital admissions demonstrate a strong association between poor housing and poor health, especially for children. This situation is compounded by overcrowded housing which impacts on mental health and social wellbeing	[65]
101	Overcrowding rate	Safety	−1	Overcrowding causes tension and conflict	[65]
102	Perceived health	Employment rate	1	Ability to work is impacted by the health of the population. People with poor health have more sick days from work or are unable to hold down a job.	[65]
103	Perceived health	Life expectancy	1	People who refrain from engaging in risky health behaviors not only have a very long life but that most of these additional years of life are spent in good health	[65]
104	Perceived health	Depressive symptoms	−1	The relationship between the number of illnesses and depressive symptoms was mediated by self-perceived health and was moderated by employment. Employment moderated the relationship between the number of illnesses and self-perceived health, such that the relationship was stronger for employees.	[174]
105	Perceived health	Adult skills	1	Health is one of the components of human capital	[175]
106	Perceived health	Life satisfaction	1	The findings indicate that race and quality of perceived health are the most salient predictors of satisfaction	[176]
107	Perceived health	Student skills	1	Good health facilitates the ability to learn and achieve high levels of education. Absence from school due to sickness (especially primary level) for many children is a barrier to learning as once children drop behind, they struggle to catch up.	[65]
108	Perceived health	Voter turnout	1	The results show that poor health decreases voting. Social connectedness partly mediates the impact of health on turnout.	[177]
109	Relative income poverty	Life expectancy	−1	The results with regard to women confirm the hypothesis that life expectancy in the developed countries has become more dissociated from average income level and more associated with income inequality. The absence of a relation in men in 1990 may be due to the large impact of premature mortality from AIDS in regions with the highest average total income per household and/or smallest income inequality.	[178]
110	Relative income poverty	Gap in life expectancy by education	1	When categories of educational level were kept fixed, implying a decreasing proportion of persons with a short education, the educational inequality in life expectancy increased. Thus, the difference in life expectancy at age 30 between men with primary or lower secondary education and men with tertiary education increased from 4.8 years in 1987 to 6.4 years in 2011.	[179]

Table A1. *Cont.*

Link ID	From	To	Value	Justification	Reference
111	Relative income poverty	Depressive symptoms	1	Across a wide range of populations and study designs, positive economic shocks to individuals are shown to improve mental health, whereas negative economic shocks undermine mental health. This robust evidence, on the effects of changes in economic circumstances, indicates that poverty does cause mental illness.	[180]
112	Relative income poverty	Life satisfaction	−1	Abundant evidence now suggests that living in relative poverty and exposure to relative income inequality, especially in childhood, may have a detrimental influence on health and well-being during childhood and across the life course.	[181]
113	Relative income poverty	Safety	−1	People living in environments characterized by high levels of economic and social inequality tend to be more exposed to violence and victimization than those living elsewhere.	[182]
114	Safety	Perceived health	1	Being able to safely exercise and commute (by walking or cycling) contributes to health. In this respect urban design is important. Safety is fundamental to health: violence and avoidable injuries, at their most extreme, threaten life itself and corrode quality of life in many ways.	[65]
115	Safety	Student skills	1	Objective assessments of neighborhood environment and students' self-reported school and neighborhood safety were both strongly associated with academic performance.	[183]
116	Safety	Life satisfaction	1	Individuals in high-crime areas are relatively less satisfied with life than those who live in low-crime counties—even after controlling for other county amenities such as population density, home ownership, and pollution. Perceived neighborhood safety is relatively more important than county-level crime rates.	[184]
117	Satisfaction with time use	Life satisfaction	1	By being able to engage in recreational and cultural activities, and spending time on one's own areas of interest, a balanced and satisfactory use of time is expected to contribute to an individual's overall life satisfaction.	[185]
118	Social interactions	Perceived health	1	There is two-way feedback between social connections and health. If a person does not feel well, it is difficult to maintain social connections. Furthermore, a lack of social connections can be detrimental to one's mental health.	[124]
119	Social interactions	Depressive symptoms	−1	The ability to build and maintain quality social connections has an essential impact on mental health.	[124]
120	Social interactions	Life satisfaction	1	Loneliness appears to be a major correlate of life satisfaction for both men and women: those respondents who report feeling lonely have consistently lower life satisfaction mean scores than those who do not. As expected then, all dimensions of loneliness influence people's life satisfaction.	[186]
121	Social interactions	Satisfaction with time use	1	Focus on negative social interactions but evidence for the link—although negative social interactions related to stressful life events and hassles, negative interactions had incremental validity beyond these in predicting psychological symptoms.	[187]

