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Individual and collective protective responses during the early phase of the COVID-19 pandemic in 10 different countries: Results from the EUCLID online survey

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ABSTRACT

Background: In times of unprecedented infectious disease threats, it is essential to understand how to increase individual protective behaviors and support for collective measures. The present study therefore examines factors associated with individual and collective pathways.

Methods: Data was collected through an online survey from 4483 participants (70.8% female, $M = 41.2$ years) across 10 countries from April 15, 2020 to June 2, 2020 as part of the "EUCLID" project (https://euclid.dbvis.de). Structural equation modeling was used to examine individual and collective pathways across and within countries.

Results: Overall, the adoption of individual protective behaviors and support for collective measures were high. Risk perception on the individual level and perceived effectiveness at the collective level were positively associated with both individual protective behaviors and support for collective measures. Further-

Abbreviations: WEIRD, Western, educated, industrialized, rich, and democratic; SEM, Structural equation model.

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more, the model explained considerable variance in individual (40.7%) and collective protective behaviors (40.8%) and was largely replicated across countries.
Conclusions: The study extends previous research by demonstrating that individual risk perception and perceived effectiveness of collective measures jointly affect individual protective health behaviors and support for collective measures. These findings highlight the need to jointly consider a variety of behavioral actions against infectious disease threats, acknowledging interactions between individual and collective pathways.

Introduction

The outbreak of COVID-19 has caused an international health emergency with large waves of infections (Johns Hopkins University, https://coronavirus.jhu.edu) and severely burdened health and economic systems (e.g., Sarkodie and Owusu, 2021). Governments worldwide have tried to control the outbreak by implementing various containment and mitigation strategies. In spring 2020, many governments intensified their efforts to slow down the spread of COVID-19 and to reduce its impact on public health, the economy, and society. This included measures such as lockdowns, closing schools and nonessential businesses (e.g., restaurants), and mandatory protective behaviors, many of which were unfamiliar to most people (e.g., physical distancing). Individual behavior change and public support for governmental measures are key to the success of such strategies (Khorram-Manesh et al., 2021; Siegrist et al., 2021).

In terms of individual behavior change, numerous studies have shown that personal risk perception is an essential motivational trigger for protective behavior change (Gaube et al., 2019; Renner and Schupp, 2011). The relation between perceived risk and protective behavior has been underscored by meta-analyses on various measures of risk perception and their relationship to a range of protective intentions and behaviors (Brewer et al., 2007; Sheeran et al., 2014). Also studies conducted during the COVID-19 pandemic have examined this relationship with regard to various protective behaviors (for a review, see Cipolletta et al., 2022), such as hygiene behavior (e.g., Betsch et al., 2021; Dryhurst et al., 2020; Qin et al., 2021; Siegrist et al., 2021), contact avoidance (e.g., Betsch et al., 2021; Dryhurst et al., 2020; Qin et al., 2021; Siegrist et al., 2021; Villinger et al., 2022; Xie et al., 2020; Yuan et al., 2021), wearing a face mask (e.g., Betsch et al., 2021; Dryhurst et al., 2020), and vaccinations (e.g., Caserotti et al., 2021). From a theoretical perspective, risk perceptions are influenced by general facts about the hazard or pandemic situation (i.e., the number of cases or deaths), information and opinions provided by governmental sources, classic or social media (e.g., Cipolletta et al., 2022; He et al., 2021; Malecki et al., 2021; Tsoy et al., 2021), and personal experience with the hazard (Cipolletta et al., 2022; Weinstein, 1989). Personal experience can range from infections within one's wider social network to infections in close social proximity (e.g., relatives; Kollmann et al., 2022; Weinstein, 1989). It may be especially influential as it provides more vivid and concrete information about the hazard (Weinstein, 1989) and can trigger a set of disease-avoidance mechanisms known as the "Behavioral Immune System" (e.g., Koller et al., 2021; Schaller et al., 2021; Schaller and Park, 2011).

While individual protective behaviors such as thorough handwashing offer protection for oneself and one's social network, governmental strategies such as lockdowns aim at collective protection. Research on COVID-19 has emphasized the importance of the perceived effectiveness of governmental strategies for the support of collective protection measures (e.g., Chen et al., 2021; Mækelæ et al., 2020). Therefore, the perceived effectiveness of collective measures may be an important prerequisite for their support (Chen et al., 2021), whereas risk perception might mainly determine the adoption of individual protective behaviors. Conversely, increasing individual risk perception could also amplify support for collective measures either directly (e.g., Siegrist et al., 2021) or indirectly via perceived effectiveness. This raises the question of whether individual risk perception also facilitates support for collective protection measures. Early studies during the pandemic suggest a link between risk perception and individuals' satisfaction with governmental responses (e.g., Sabat et al., 2020). In contrast, higher perceived effectiveness of and support for collective protection measures may motivate people to adopt individual protective behaviors (Siegrist and Zingg, 2014; The Independent Scientific Advisory Group for Emergencies, 2020). Individual and collective pathways may therefore cross-amplify their impact on individual and collective protection measures.

