The longitudinal relation between time perspective and preventive behaviors during the COVID-19 pandemic: The mediating role of risk perception

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Abstract

Understanding psychological factors and the mechanisms involved in compliance with recommended preventive behaviors against COVID-19 is important for effective public health strategies. Time perspective was previously linked with risk perception and health-related behaviors, but it has not been explored in the context of infectious diseases. Furthermore, little is known about the explaining mechanisms that may link time perspective with adoption of preventive behaviors against health threats. The aim of the present study was to examine the longitudinal relations between time perspectives and COVID-19 risk perception and preventive behaviors. Using a six-month longitudinal design, we explored the mediating role of risk perception on the relations between the Zimbardo's time perspectives, and preventive behaviors to protect from COVID-19. Time perspectives and COVID-19 risk perception were assessed after the lock-down (May 2020) and preventive behaviors were reported after six months (December 2020) via online surveys in a sample of 460 Romanian young adults, aged 18 to 66 years (Mage = 25.53, 87.8% women). Path analysis revealed that risk perception (i.e., perceived severity of COVID-19) mediated the relations of past negative, positive and negative future time perspectives with adoption of preventive behaviors. Our findings highlight that risk perception is an important mechanism in explaining the relation between time perspectives and preventive behaviors against major health-threats such as COVID-19.

Keywords Time perspective · Risk perception · Preventive behaviors · COVID-19 pandemic

Introduction

Since January 2020, the Coronavirus Disease 2019 (Covid-19) pandemic remained an ongoing unprecedented threat to the health and lives of people and an enormous challenge for health systems around the world. Actions of health authorities to slow and contain the transmission of the virus have focused on public health preventive measures and behaviors, such as physical distancing, personal protective measures, and temporary lock-down restrictions (Dryhurst et al., 2020; World Health Organization [WHO],

2020b). Population compliance with preventive measures set out by health authorities is critical for public health prevention efforts aimed at limiting the spread of this disease (Van Bavel et al., 2020). Public health efforts would greatly benefit from insights provided by social science into personal factors, such as time perspective and risk perception that may influence willingness to comply with the recommended prevention behaviors (Dryhurst et al., 2020; Van Bavel et al., 2020). Time perspective (TP) was previously linked with risk perception and health-related behaviors (e.g., Apostolidis et al., 2006; Griva et al., 2013, see Boyd & Zimbardo, 2005 for a review), but it has not been explored in the context of infectious diseases. In addition, little is known about the explaining mechanisms that may link TPs with adoption of preventive behaviors (Griva et al., 2013). Given the ongoing public health threat of COVID-19, TP may be particularly relevant for individuals' perception of the risk posed by this disease and the preventive behaviors they consequently engage in to avoid it. Understanding psychological factors and mechanisms involved in adoption

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of preventive behaviors against major health-threats such as COVID-19 is important for articulating effective public health strategies. Thus, using a six-month longitudinal design, this study contributes to the literature by exploring whether TPs are related to adoption of preventive behaviors against COVID-19. In addition, considering recent literature showing that risk perception is a key factor in adopting preventive behaviors during the COVID-19 pandemic (e.g., Breakwell et al., 2021; Fu et al., 2021), we also investigated the potential mediating role of risk perception on the relation between TP and preventive behaviors to protect from COVID-19 infection.

Time Perspective and Health-related Behaviors

As described by Zimbardo and Boyd (1999), TP reflects the cognitive processes that organize one's life experiences into distinct time frames (past, present, future), providing structure and coherence to one's life events. These temporal categories guide and shape an individual's appraisals, decisions, actions and expectations (Zimbardo & Boyd, 1999). Past negative TP describes a bitter and painful reflection of the past as opposed to past positive perspective that denotes a gratifying and favorable view of the past. The present fatalistic TP involves a helpless and defeatist view over one's life. The present hedonistic TP describes a risk-taking attitude toward the present, focused on immediate gratification, disregarding future consequences of own behaviors. Future TP entails a focus on future goals and high consideration of future consequences (Zimbardo & Boyd, 1999); future positive TP is characterized by optimism and positive expectations toward future goals, whereas future negative TP describes a worrisome view of the future and anticipation of negative consequences (Carelli et al., 2011, 2015).

There is growing evidence indicating that TPs are connected with health-related behaviors and conditions (see Boyd & Zimbardo, 2005; Hall et al., 2015 for reviews). Specifically, the past negative TP was positively linked to risky health-behaviors, such as alcohol use (McKay et al., 2014) and past positive TP was positively related with health-promoting behavior for cardiac rehabilitation (Hamilton et al., 2003) and cancer screening intentions (Griva et al., 2013). The present fatalistic TP predicted more risky sexual behavior and substance use (Chavarria et al., 2015), whereas present hedonistic TP was linked with risky health-behaviors, including alcohol and drugs use (Apostolidis et al., 2006; Daugherty & Brase, 2010; Henson et al., 2006). Further, the future TP was linked with increased health-protective behaviors, including more physical exercise (Daugherty & Brase, 2010; Griva et al., 2015), condom-use (Henson et al., 2006) and breast cancer screening (Griva et al., 2013). However, studies exploring the separate links between future positive

and future negative TPs and health-related behaviors are missing from literature.