Table A1. *Cont.*

Link ID	From	To	Value	Justification	Reference
122	Social interactions	Social support	1	Although both negative social interactions and perceived support were consistent predictors of psychological distress, negative interactions were weakly or unrelated to perceived and enacted support.	[187]
123	Social support	Job strain	−1	Social support was found to act as a robust mediator between job control and job strain. This finding underscored the importance of social support in enabling skill utilization and decision making at the job place to reduce job strain.	[188]
124	Social support	Perceived health	1	Good social relationships contribute to mental health. Community activities (involving exercise) improve physical health.	[65]
125	Social support	Depressive symptoms	−1	Good social relationships contribute to mental health.	[65]
126	Social support	Life satisfaction	1	Community engagement (your social support network) contributes to your life satisfaction as you have help when needed and are not isolated.	[65]
127	Social support	Safety	1	Our findings show a positive unique group-level effect of perceived tutor support on psychological safety, where an individual's level of self-consciousness strengthens this positive impact.	[189]
128	Student skills	Adult skills	1	Mean years of schooling increase the knowledge and skills gained through formal education, hence the adult skills.	[66]
129	Time off	Job strain	−1	Good control over working times reduces the adverse effect of work stress on sickness absence especially among female employees.	[190]
130	Time off	Perceived health	1	Good work–life balance enables physical activity and healthier food behavior.	[65]
131	Time off	Depressive symptoms	−1	Women who do not take vacations are at greater risk for depression.	[119]
132	Time off	Life satisfaction	1	A balance between work and time to devote to family, community, and other interests contributes significantly to Life Satisfaction.	[65]
133	Time off	Satisfaction with time use	1	Many poor Americans often receive no paid vacation and often feel pressure to not take it. This shows that not only do some individuals have less opportunity to physically rest and relax, they also face difficultly finding time for family and friends and pursuing hobbies, which all contribute to subjective wellbeing.	[191]
134	Time off	Social interactions	1	If people work less hours, they are able to connect with people.	[65]

Table A2. Literature-based evidence for the links between components of the National Well-being System (Figure A1). Some trivial effects are added based on the authors' own judgment, therein no reference is provided. Numbers in the "Value" column denote the polarity of the links, i.e., "1" stands for a positive relationship while "−1" stands for a negative relationship.

Link ID	From	To	Value	Justification	Reference
1	State of emergency	Depressive Symptoms	1	This study examined the state of emergency during the COVID-19 pandemic on mental health in Latvia and identified several risk and protective factors for self-reported changes in anxiety, depressive thoughts, suicidal thoughts as well as distress and depression.	[192]
2	State of emergency	Safety	1	In all of our tests across different years and different time periods, we find that the implementation of social distancing and quarantine protocols led to significant decreases in crime in the first two weeks. There were declines during the state-of-emergency time period (9–21 March), but they were not statistically significant.	[193]
3	Restrictions on population mobility	Overcrowding rate	1	Nearly 12% of OECD households, on average, live in crowded conditions. This is likely to add to the psychosocial strains of confinement and social distancing measures, whilst also making it very difficult to isolate symptomatic individuals from other household members.	[28]
4	Restrictions on population mobility	Exposure to air pollution	−1	The transportation reduction is responsible for the declines of NO_2 and CO, due to the restriction of human mobility (e.g., automobile use decreased in all cities during lockdown)	[194]
5	Restrictions on population mobility	Access to green space	−1	< . . . > many public parks and green spaces were also closed because of concerns about social distancing, and most state and local shelter-in-place orders allow only limited use of parks and green space.	[195]
6	Restrictions on population mobility	Life satisfaction	−1	Life satisfaction decreased as the days of home confinement progressed.	[196]
7	Restrictions on population mobility	Social Support	−1	Both voluntary social distancing and mandatory confinement policies have obvious implications for people's ability to maintain social relationships beyond immediate household members—whether for instrumental or emotional support, or simply for companionship.	[28]
8	Restrictions on population mobility	Social interactions	−1	We found that most of our participants (92%) were respecting the stay-at-home order which meant that they could not have in-person contact with family and friends outside of household members.	[197]
9	Quarantines	Overcrowding rate	1	Nearly 12% of OECD households, on average, live in crowded conditions. This is likely to add to the psychosocial strains of confinement and social distancing measures, whilst also making it very difficult to isolate symptomatic individuals from other household members.	[28]
10	Quarantines	Depressive Symptoms	1	We conducted a rapid review of the psychological impact of quarantine using three electronic databases. The majority of reviewed studies reported negative psychological effects including post-traumatic stress symptoms, confusion, and anger.	[198]
11	Quarantines	Life satisfaction	−1	Perceived social isolation was associated with poor life satisfaction.	[199]