The present study

The present study aimed to investigate individual and collective pathways for protective behaviors and support for collective protection measures during the early phase of the COVID-19 pandemic in spring 2020 across ten countries. Specifically, we tested (a) how risk perception impacts the adoption of individual protective behaviors ("individual pathway"), (b) how the perceived effectiveness of collective protection measures impacts their support ("collective pathway"), and (c) how personal experience relates to both pathways and whether the individual and collective pathways are independent or cross-amplify their impact (Figure 3). In addition, the consistency of the proposed model was tested for ten countries, as they differed in their governmental responses to COVID-19 and their epidemiological situations.

Method

Data were collected within the "EUCLID" project (see: https://euclid.dbvis.de), which tracks risk perception, protective behaviors, and future expectations across countries throughout the COVID-19 pandemic. The project was approved by the ethics committee of the University of Konstanz (ID number: 07/2020) and adhered to the guidelines of the German Psychological Society and the Declaration of Helsinki. All participants gave written informed consent before their participation.

Participants

Data were collected between April 15, 2020 and June 2, 2020 in Costa Rica, Finland, Germany, Greece, Israel, Latvia, North Macedonia, Portugal, Slovenia, and Switzerland through online surveys (Qualtrics, April 2020). Participants were recruited through different strategies (e.g., social media and university participant pools),

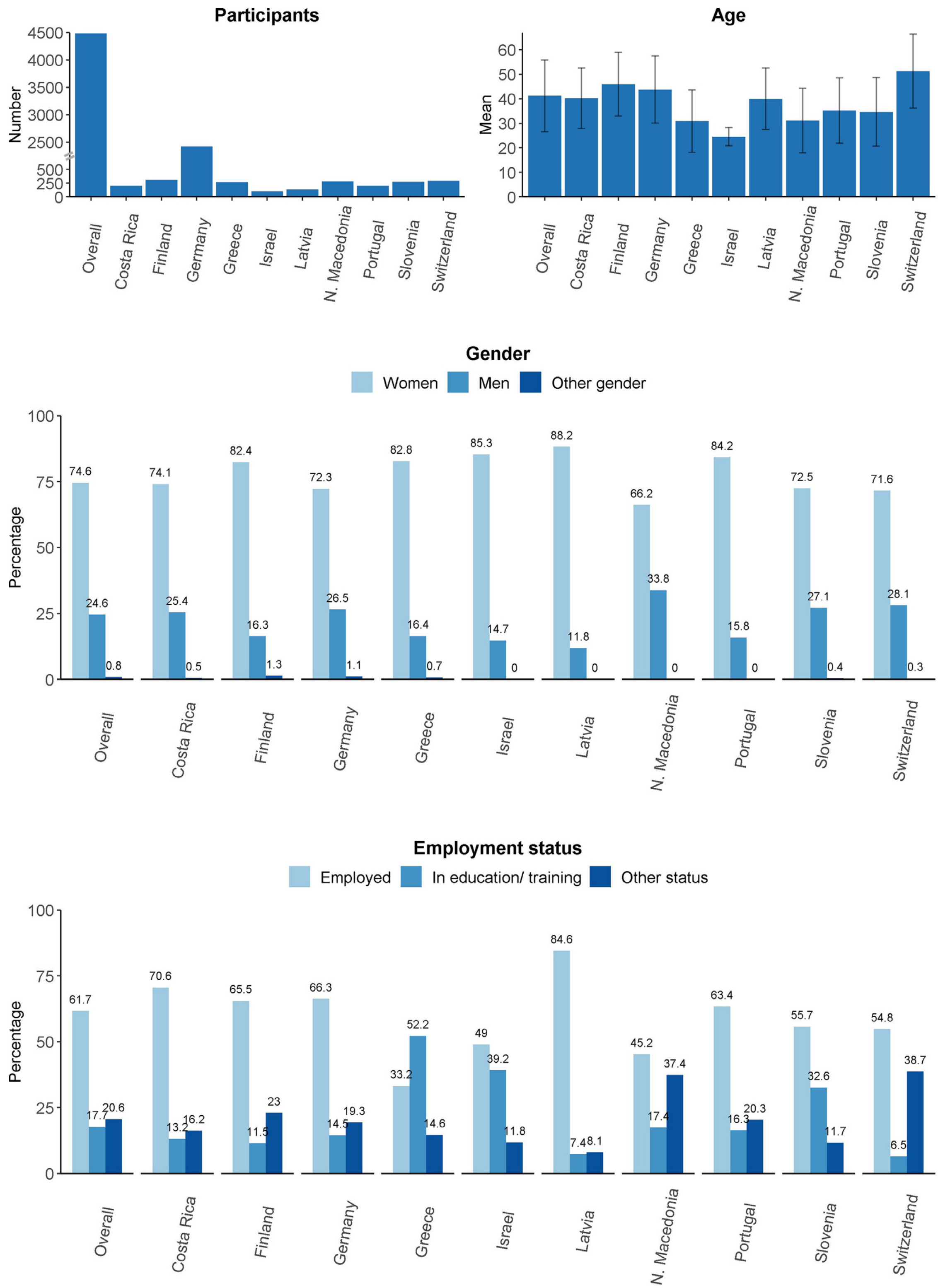

Figure 1. Number of participants, average age, and standard deviation, as well as percentage of genders and employment status overall and per country.

and participants in Finland, Germany, Slovenia, and Switzerland could take part in a lottery.