To extend the knowledge on the role of TP in health-protective behaviors, the first aim of this study was to examine the relative contribution of TPs to the adoption of preventive behaviors against COVID-19, using a six-month longitudinal design. Based on theoretical models (Boyd & Zimbardo, 2005; Zimbardo & Boyd, 1999) and previous empirical evidence (e.g., Griva et al., 2013; Hamilton et al., 2003), we hypothesize that a higher past negative TP will be related with adoption of less preventive behaviors over time, whereas a higher past positive TP will be related to more preventive behaviors to avoid COVID-19 infection. Further, fatalist and hedonist present TPs at Time 1 will be negatively related with the adoption of preventive behaviors at Time 2, whereas the future positive and future negative TPs will be positively related over time with the number of preventive behaviors reported by participants.

Risk Perception and Preventive Behavior During Pandemics

According to theories of health-behavior (e.g., Protection Motivation Theory; PMT, Rogers, 1983; Health Belief Model; HBM, Rosenstock, 1974), risk perception represent a perceived threat to one's health and is composed of perceived severity and perceived vulnerability to the disease. Perceived severity indicates how serious or harmful the individual believes the threat will be for his life, while perceived vulnerability indicates how personally susceptible someone feels to the disease (Milne et al., 2000). Previous literature indicated that risk perception components are important determinants of preventive behaviors against health threats. Perceived severity and perceived vulnerability have been extensively investigated in predicting a wide range of health-protective behaviors, such as physical exercise, cancer prevention and medical adherence (see Floyd et al., 2000, Milne et al., 2000 for meta-analyses).

Risk perception dimensions were also important predictors of behavioral responses during previous pandemics of influenza (e.g., Bults et al., 2011; de Zwart et al., 2010). Perceived severity and perceived vulnerability received extensive empirical support as determinants of compliance with prevention measures and health-protective behaviors during pandemics (Bults et al., 2011; de Zwart et al., 2010; see Bish & Michie, 2010 for a review).

Thus, perceived risk could be potentially important determinant of adoption of preventive behaviors against the COVID-19 health threat. Perceived vulnerability or likelihood to be infected with COVID-19 was also examined, and cross-sectional findings indicated positive relations with preventive behaviors, like handwash, maintaining social distance or avoiding public spaces (Breakwell et al., 2021;

Wise et al., 2020). In addition, an overall composite measure of COVID-19 risk perception was positively related with a global index of preventive health behaviors in an international cross-sectional study (Dryhurstet al., 2020).

Although there is growing evidence for the link between COVID-19 risk perception and preventive behaviors, only few recent studies provided longitudinal evidence for this relation. There are some findings indicating that COVID-19 risk perception, perceived severity of the disease and perception of own vulnerability or likelihood to be infected, are longitudinally positively related with the engagement in preventive behaviors across different phases of the pandemic (Fu et al., 2021; Qin et al., 2021).

To contribute to this emerging evidence, the second aim of the study was to investigate the role of risk perception components (i.e., perceived severity and perceived vulnerability) on the adoption of preventive behaviors against COVID-19, using a longitudinal design. Based on PMT (Rogers, 1983) and previous empirical evidence (e.g., Bults et al., 2011; Qin et al., 2021), we hypothesized that perceived severity and vulnerability to COVID-19 reported at Time 1 will be positively related with adoption of preventive behaviors at Time 2, six months later.

The Mediating Role of Risk Perception

Previous literature argues that TPs, as stable traits, may have a distal, indirect effect on preventive behaviors, mediated by more proximal determinants of behaviors (Apostolidis et al., 2006; Hall et al., 2015). Further, risk perception is conceptualized as an important proximal precursor of behaviors in some important theoretical frameworks of health-protective behaviors (e.g., PMT, Rogers, 1983; Ajzen & Fishbein, 1980; HBM, Rosenstock, 1974). How people perceive time may be important for how they evaluate major health risk such as COVID-19 and how they consequently act to prevent being infected.

Empirical evidence linked TPs with risk perception. Thus, a high level of future TP was related to a high level of perceived risk for developing breast cancer (Griva et al., 2013), for being involved in road traffic accidents (Măirean & Diaconu-Gherasim, 2021), or for adopting drug consumption (Apostolidis et al., 2006) in cross-sectional studies. Both positive and negative past TPs were also related to high risk perception on the road, whereas present hedonistic TP negatively predicted risk perception for events produced in traffic situations (Măirean & Diaconu-Gherasim, 2021). Another cross-sectional study reported non-significant relations between past and present TPs and risk perception for breast cancer (Griva et al., 2013). One study explored the longitudinal relation between TPs (i.e., future) and risk perception, and findings indicated that future TP was positively related to a general measure of risk perception in a 6-months longitudinal study (Jackman & MacPhee, 2017).