Table A2. *Cont.*

Link ID	From	To	Value	Justification	Reference
12	Quarantines	Social interactions	−1	Using both survey data and diary records, we found some major differences across stages of home quarantine and between groups. Not only did the extent of daily contacts shrink during and after quarantine, but the proportion of face-to-face contacts also decreased.	[200]
13	Medical capacity enhancement	Perceived health	1	This shift to telehealth has simultaneously decreased exposure for patients and providers and has kept medical staff who are serving on the front lines less exposed and thus available for in person care when needed. Furthermore, telehealth has allowed providers who are COVID-19 positive with mild symptoms and providers who are in the "high risk" population for COVID-19 to remain at home while still contributing to the care of patients. This dual benefit of flattening the curve and maintaining capacity in the healthcare system during the COVID-19 crisis cannot be overstated.	[201]
14	International travel restrictions	Exposure to air pollution	−1	Of course, the decrease in the number of commercial flights concomitantly has led to a decrease in aviation emissions from flight operations, and even to a halt in a number of months of 2020. International commercial flights in Turkey in particular, came to a halt in April, May, June, and July 2020, and the emissions amounts presented by the COVID-19 period show an approximate 99% reduction compared to the previous year.	[202]
15	International travel restrictions	Life satisfaction	−1	< . . . > countless travel plans have been disrupted globally. The loss of these travel experiences, however, may cause a negative psychological impact (e.g., anxiety, frustration, or stress). Depending on an individual's ability to cope with adversity, these negative emotional responses can cause abnormal compensating behavior.	[203]
16	Gatherings restriction	Depressive Symptoms	1	In within-person comparisons we find that interaction and co-studying networks had become sparser, and more students were studying alone. Furthermore, students' levels of stress, anxiety, loneliness, and depressive symptoms became worse, compared to measures before the crisis. Stressors shifted from fears of missing out on social life to worries about health, family, friends, and their future.	[204]
17	Gatherings restriction	Life satisfaction	−1	The lockdown measures discouraged group gatherings, which might have affected boys' life satisfaction more than girls' life satisfaction.	[205]
18	Gatherings restriction	Satisfaction with time use	−1	We also found clear evidence that the quality of time use decreased during both lockdowns, with increases in leisure time spent alone and a larger proportion of individuals working unusual hours and conducting housework during working hours.	[206]
19	Gatherings restriction	Having a say in government	−1	There is a risk that governments may use the current need to restrict public gatherings as a pretext to crack down on the wave of antigovernment protests that have roiled global politics over the past several years. < . . . > The pandemic threatens to upend electoral processes around the world. Putting off elections means that citizens are (at least temporarily) deprived of their right to choose their leaders, at a time when leadership choices are of paramount importance.	[207]