Overall, data were collected from 4583 participants. Of these, $n = 100$ were excluded due to failed attention checks. The final sample includes 4483 participants (70.8% women) with an average age of 41.2 years ($SD = 14.7$, 18-89 years). Most participants (61.7%) were either employed or self-employed, and 17.7% were in training or education (see Table S1 and Figure 1 for country-specific sample characteristics).

Measures and materials

The questionnaire was developed within the "EUCLID" project. Bilingual researchers and native speakers translated the original

Table 1
Goodness of fit indices for the overall model, the multigroup model, and each country.

	χ^2	df	χ^2/df	Robust CFI	SRMR	Robust RMSEA	90% CI
Overall model	994.14	81	12.27	0.95	0.037	0.055	0.052, 0.058
Multigroup model[a;b]	1687.50	733	2.30	0.95	0.047	0.056	0.053, 0.060
Costa Rica[b]	152.30	82	1.86	0.90	0.067	0.069	0.051, 0.085
Finland	179.22	82	2.19	0.89	0.065	0.066	0.053, 0.079
Germany	460.29	81	5.68	0.97	0.035	0.048	0.044, 0.052
Greece	148.60	82	1.81	0.91	0.054	0.060	0.044, 0.075
Israel	146.66	82	1.79	0.85	0.098	0.094	0.069, 0.118
Latvia	108.34	81	1.34	0.94	0.065	0.052	0.020, 0.076
North Macedonia	166.43	82	2.03	0.92	0.062	0.065	0.051, 0.079
Portugal	104.66	81	1.29	0.95	0.066	0.045	0.010, 0.067
Slovenia	165.68	82	2.02	0.92	0.059	0.062	0.048, 0.076
Switzerland	212.74	81	2.63	0.90	0.059	0.079	0.066, 0.092

CFI = comparative fit index; SRMR = standardized root-mean-squared residual; RMSEA = root-mean-square error of approximation.
Robust estimates are based on the Satorra-Bentler correction. All χ^2 are significant at $P < .05$. [a] Multigroup model without constraints. [b] Please note that since the model for Costa Rica yielded a negative variance for worry due to low correlations between the items of the latent factor of risk perception, it was not included in the multigroup model.

German version according to a standardized protocol and adapted it to country-specific requirements.

Personal experience with COVID-19. Personal experience was assessed by two items which asked the participants to estimate the total number (current and past) of suspected and confirmed coronavirus infections among their acquaintances on a 6-point response scale from 'no person' (1), '1 person' (2), '2 persons' (3), '3–4 persons' (4), '5–7 persons' (5), to '8 or more persons' (6).

Risk perception. Risk perception was assessed using three items for perceived likelihood, perceived severity, and worry (cf. Brewer et al., 2007; Renner et al., 1996; Renner and Reuter, 2012; Sun and Croyle, 1995; Weinstein et al., 2007). Specifically, participants were asked to estimate (a) their likelihood of contracting COVID-19 from 'very unlikely' (1) to 'very likely' (5), (b) the severity of COVID-19 for their health from 'not at all serious (can be neglected)' (1) to 'very serious (life-threatening)' (5), and (c) their worry about contracting COVID-19 from 'not at all worried' (1) to 'very worried' (5). A risk perception index was calculated as an averaged sum score.

Individual protective behaviors. Adoption of six individual behaviors recommended by the World Health Organization (2020), including wearing a face mask, following sneezing and coughing rules, washing hands often or thoroughly, avoiding touching one's face, avoiding shaking hands, avoiding leaving home (i.e., leaving home only for essential needs) was assessed by asking the participants whether and how they had changed their respective behavior due to the coronavirus from 'much less frequently than in the past' (1) to 'much more frequently than in the past' (5). An individual protective behavior index across all behaviors was calculated as an averaged sum score.

Perceived effectiveness of collective protection measures against COVID-19. The participants were asked to judge the effectiveness of four governmental measures from 'very ineffective' (1) to 'very effective' (5), including canceling public events, closing schools and daycare centers, social distancing, and implementing a lockdown. An effectiveness index across the governmental measures was calculated as an averaged sum score.

Support for collective protection measures against COVID-19. The participants were asked to judge the collective protection measures implemented by their government against COVID-19 from 'completely exaggerated' (1), 'exaggerated' (2), 'in moderation' (3), 'insufficient' (4) to 'completely insufficient' (5). Scores between 3 and 5, where participants rated the implemented measures as appropriate or were supportive of even stronger collective measures, were categorized as 'support for collective measures'.