Further, the relation between future TP and preventive behaviors was mediated by risk perception (e.g., Griva et al., 2013). Moreover, risk perception mediated the relation between TPs (i.e., past negative, present hedonistic, and future) with risky behaviors for mental and physical health (i.e., risky driving) (Măirean & Diaconu-Gherasim, 2021). Based on theoretical models (Ajzen & Fishbein, 1980; Rogers, 1983) and limited empirical evidence for the relation between TPs and the components of risk perception (Griva et al., 2013), our third aim was to explore the relation between TPs and the two components of risk perception for COVID-19 - perceived severity and personal vulnerability. We also explored whether TPs may have a mediated effect through risk perception dimensions on preventive behaviors. According to the literature presented above (e.g., Apostolidis et al., 2006; Griva et al., 2013), we anticipate that future positive TPs will increase COVID-19 risk perception, which will further promote the adoption of preventive behaviors. Moreover, based on the assumption of time perspective theory (Zimbardo & Boyd, 2015), we expect that a positive past and negative future TPs will enhance risk perception and, further, they will positively predict adoption of preventive behaviors. Further, past negative, present hedonist and present fatalist TPs will decrease COVID-19 risk perception, and this will positively predict preventive behaviors.

Method

Participants and Procedure

After obtaining IRB approval, the participants were selected from a university from the North Eastern part of Romania. A total of 844 students were invited to take part in the study and 634 participants (84.7% women), aged 18 to 66 years ($M = 25.91$, $SD = 9.19$) agreed to participate. Of these students, 460 of the participants (87.8% female, Mage = 25.53, $SD = 9.19$, range = 18–66 years) participated at Time 2. The majority of the participants (85.7%) were undergraduate students, and 15.3% were graduate students. Regarding family status, 15.9% were married, 80.4% of the participants were single, and 3.7% reported other marital status (divorced or widow). Most of the participants (52.6.7%) reported that have an employment contract; among them 18.9% reported a low level of income (less than 465 Euros per month), 25.9% reported a medium level of income (ranging from 465 to 1131 Euros, and 7.8% with a high level of income (more than 1131 Euros per month). Among them, 1.3% of participants lived alone, and 98.7% lived with at least one family member ($M = 3.31$, $SD = 1.52$, range = 0–9 family members).

Regarding the place of residence, 67.4% of the participants lived in urban areas and 32.6% lived in rural areas.

Potential participants received brief information about the study during their online lectures. The students who agreed to participate in the study completed a written informed consent, and then they received a link to the questionnaires. Considering the COVID-19 outbreak restrictions, the participants completed the online survey. The students' participation was voluntary. As part of a larger study investigating the psychological changes due to COVID-19 pandemic, the participants filled out questionnaires measuring their time perspective, COVID-19 risk perception and preventive behaviors at Time 1, May 2020 in the first two weeks after the state of emergency ended. The students also completed questionnaire assessing the preventive behaviors six months later, in December 2020, during the second wave of COVID-19 pandemic (Time 2), and each application was about 30 min. The students received extra credit for their participation. No exclusion criteria based on demographic variables was used.

Measures

Covid-19 risk perception and preventive behavior measures were translated from English into Romanian using the Hambleton's (2005) forward-backward translation method. The back-translation method retained the conceptual meaning of the original measures.

Time Perspectives

Romanian adapted form (Măirean & Diaconu-Gherasim, 2019) of the *Time Perspective Inventory* (S-ZTPI; Carelli et al. 2011) was used to evaluate the participants' experience of time. The S-ZTPI consists of 64 items and measure six distinct subscales: Past Positive (9 items, e.g., *I enjoy stories about how things used to be in the good old times*, α=0.75), Past Negative (10 items, e.g., *Painful past experiences keep being replayed in my mind*, α=0.80), Present Hedonistic (15 items, e.g., *I make decisions on the spur of the moment*, α=0.76), Present Fatalistic (9 items, e.g., *My life path is controlled by forces I cannot influence*, α=0.71), Future Positive (11 items, e.g., *When I want to achieve something, I set goals and consider specific means for reaching those goals*, α=0.68), and Future Negative (10 items, e.g., *Usually, I do not know how I will be able to fulfill my goals in life*, α=0.66). The participants evaluated the items on a 5-point scale ranging from 1=*very uncharacteristic* to 5=*very characteristic*. Total scores were computed by averaging items for each subscale. The scale has good validity in various cultural samples (e.g., Măirean & Diaconu-Gherasim, 2019).

Risk Perception of COVID-19 Infection

An adapted form of *Perception of risk scale* of infection with avian influenza and Influenza A (H1N1) (Bults et al., 2011) was used to assess the participants' perception of risk of infection with COVID-19. The scale contains six items and measure the perceived severity (3 items, e.g., *COVID-19 would be very harmful for my health*) and perceived vulnerability (3 items, e.g., *Do you think that you are susceptible to getting COVID-19 if you take no preventive measures?*). Each item was answered using a 5-point Likert response format (1=*disagree*, 5=*agree*). The confirmatory factor analysis indicated that the fit for the two factorial model was good: $\chi^2(16)=7.60$, p=.18; TLI=0.99; CFI=0.99; RMSEA=0.03, 90% CI [0.000, 0.080]. Total scores were computed by averaging items for each dimension (α=0.82 for perceived severity and α=0.68 for perceived vulnerability, respectively). The scale has good validity, as it has been associated with taking preventive measure during influenza pandemic in Netherlands (Bults et al., 2011).