Table A2. *Cont.*

Link ID	From	To	Value	Justification	Reference
20	Gatherings restriction	Social interactions	−1	Large social gatherings—for example, weddings, school assemblies, sporting events—also present key opportunities for affirming and assimilating interactional norms, building cohesion and shared identity, and facilitating cooperation across social groups. Online 'equivalents' do not easily support 'social-bonding' activities such as singing and dancing, and rarely enable chance/spontaneous one-on-one conversations with peripheral/weaker network ties (see the Social networks section) which can help strengthen bonds across a larger network.	[208]
21	Enhancement of physical barriers	Job strain	1	Wearing a mask and gloves and also using a face shield for several hours are very difficult because it cannot be tolerated for an hour, but you have to endure it in six hours, and you cannot even meet your basic needs.	[209]
22	Enhancement of physical barriers	Exposure to air pollution	−1	Prior to the COVID-19 epidemic, there has been a vigorous debate about the efficacy of PPEs, including N95 respirators and masks, in protecting the public against air pollution risk (which is for the most part cardiovascular) and 'flattening' the shape of the air pollution exposure response curve. < . . . > The lessons learnt from COVID-19 could be leveraged to reduce air pollution-related cardiovascular mortality and morbidity once this current impasse from the virus lifts, the inevitable resumption of anthropogenic activity and related fossil fuel consumption at least in the short term.	[210]
23	Closures	Household Income	−1	The total employment income at EU level decreases by −4.8%, with the largest decreases due to absences and reduced hours.	[211]
24	Closures	Relative income poverty	1	Our analysis reveals substantial and uneven potential wage losses across the distribution all around Europe and we consistently find that both poverty and wage inequality rise in all European countries. Under four different scenarios (2 months of lockdown and 2 months of lockdown plus 6 months of partial functioning of closed occupations at 80%, 70% and 60% of full capacity) we estimate for 29 European countries an average increase in the headcount poverty index that goes from 4.9 to 9.4 percentage points and a mean loss rate for poor workers between 10% and 16.2%	[212]
25	Closures	Financial insecurity	1	Three fourths of Indian population are working in unorganized sectors and lockdown may result in financial insecurity for them.	[213]
26	Closures	Overcrowding rate	1	In the living space dimension, we do not only capture whether the household is overcrowded or not—clearly related to its composition and number of household members—but also the degree of overcrowding. This last aspect is even more relevant given that in a lockdown situation the level of occupancy of the dwelling—in terms of the number of members that reside there and the time they spend in that dwelling—has changed.	[214]
27	Closures	Employment rate	−1	The initial impact of the COVID-19 crisis on OECD labor markets where data are available has been ten times larger than that observed in the first months of the 2008 global financial crisis: taking into account both the drop in employment and the reduction in hours worked among those who remained in work.	[215]

Table A2. *Cont.*

Link ID	From	To	Value	Justification	Reference
28	Closures	Labor market insecurity	1	The COVID-19 pandemic has generated a deep economic crisis, exacerbating worldwide feelings of uncertainty and precarity. Individuals with insecure jobs have (and will) probably suffered the most from this situation.	[216]
29	Closures	Gender wage gap	1	Thus, it seems that the COVID-19 pandemic affects women more heavily than men at the physical level of work (e.g., women are reducing more paid work hours than men). In addition, the pandemic seems to boost existing differences at the cognitive level of work further (e.g., women are more worried about childcare work while men about paid work). Both processes may lead to a widening of the gender wage gap during the recovery process.	[217]
30	Closures	Depressive Symptoms	1	Our findings suggest that small business closures and reduced mobility during COVID-19 pandemic were negatively associated with the two mental health outcomes in the USA, despite their important roles in preventing the infection.	[218]
31	Closures	Student Skills	−1	Despite favorable conditions, we find that students made little or no progress while learning from home. Learning loss was most pronounced among students from disadvantaged homes.	[219]
32	Closures	Exposure to air pollution	−1	We find that, after accounting for meteorological variations, lockdown events have reduced the population-weighted concentration of nitrogen dioxide and particulate matter levels by about 60% and 31% in 34 countries, with mixed effects on ozone.	[220]
33	Closures	Life satisfaction	−1	Controlling for the evolution of the pandemic itself (via the 4-week average number of daily deaths), our panel analysis reveals that more-stringent policies significantly reduce life satisfaction.	[221]
34	Closures	Satisfaction with time use	−1	The main finding of this paper is the negative and statistically significant association found between the closures of bars and restaurants and people's life satisfaction.	[222]
35	Closures	Social interactions	−1	Perceived levels of loneliness under strict lockdown measures due to COVID-19 were relatively stable in the UK, but for many people these levels were high with no signs of improvement.	[223]

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