Statistical Analyses

Missing values on core variables were imputed using predictive mean matching with the R package "mice" (version 3.13.0; van Buuren and Groothuis-Oudshoorn, 2011). Analyses were conducted using R (version 4.0.3; R Core Team, 2020).

To investigate the impact of individual and collective pathways on individual protective behavior and collective protection measures, structural equation models (SEM) were calculated (see Figure 3) using the R package "lavaan" (version 0.6-9.1633; Rosseel, 2012). One item assessing individual protective behavior (wearing a face mask) was excluded from the model because of a low factor loading ($\lambda = .25$) and a low corrected item-total correlation ($r = .19$). For the cross-country model comparison, multigroup SEMs were calculated to compare (1) a baseline model without any equality constraints, (2) a model assuming a comparable factor structure across countries (i.e., measurement invariance), and (3) a model additionally assuming comparable factor variances-covariances across countries (i.e., structural invariance; cf. Byrne and van de Vijver, 2010; Horn and McArdle, 1992). Robust CFI estimates were compared between models to test invariance (ΔCFI < 0.01; Cheung and Rensvold, 2002). Goodness of fit indices for the overall, multigroup, and country-specific models are listed in Table 1.

Results

Personal experience with COVID-19 was rather low, with participants on average knowing between 0 and 1 infected person. However, personal experience differed between countries, being lowest in Greece (suspected: $M = 1.65$, $SD = 0.87$/ confirmed: $M = 1.31$, $SD = 0.72$) and highest in Finland (suspected: $M = 2.18$, $SD = 1.35$/ confirmed: $M = 1.70$, $SD = 1.08$) and Portugal (suspected: $M = 2.08$, $SD = 1.35$/ confirmed: $M = 1.75$, $SD = 1.18$). For descriptive results see Table 2 and Figure 2.

Individual pathway

While the average risk perception (index) was in the mid-range of the scale ($M = 2.90$, $SD = 0.82$), adoption rates of individual protective behaviors were generally high, ranging from 88.6% for avoiding handshakes to 69.0% for staying at home. However, risk perception ($F(9, 4461) = 36.48$, $P < .001$, $\eta^2 = 0.07$) and adoption rates of individual protective behaviors ($F(9, 4473) = 11.9$, $P < .001$, $\eta^2 = 0.02$) differed between countries. While risk perception was lowest in Slovenia ($M = 2.60$, $SD = 0.79$) and highest in Costa Rica

Table 2
Study variables' characteristics overall and per country.

Country	Personal experience: Suspected cases	Personal experience: Confirmed cases	Risk perception (index)	Adoption rate of individual protective behaviors (index)	Perceived effectiveness of collective protection measures (index)	Support for collective protection measures (% support)
Overall	$M = 2.00$ ($SD = 1.25$)	$M = 1.59$ ($SD = 0.98$)	$M = 2.90$ ($SD = 0.82$)	$M = 4.17$ ($SD = 0.54$)	$M = 3.90$ ($SD = 0.90$)	75.7
Costa Rica	$M = 1.69$ ($SD = 1.15$)	$M = 1.62$ ($SD = 1.08$)	$M = 3.30$ ($SD = 0.70$)	$M = 4.21$ ($SD = 0.55$)	$M = 4.49$ ($SD = 0.67$)	93.9
Finland	$M = 2.18$ ($SD = 1.35$)	$M = 1.70$ ($SD = 1.08$)	$M = 3.01$ ($SD = 0.73$)	$M = 4.24$ ($SD = 0.44$)	$M = 4.18$ ($SD = 0.65$)	88.8
Germany	$M = 2.08$ ($SD = 1.27$)	$M = 1.61$ ($SD = 0.97$)	$M = 2.81$ ($SD = 0.81$)	$M = 4.15$ ($SD = 0.54$)	$M = 3.76$ ($SD = 0.97$)	72.9
Greece	$M = 1.65$ ($SD = 0.87$)	$M = 1.31$ ($SD = 0.72$)	$M = 3.35$ ($SD = 0.75$)	$M = 4.23$ ($SD = 0.52$)	$M = 4.18$ ($SD = 0.68$)	68.3
Israel	$M = 1.72$ ($SD = 1.12$)	$M = 1.45$ ($SD = 0.80$)	$M = 2.67$ ($SD = 0.83$)	$M = 4.10$ ($SD = 0.60$)	$M = 4.44$ ($SD = 0.61$)	85.3
Latvia	$M = 2.13$ ($SD = 1.35$)	$M = 1.46$ ($SD = 0.90$)	$M = 3.14$ ($SD = 0.76$)	$M = 4.09$ ($SD = 0.54$)	$M = 4.11$ ($SD = 0.69$)	85.3
North Macedonia	$M = 1.96$ ($SD = 1.14$)	$M = 1.69$ ($SD = 1.03$)	$M = 3.01$ ($SD = 0.80$)	$M = 4.19$ ($SD = 0.52$)	$M = 3.84$ ($SD = 0.86$)	72.6
Portugal	$M = 2.08$ ($SD = 1.35$)	$M = 1.75$ ($SD = 1.18$)	$M = 3.36$ ($SD = 0.71$)	$M = 4.48$ ($SD = 0.44$)	$M = 4.20$ ($SD = 0.59$)	93.1
Slovenia	$M = 1.81$ ($SD = 1.22$)	$M = 1.44$ ($SD = 0.89$)	$M = 2.60$ ($SD = 0.79$)	$M = 4.08$ ($SD = 0.49$)	$M = 3.84$ ($SD = 0.83$)	65.9
Switzerland	$M = 1.90$ ($SD = 1.22$)	$M = 1.61$ ($SD = 1.00$)	$M = 2.68$ ($SD = 0.82$)	$M = 4.04$ ($SD = 0.63$)	$M = 3.73$ ($SD = 0.95$)	71.9