Covid-19 Preventive Behaviors

A 12-item scale was used to assess the preventive behaviors that participants adopted against COVID-19 infection, with 9 items adapted from studies regarding Influenza pandemic preventive behaviors (e.g., avoiding public transportations or staying home from school or work; Bults et al., 2011; Sadique et al., 2007) and three additional preventive behaviors recommended by the health authorities against COVID-19 (e.g., maintain at least 1-meter distance from others, WHO, 2020a). Each item was answered using yes (1) or no (0) format. A total score was computed by summing the scores across items (αs=0.71 at Time 1 and 0.71 at Time 2).

A demographic questionnaire requested information about the participant age, gender, education level, family status, area of residence and employment status and if they suffered from chronic diseases (e.g., diabetes).

Overview of Statistical Analysis

First, preliminary analyses were conducted in order to test whether participants socio-demographic characteristics were related to the adoption of preventive behaviors. Then, zero-order correlations among the main study variables were computed. Finally, to test the study's hypotheses we used the structural equation model (SEM) framework in AMOS Graphics 24 and the following indices were used for evaluation of the overall model fit: the chi-square statistic ($\chi 2$), the normative fit index (NFI), the comparative fit index (CFI) and the root mean square error of approximation (RMSEA). A RMSEA < 0.08, the CFI and NNFI values ≥ 0.90 indicate a good model fit (Hu & Bentler, 1999). Further, to assess

the significance of the mediation effects, we computed the confidence interval for the indirect effect based on Tofighi and MacKinnon's (2011) method.

Results

Preliminary Analysis

Table 1 presents the descriptive statistics for all the variables analyzed. The participants' age and number of family members were not significantly correlated with adoption of preventive behaviors, $rs < 0.05$, all $ps > 0.05$. The independent sample t-test revealed no residence area or gender differences in adoption of the preventive behaviors, $ts < 1.36$, all $ps > 0.05$. Further, there was no effect of the participants' medical condition on preventive behaviors, $t(457) < 1.57$, $p > .05$. The participants' income level or marital status

had no effects of on adoption of the preventive behaviors, $Fs < 1.35$, all $ps > 0.05$.

Associations Among the Main Study Variables

As presented in Table 2, zero-order associations indicated that the past negative, future positive and future negative TPs were positively linked with preventive behaviors at Time 1, however, some of these associations have small effect sizes. Participants who experienced higher levels of perceived severity and perceived vulnerability also reported higher number of adopted preventive behaviors at Time 1. Further, participants who are more positively orientated toward future reported adoption of more preventive behaviors six months later at Time 2, although the correlation has small effect size. Finally, participants' perceived severity of COVID-19 was positively related with the adoption of preventive behaviors at Time 2 (see Table 2).

Table 1 Means, standard deviations, and minimum and maximum values of the main study variables

Variables	N	Mean	SD	Minimum	Maximum
1. Time perspective - Time 1					
1.1. Past Negative TP	634	3.43	0.77	1.33	5.44
1.2. Past Positive TP	634	3.57	0.60	1.33	5.00
1.3. Present Hedonistic TP	634	3.52	0.47	2.27	4.93
1.4. Present Fatalistic TP	634	2.75	0.54	1.22	4.89
1.5. Future Positive TP	634	3.69	0.43	2.45	4.91
1.6. Future Negative TP	634	3.22	0.54	1.40	4.90
2. Risk perception - Time 1					
2.1. Perceived severity	634	3.71	0.90	1.00	5.00
2.2. Perceived vulnerability	634	3.01	0.78	1.00	5.00
3. Preventive behaviors -Time 1	634	10.42	1.57	0.00	12.00
4. Preventive behaviors Time 2	459	8.89	2.09	0.00	12.00

Table 2 Zero-order correlations among the main study variables

Variables	1	2	3	4	5	6	7	8	9
Time 1									
1. Past Negative TP									
2. Past Positive TP	−0.32***								
3. Present Hedonistic TP	0.15***	0.23***							
4. Present Fatalistic TP	0.41***	0.01	0.41***						
5. Future Positive TP	−0.18***	0.21***	−0.11**	−0.27***					
6. Future Negative TP	0.63***	−0.18***	0.12**	0.38***	−0.09*				
7. Perceived severity	0.19***	0.02	0.03	0.07	0.11**	0.22***			
8. Perceived vulnerability	0.10**	−0.11**	−0.08*	−0.04	0.02	0.14***	0.30***		
9. Preventive behaviors	0.09*	−0.05	0.02	0.02	0.10**	0.12**	0.28***	0.17**	
Time 2									
10. Preventive behaviors	0.07	−0.04	0.02	0.01	0.11*	0.06	0.23***	0.08	0.39***

Note: $N = 459$

*$p < .05$. **$p < .01$, $p*** < 0.001$

Path Analysis Testing the Study's Hypotheses

We tested the main effects of the TPs and risk perception (i.e., perceived severity and vulnerability) at Time 1 on adoption of the preventive behaviors at Time 2, and the mediating role of the risk perception on these relations. The preventive behaviors measured at Time 1 were included as control variables because of their significant association with the adoption of preventive behaviors at Time 2. The indices for the model indicate a good fit: χ^2 (56) = 7.76, $p < .001$; NFI = 0.93; CFI = 0.94, RMSEA = 0.10, CI 90% [0.082; 0.127]. The model explains 17.4% of the variance in adoption of the preventive behaviors measured at Time 2. Significant standardized path estimates are presented in Fig. 1.