($M = 3.30$, $SD = 0.70$), the rates of individual protective behaviors were lowest in Switzerland ($M = 4.04$, $SD = 0.63$) and highest in Portugal ($M = 4.48$, $SD = 0.44$).

Collective pathway

The perceived effectiveness of collective protection measures was high ($M = 3.90$, $SD = 0.90$), with most participants (75.7%) believing them to be effective. Lockdowns were rated as the least effective ($M = 3.52$, $SD = 1.18$), and the cancelation of public events as the most effective measures ($M = 4.31$, $SD = 0.94$). Similarly, the rate of support for collective protection measures was high (75.7%). However, countries differed both in the perceived effectiveness of ($F(9, 4473) = 32.99$, $P < .001$, $\eta^2 = 0.06$) and support for ($\chi^2(9) = 146.00$, $P < .001$) collective protection measures. While perceived effectiveness was lowest in Switzerland ($M = 3.73$, $SD = 0.95$) and highest in Costa Rica ($M = 4.49$, $SD = 0.67$), support was lowest in Greece (68.3%) and highest in Costa Rica (93.9%).

Individual and collective pathways

Figure 3 shows the individual and collective pathways within the SEM. As expected, higher risk perceptions were related to more protective behaviors ($\beta = 0.33$, $P < .001$), supporting the "individual pathway". The SEM also yielded evidence for the "collective pathway", as higher perceived effectiveness of collective protection measures was related to higher support for such measures ($\beta = 0.52$, $P < .001$).

Importantly, the SEM also provides evidence for cross-pathways. Participants who felt more at risk from COVID-19 also believed that collective protection measures were more effective ($\beta = 0.56$, $P < .001$). Moreover, higher individual risk perception cross-amplified support for collective protection measures both directly ($\beta = 0.17$, $P < .001$) and indirectly via perceived effectiveness ($\beta = 0.29$, $P < .001$). Conversely, higher perceived effectiveness of collective protection measures facilitated the adoption of individual protective behaviors ($\beta = 0.38$, $P < .001$). While these findings demonstrate interconnections between the individual and collective pathways, only a small correlation between individual protective behavior and support for collective protection measures was observed ($r = .12$). Personal experience only had small positive effects on both pathways. Taken together, direct and cross-pathways explained 40.8% of the variance in individual protective behaviors and 40.7% of the variance in collective protection measures.

Furthermore, we tested cross-country differences in a multi-group SEM (for country-specific results, please see Table S4). Inducing constraints further showed that the measurement model was comparable across the nine countries that were included (ΔCFI = 0.005), whereas the structural model differed between them (ΔCFI = 0.014). Importantly, however, the individual and collective pathways were generally replicated. Higher individual risk perception was associated with more individual protective behavior in all countries, except Israel ($\beta = -0.07$, $P = .573$), with effects ranging from $\beta = 0.47$ in Greece to $\beta = 0.24$ in Slovenia. A higher perceived effectiveness of collective protection measures was also related to greater support for them in all countries ($0.58 \geq \beta \geq 0.26$, $Ps \leq .024$) except Greece ($\beta = 0.10$, $P = .208$). Furthermore, cross-pathways were observed. Higher individual risk perception was related to the higher perceived effectiveness of collective protection measures in all countries except Israel ($\beta = 0.23$, $P = .057$), ranging from $\beta = 0.60$ in Germany to $\beta = 0.40$ in Greece, and facilitated greater support for them both directly ($0.29 \geq \beta \geq 0.16$, $Ps \leq .047$) in five (Germany, North Macedonia, Portugal, Slovenia, Switzerland) and indirectly via greater perceived effectiveness ($0.34 \geq \beta \geq 0.22$, $Ps \leq .001$) in four of nine countries (Finland, Germany, North Macedonia, and Switzerland). Likewise, higher perceived effectiveness of collective protection measures facilitated the adoption of individual protective behaviors in all countries except Greece ($\beta = 0.18$, $P = .064$), ranging from $\beta = 0.48$ in Slovenia to $\beta = 0.23$ in Portugal. As in the general model, personal experience had little or no significant impact in all countries.