Past negative, future positive and future negative TPs were positively significantly related with perceived severity. The present fatalist TP was negatively significantly related with perceived vulnerability, whereas future negative TP were positively significantly related to perceived vulnerability. Perceived severity at Time 1 was positively related to adoption of the preventive behaviors at Time 2. Regarding the control variables, preventive behaviors measured at Time 1 was positively correlated with the adoption of preventive behaviors six month later, at Time 2.

Assessment of the Mediating Paths

Perception of severity played a mediating role on the relations between past negative TP, Estimate (SE) = 0.063 (0.033), 95% CI is [0.009, 0.137], future positive TP, Estimate (SE) = 0.104 (0.046), 95% CI is [0.027, 0.207] and future negative TP, Estimate (SE) = 0.104 (0.044), 95% CI [0.031, 0.2] with adoption of the preventive behaviors. Perceived vulnerability did not mediate the relation of TPs with adoption of preventive behaviors.
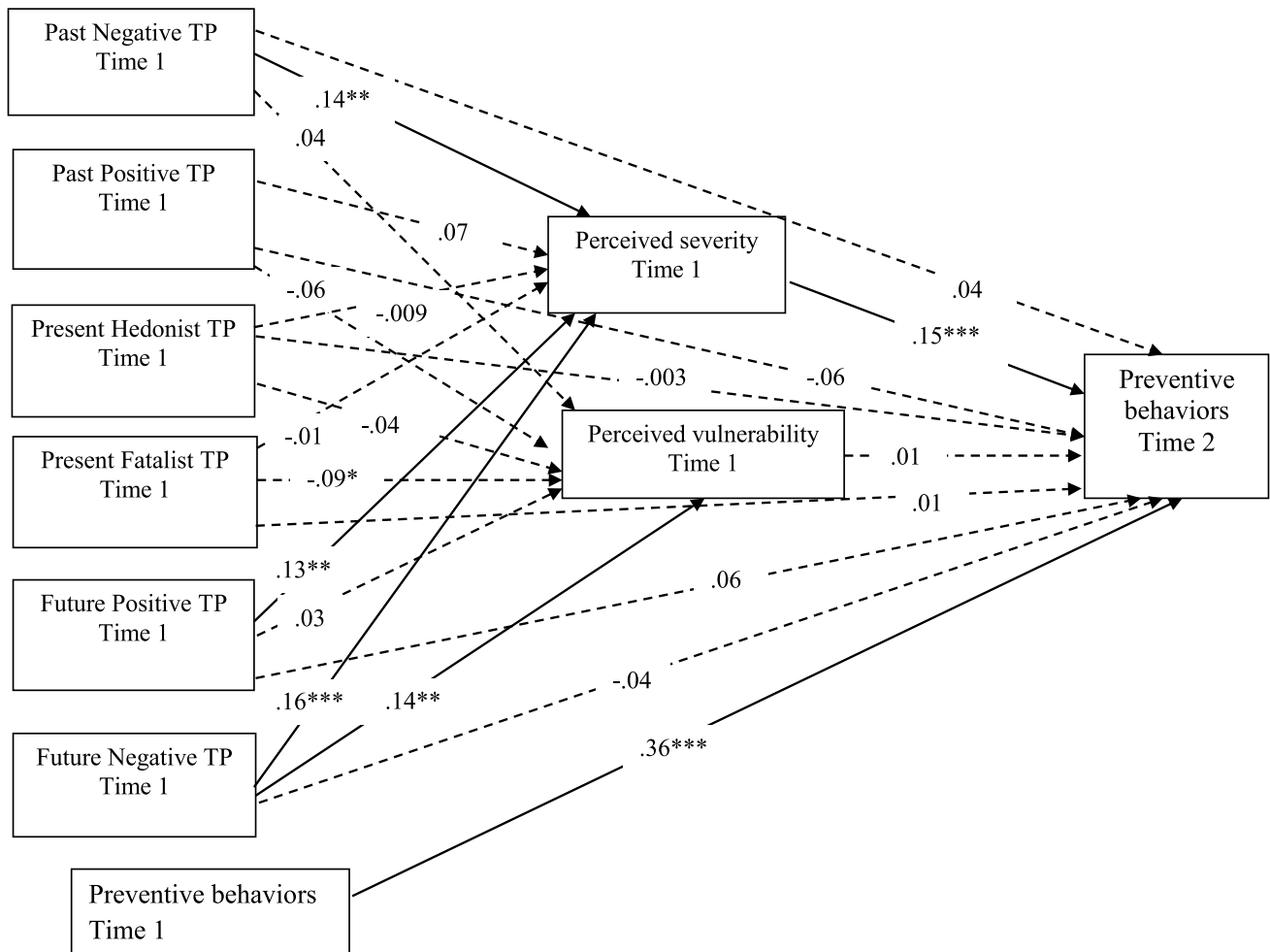

Fig. 1 Path analysis evaluating the mediation. Standardized path coefficients are reported. Non-significant paths are indicated with dotted lines. *$p < .05$; **$p < .01$; ***$p < .001$

Discussion

This study aimed to examine the relations among TPs, COVID-19 risk perception dimensions and adoption of preventive behaviors against COVID-19 over time. Furthermore, we aimed to explore whether COVID-19 risk perception mediates the longitudinal relations between TPs and preventive behaviors against COVID-19.

Our results indicated that the past negative, positive and negative future TPs are positively associated with preventive behaviors against COVID-19 at Time 1. These findings are consistent with prior evidence also showing positive relations of past negative and future positive TPs with health-protective behaviors (e.g., Daugherty & Brase, 2010; Griva et al., 2013, 2015; Henson et al., 2006). The novel finding about the positive link between future negative TP and preventive behaviors confirms the idea that people who worry more for future and anticipate adverse outcomes may adopt more preventive behaviors to avoid future detrimental consequences (Zimbardo & Boyd, 1999). When examining the longitudinal relations, the future positive TP at Time 1 was positively associated with preventive behaviors reported six months later at Time 2. This finding is consistent with prior cross-sectional findings documenting that high levels of future TP are related with increased engagement in health-protective behaviors (Daugherty & Brase, 2010; Griva et al., 2013, 2015). In addition, the novel findings of our study extend prior knowledge by providing evidence for a longitudinal relation between future positive TP and preventive behaviors against COVID-19 pandemic infectious disease.

Results of path analysis, when controlling for other variables (e.g., preventive behaviors at Time 1), showed that TPs did not directly predict the adoption of preventive behaviors over time. One possible explanation explored in this study may rely on the mediating role of more proximal predictors for preventive behaviors against COVID-19, like risk perception. In our study, path analysis showed that the participants with high levels of past negative and future TPs also reported high perceived severity of COVID-19. Further, future negative TP is positively related with the perceived vulnerability to the COVID-19 infection. These findings are in agreement with previous results about the relation between future TP and risk perception in health domain (Apostolidis et al., 2006; Griva et al., 2013). The results also expand prior scant findings about the relations between past and present TPs and different dimensions of risk perception (i.e., perceived severity and perceived vulnerability).

Further, our results show that the participants perceiving higher severity of COVID-19 infection at the end of the lock-down adopted more preventive behaviors in the following six months. The results are consistent with evidence from previous pandemics of influenza that found perceived disease severity to be positively related with adoption of preventive measures (Bish & Michie, 2010; Bults et al., 2011; de Zwart et al., 2010). Our findings confirm limited previous longitudinal studies showing positive associations between risk perception and engagement in recommended preventive behaviors during the COVID-19 pandemic (Fu et al., 2021; Qin et al., 2021).

In the current study, the perception of COVID-19 severity mediated the relation between TPs and adoption of preventive behaviors reported after six months. Specifically, high levels of past negative and future TPs (positive and negative) predicted high levels of perceived severity that further predicted the tendency to adopt preventive behaviors in the following six months. These findings are in accordance with the only one published study that also documented the role of risk perception in the relation between future TP and health-related behaviors (Griva et al., 2013). Moreover, our results also expand previous literature, by highlighting the fact that risk perception mediate the relation between different TPs (e.g., past negative, future negative) and the adoption of preventive behaviors. These findings emphasize that during the COVID-19 pandemic, perception of disease severity may have a crucial role in determining people to adopt and maintain the preventive behaviors advised by the authorities.

The findings may have important practical implications given that the effectiveness of prevention efforts during pandemics depends on the population's willingness to comply with recommended preventive behaviors (Van Bavel et al., 2020). The effective promotion of public health recommendations could be supported by strategies to encourage compliance with recommended preventive behaviors (WHO, 2020b; Van Bavel et al., 2020). These should focus more on emphasizing the potential severity of the disease if infected, as well as the effectiveness of the preventive behaviors in offering protection against the risk of COVID-19. Enhancing the perception of severity of the infection may be particularly effective in increasing preventive behaviors especially among people with a past negative orientation and among those who are predominantly future oriented. The results suggest that focusing attention on past negative experiences related to the current pandemic, as well as raising awareness of unwanted consequences of non-compliance and also of positive consequences of compliance with health protective behaviors may increase the tendency to adopt these behaviors.