Discussion

The COVID-19 pandemic has highlighted the need to establish successful emergency responses at both the individual and collective levels. The present study proposes a model to examine individual and collective pathways for the adoption of individual

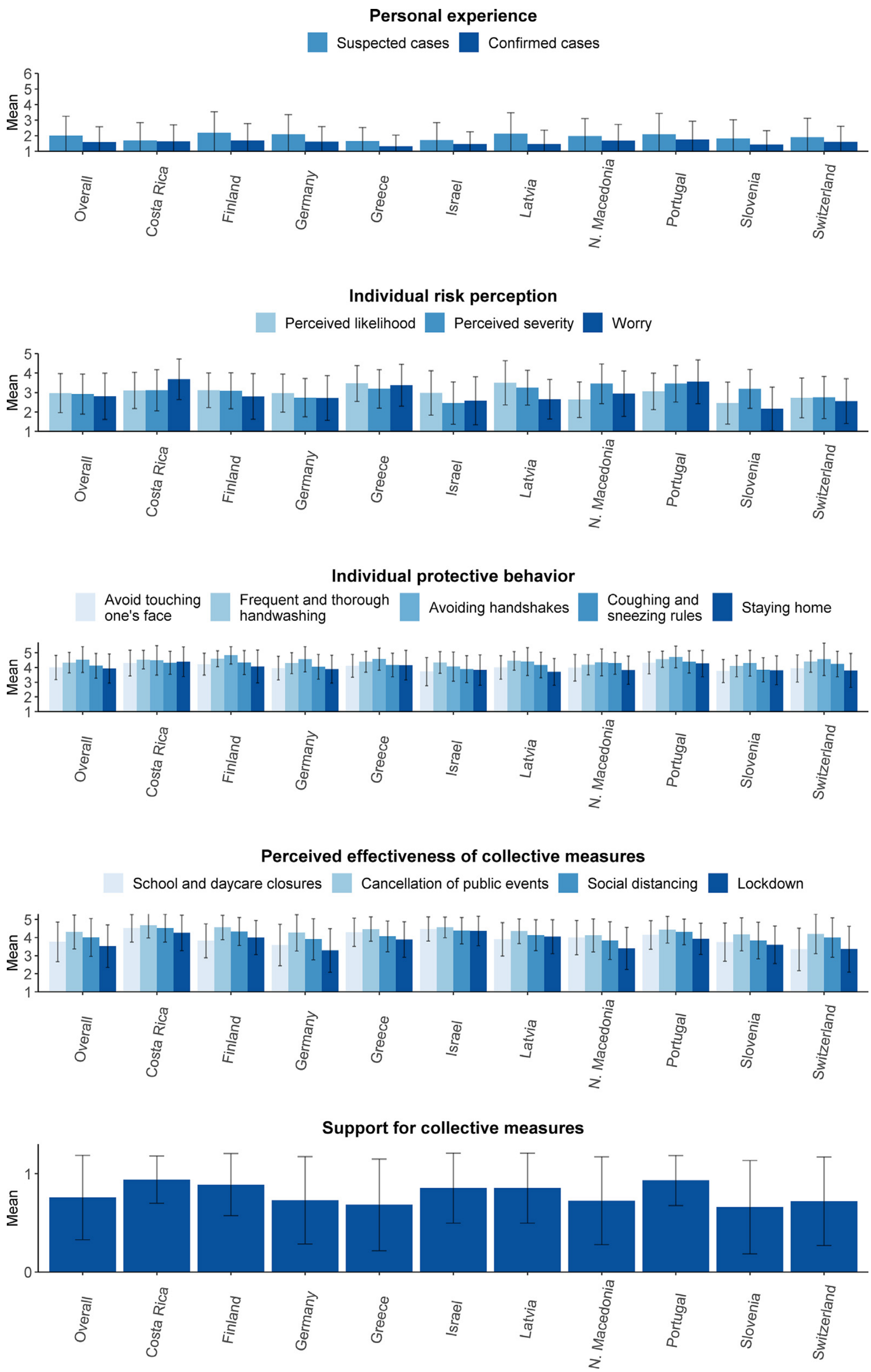

Figure 2. Means and standard deviations of variables used as indicators of each construct in the SEMs overall and per country. The x-axis displays the range of the respective indicators.

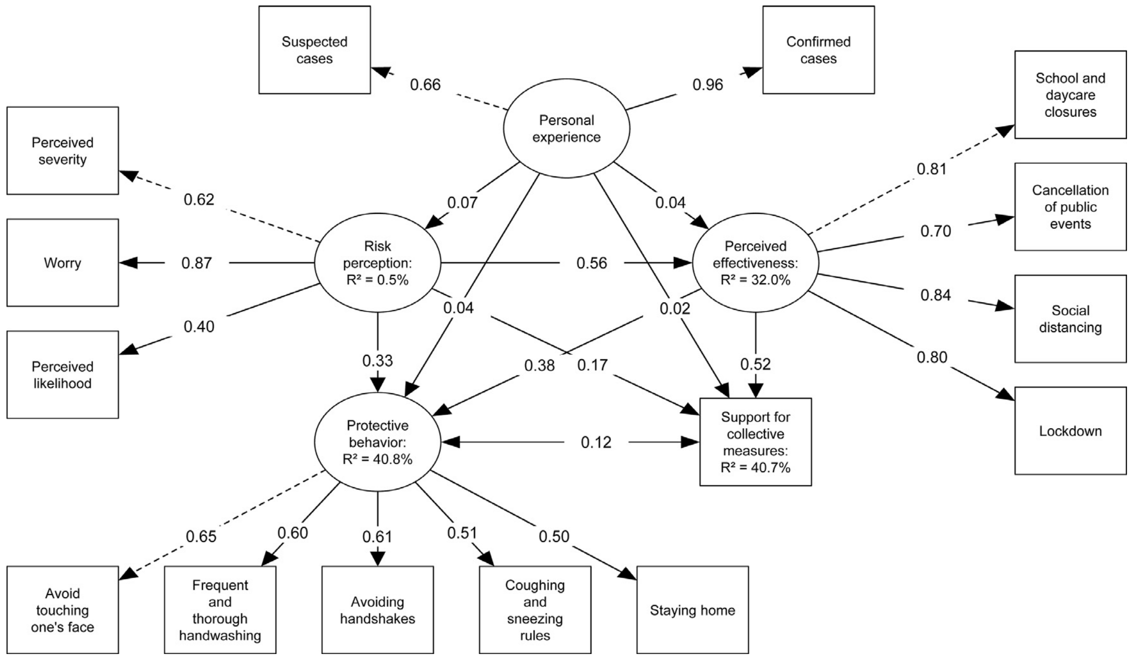

Figure 3. Structural equation model of individual and collective pathways on individual protective behavior and collective protection measures ($N = 4471$).

protective behaviors and support for collective protection measures. Overall, the model explained a large amount of the variance in both individual protective behavior (40.8%) and collective protection measures (40.7%). Comparably small differences between countries emerged on both pathways. The replication of the overall structure of the model across countries is promising as countries vary substantially in their public health infrastructure and governmental responses, especially as best practices to address COVID-19, both individually and collectively, were limited in the early stages of the pandemic.

Overall, reported rates of individual protective behaviors were high, and collective measures were generally perceived to be effective and largely supported. Interestingly, however, the introduction of lockdowns, i.e., the most intensive collective measure to reduce contact, was rated as the least effective measure in all countries. This subjective evaluation corresponds to retrospective cross-country data modeling, indicating that stay-at-home orders (i.e., lockdowns) only had small effects in addition to other large-scale collective measures during the first wave of COVID-19 (Brauner et al., 2021). Furthermore, some variability between countries emerged, potentially reflecting different governmental strategies and country-specific messaging. For example, individual protective behaviors and the perceived effectiveness of collective measures were comparably low in Switzerland, a country with a liberal approach toward COVID-19. In contrast, both were comparably high in Portugal, which was hit hard during the first wave of COVID-19 and consequently introduced intensive collective measures.

The present pattern of results reveals a cross-amplifying effect between individual protective behaviors and the perceived effectiveness of collective measures. Willingness to adopt individual protective behaviors was higher when perceived collective measures were perceived to be more effective. This pattern of results does not support the notion that people tend to “free ride” on collective measures (Cato et al., 2020; Yong and Choy, 2021), which would imply that people who are more confident in the protective value of collective measures minimize individual costs by relying on collective protection while refraining from taking individual protective measures. In line with this, research on crisis events such as mass emergencies (e.g., train accidents) and disasters (e.g., hurricanes) shows that, in the face of a shared threat, most people do not put themselves first and engage in exclusively selfish behaviors but rather respond prosocially, showing solidarity and cooperation (Drury et al., 2009; Drury et al., 2020; Rodríguez et al., 2006; Tekin et al., 2021). Alternatively, following the concept of “risk compensation”, one could have assumed that people who perceive collective measures to be effective show less individual protective behavior because their perceived risk falls below their individual target level of risk, which they strive to maintain (Hedlund, 2000). Although this may be of concern when collective measures are considered (Mantzari et al., 2020), it was not supported by the present findings. Therefore, it is important to combine all effective means to address COVID-19 rather than refraining from collective measures for fear of risk compensation.

Furthermore, the model also showed a cross-amplified effect of individual risk perception on support for collective protection measures. The direct effect indicates that when people perceive the risk of COVID-19 as high, they are more willing to support collective measures (Betsch et al., 2021; Siegrist et al., 2021). However, it is important to note that while the direct effect was comparably small ($\beta = 0.17$), the indirect effect ($\beta = 0.29$) via perceived effectiveness was markedly larger, suggesting that support for collective measures is mediated by considerations of perceived effectiveness rather than being unconditional. Since these considerations could reflect a process similar to the weighing of response efficacy and response costs in the “Protection Motivation Theory” (Maddux and Rogers, 1983; Rogers, 1975), costly collective measures may only be seen as justified if they are perceived as necessary and effective (cf. Betsch et al., 2021; Leder et al., 2020). This emphasizes the importance of public support, which requires transparent, timely, and effective public communication about the benefits, drawbacks, and expected mechanisms of collective measures.