Several limitations need to be discussed. First, we exclusively used self-report measures that may produce socially desirable responses and common method variance. In addition, some of the relations between TPs and preventive behaviors are weak indicating small effect sizes. Future

studies should continue to investigate the longitudinal relations among these constructs. A second limitation may be that we did not examine the participants' evaluation of the advantages and costs of the recommended behaviors for avoiding the transmission of the virus (e.g., barriers or difficulties to adopt the preventive behaviors). Social distancing measures may be perceived as difficult to follow and with high personal costs, but also beneficial for protecting oneself and loved ones against the disease. Future studies should examine whether these perceptions may affect people's compliance with preventive measures. Moreover, future research could explore different psychosocial factors (e.g., anxiety, (mis)trust in authorities, efficacy beliefs, or conspiracy beliefs) responsible for the (non)compliance with recommended behaviors, as well as their links with TPs.

The present study extends previous literature on psychological determinants of engaging in preventive behaviors against COVID-19 as a pandemic infectious disease. The results highlight the role of perceived severity of the disease on the longitudinal relations between past negative, positive and negative future TPs and the adoption of preventive behaviors. The findings suggest that relying on harsh lessons from the past while being cautious for future threats as well as maintaining optimism and positive expectations to overcome them, may be beneficial for taking preventive actions when perceiving and facing with the risk of a severe disease.

Data Availability The individual de-identified participant data in particular are shared from the corresponding author.

Code Availability Not applicable.

Declarations

Conflict of Interest The authors declare that they have no conflict of interest.

Ethics Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Consent to Participate Informed consent was obtained from all individual participants included in the study.

References

Ajzen, I., & Fishbein, M. (1980). *Understanding attitudes and predicting social behaviour*. Prentice Hall

Apostolidis, T., Fieulaine, N., Simonin, L., & Rolland, G. (2006). Cannabis use, time perspective and risk perception: Evidence of a moderating effect. *Psychology and Health, 21*(5), 571–592. https://doi.org/10.1080/14768320500422683

Bish, A., & Michie, S. (2010). Demographic and attitudinal determinants of protective behaviours during a pandemic: A review. *British Journal of Health Psychology, 15*(4), 797–824. https://doi.org/10.1348/135910710X485826

Boyd, J. N., & Zimbardo, P. G. (2005). Time perspective, health, and risk taking. In A. Strathman, & J. Joireman (Eds.), *Understanding behavior in the context of time: Theory, research, and application* (pp. 85–107). Lawrence Erlbaum Associates Publishers

Breakwell, G. M., Fino, E., & Jaspal, R. (2021). COVID-19 preventive behaviours in White British and Black, Asian and Minority Ethnic (BAME) people in the UK. *Journal of Health Psychology*. https://doi.org/10.1177/13591053211017208

Bults, M., Beaujean, D. J., de Zwart, O., Kok, G., van Empelen, P., van Steenbergen, J. E. … Voeten, H. A. (2011). Perceived risk, anxiety, and behavioural responses of the general public during the early phase of the Influenza A (H1N1) pandemic in the Netherlands: results of three consecutive online surveys. *BMC Public Health*, *11*(1), 2. https://doi.org/10.1186/1471-2458-11-2

Carelli, M. G., Wiberg, B., & Åström, E. (2015). Broadening the TP profile: Future negative time perspective. In M. Stolarki, N. Fieulaine, & W. van Beek (Eds.), *Time perspective theory; review, research and application* (pp. 87–97). Springer

Carelli, M. G., Wiberg, B., & Wiberg, M. (2011). Development and construct validation of the Swedish Zimbardo time perspective inventory. *European Journal of Psychological Assessment, 27*(4), 220–227. https://doi.org/10.1027/1015-5759/a000076

Chavarria, J., Allan, N. P., Moltisanti, A., & Taylor, J. (2015). The effects of present hedonistic time perspective and past negative time perspective on substance use consequences. *Drug and Alcohol Dependence, 152*, 39–46. https://doi.org/10.1016/j.drugalcdep.2015.04.027

Daugherty, J. R., & Brase, G. L. (2010). Taking time to be healthy: Predicting health behaviors with delay discounting and time perspective. *Personality and Individual Differences, 48*(2), 202–207. https://doi.org/10.1016/j.paid.2009.10.007

de Zwart, O., Veldhuijzen, I. K., Richardus, J. H., & Brug, J. (2010). Monitoring of risk perceptions and correlates of precautionary behaviour related to human avian influenza during 2006–2007 in the Netherlands: Results of seven consecutive surveys. *BMC Infectious Diseases, 10*(1), 114. https://doi.org/10.1186/1471-2334-10-114

Dryhurst, S., Schneider, C. R., Kerr, J., Freeman, A. L., Recchia, G., Van Der Bles, A. M. … van der Linden, S. (2020). Risk perceptions of COVID-19 around the world. *Journal of Risk Research*, 1–13. https://doi.org/10.1080/13669877.2020.1758193

Floyd, D. L., Prentice-Dunn, S., & Rogers, R. W. (2000). A meta-analysis of research on protection motivation theory. *Journal of Applied Social Psychology, 30*(2), 407–429. https://doi.org/10.1111/j.1559-1816.2000.tb02323.x

Fu, L., Wang, X., Deng, S., Zhang, Q., & Liu, Y. (2021). Informational support, risk perception, anti-pandemic motivation and behavior: A longitudinal study in China. *Current Psychology*. https://doi.org/10.1007/s12144-021-02071-1