Despite the identified cross-amplifying interconnections between the individual and collective pathways, only a small correlation emerged between individual protective behavior and support for collective protection measures ($r = .12$). This contradicts a general support for protective measures, regardless of their nature, i.e., individual or collective. Rather, it suggests that both types of protection depend on different factors (e.g., risk perception, perceived effectiveness) even though they are part of the same continuum of behavioral actions. This finding could also be due to differing (i.e., self-protective or public-protective) motivations for individual protective behaviors and support for collective measures (cf. Leder et al., 2020; Liekefett and Becker, 2021). For instance, a person who feels relatively invulnerable to COVID-19 and therefore engages in relatively few protective behaviors might still endorse collective measures to protect vulnerable groups in society. Therefore, addressing motivation for self-protection and public protection may reinforce behavioral actions against COVID-19.

While communications with the public could reinforce behavior and influence the perceived effectiveness of collective measures, how people perceive their risk may also depend on personal experience. Personal experiences have been shown to function as amplifiers of risk by reducing the degree of abstraction of a hazard, which is consequently perceived as closer and more threatening, thus increasing risk perception (Cipolletta et al., 2022; Dryhurst et al., 2020; Kollmann et al., 2022; Weinstein, 1989). Surprisingly, however, personal experience only appears to have small effects in the present model. Although personal experience was generally low, the variability suggests that this cannot be fully explained by a floor effect. Instead, it could be explained by a moderating effect of disease severity and outcome that lowers people's risk perception when knowing someone who has recovered and increases it when knowing someone who has died (Betsch et al., 2011; Leder et al., 2020; Weinstein, 1989). Thus, future studies should examine personal experience with COVID-19 more closely, including the severity and type of experience.

In addition to the model and its implications, the applicability to other countries is of interest. While the model's overall structure was generally replicated in nine of ten countries, some differences emerged. Importantly, differences in significance levels of similar-sized effects could result from differences in sample size rather than qualitative differences between countries. Qualitative differences, by contrast, could be based on a variety of factors, including differences in the epidemiologic situation and collective measures. However, as the study did not aim to analyze differences between countries, we must be cautious in drawing conclusions about cross-country differences. In addition, the model could not be replicated for Costa Rica because of estimation problems resulting from unexpectedly low correlations among risk perception indicators during the assessment period of the present study. Nevertheless, the replication of the general structure of the model for most countries is noteworthy, especially given the relatively large number of countries (cf. Byrne and van de Vijver, 2010).

The study has certain limitations. First of all, and although the cross-country examination of the model is a strength of the study, data only represent a snapshot of the rapidly changing and dynamic situation during the COVID-19 pandemic in the ten countries analyzed. Furthermore, because of the cross-sectional design, we can only hypothesize about the direction of effects in the model (cf. Weinstein et al., 1998). Future research should preferably replicate and expand on the present findings using representative and longitudinal data, also including more non-WEIRD (non-WEIRD populations rather than WEIRD ones) populations and taking the epidemiologic situation in each country into account. Secondly, whereas the study focused on the main factors contributing to individual and collective pathways, other important aspects were not incorporated into the model. For instance, it would have been interesting to explore the influence of people's trust in their government, as several studies show its importance for compliance with behavioral recommendations and support of collective measures (e.g., Bargain and Aminjonov, 2020; Betsch et al., 2021; Cipolletta et al., 2022; Harring et al., 2021; Siegrist et al., 2021). Similarly, classic and social media play an important role in shaping public perceptions of the risk of COVID-19 (e.g., Cipolletta et al., 2022; He et al., 2021; Malecki et al., 2021; Tsoy et al., 2021). Finally, social-cognitive factors such as self-efficacy or outcome expectancies (see e.g., the Health Action Process Approach; Schwarzer, 1992) and interindividual differences (e.g., age and education level) can systematically affect the adoption of protective behaviors and the acceptance of more restrictive policies (Betsch et al., 2021). Future research could expand our model to provide a more complete picture of individual and collective pathways and their interactions.

Conclusions

The present study advances previous research by providing a more comprehensive view of perceptions and measures on the individual and collective levels, thereby revealing considerable connections between these pathways. Specifically, while the adoption of individual protective behavior and support for collective measures are mostly distinct, both are strengthened by risk perceptions at the individual level and effectiveness ratings at the collective level. This highlights the importance of considering the full range of behavioral actions against an infectious disease threat, taking interactions and the influence of perceptions on different levels into account. Pursuing an integrative view is important for communicating with the public to successfully address the current global crisis.

Competing interests

The authors have no competing interests to declare.

Ethical approval statement

The project was approved by the ethics committee of the University of Konstanz (ID number: 07/2020) and adhered to the guidelines of the German Psychological Society and the declaration of Helsinki. All participants gave written informed consent before their participation.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.ijid.2022.06.012.

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