Griva, F., Anagnostopoulos, F., & Potamianos, G. (2013). Time perspective and perceived risk as related to mammography screening. *Women & Health, 53*(8), 761–776. https://doi.org/10.1080/03630242.2013.836140

Griva, F., Tseferidi, S. I., & Anagnostopoulos, F. (2015). Time to get healthy: Associations of time perspective with perceived health status and health behaviors. *Psychology, Health & Medicine, 20*(1), 25–33. https://doi.org/10.1080/13548506.2014.913798

Hall, P. A., Fong, G. T., & Sansone, G. (2015). Time perspective as a predictor of healthy behaviors and disease-mediating states. In M. Stolarski, N. Fieulaine, & W. van Beek (Eds.), *Time perspective theory; review, research and application* (pp. 339–352). Springer

Hambleton, R. K. (2005). Issues, designs, and technical guidelines for adapting tests into multiple languages and cultures. In R. K. Hambleton, P. E. Merenda, & C. D. Spielberger (Eds.), *Adapting educational and psychological tests for cross-cultural assessment* (pp. 3–38). Lawrence Erlbaum

Hamilton, J. M., Kives, K. D., Micevski, V., & Grace, S. L. (2003). Time perspective and health-promoting behavior in a cardiac rehabilitation population. *Behavioral Medicine, 28*(4), 132–139. https://doi.org/10.1080/08964280309596051

Henson, J. M., Carey, M. P., Carey, K. B., & Maisto, S. A. (2006). Associations among health behaviors and time perspective in young adults: Model testing with boot-strapping replication. *Journal of Behavioral Medicine, 29*(2), 127–137. https://doi.org/10.1007/s10865-005-9027-2

Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal, 6*(1), 1–55. https://doi.org/10.1080/10705519909540118

Jackman, D. M., & MacPhee, D. (2017). Self-esteem and future orientation predict adolescents' risk engagement. *The Journal of Early Adolescence, 37*(3), 339–366. https://doi.org/10.1177/0272431615602756

Măirean, C., & Diaconu-Gherasim, L. R. (2019). Adolescents' subjective well-being: The role of adolescents' and mothers' time perspectives. *Time & Society, 28*(3), 1084–1104. https://doi.org/10.1177/0961463X17752282

Măirean, C., & Diaconu-Gherasim, L. R. (2021). Time perspective, risk perception on the road, and risky driving behavior. *Current Psychology*, 1–10. https://doi.org/10.1007/s12144-021-01921-2

McKay, M. T., Andretta, J. R., Magee, J., & Worrell, F. C. (2014). What do temporal profiles tell us about adolescent alcohol use? Results from a large sample in the United Kingdom. *Journal of Adolescence, 37*(8), 1319–1328. https://doi.org/10.1016/j.adolescence.2014.09.008

Milne, S., Sheeran, P., & Orbell, S. (2000). Prediction and intervention in health-related behavior: A meta-analytic review of protection motivation theory. *Journal of Applied Social Psychology, 30*(1), 106–143. https://doi.org/10.1111/j.1559-1816.2000.tb02308.x

Qin, H., Sanders, C., Prasetyo, Y., Syukron, M., & Prentice, E. (2021). Exploring the dynamic relationships between risk perception and behavior in response to the Coronavirus Disease 2019 (COVID-19) outbreak. *Social Science & Medicine, 285,* 114267. https://doi.org/10.1016/j.socscimed.2021.114267

Rogers, R. W. (1983). Cognitive and physiological processes in attitude change: A revised theory of protection motivation. In J. Cacioppo & R. Petty (Eds.), *Social Psychophysiology* (pp. 153–176). Guildford Press

Rosenstock, I. M. (1974). Historical origins of the health belief model. *Health Education Monographs, 2*(4), 328–335. https://doi.org/10.1177/109019817400200403

Sadique, M. Z., Edmunds, W. J., Smith, R. D., Meerding, W. J., de Zwart, O., Brug, J., & Beutels, P. (2007). Precautionary behavior in response to perceived threat of pandemic influenza. *Emerging Infectious Diseases, 13*(9), 1307. https://doi.org/10.3201/eid1309.070372

Tofighi, D., & MacKinnon, D. P. (2011). R Mediation: An R package for mediation analysis confidence intervals. *Behavior Research Methods, 43*(3), 692–700. https://doi.org/10.3758/s13428-01100 76-x

Van Bavel, J. J., Baicker, K., Boggio, P. S., Capraro, V., Cichocka, A., Cikara, M. … Willer, R. (2020). Using social and behavioural science to support COVID-19 pandemic response. *Nature Human Behaviour*, 1–12. https://doi.org/10.1038/s41562-020-0884-z

Wise, T., Zbozinek, T. D., Michelini, G., Hagan, C. C., & Mobbs, D. (2020). Changes in risk perception and self-reported protective behaviour during the first week of the COVID-19 pandemic in the United States. *Royal Society Open Science*. https://doi.org/10.1098/rsos.200742

World Health Organization (2020a). *Coronavirus Disease (COVID-19) advice for the public.* https://www.who.int/emergencies/diseases/novel-coronavirus-2019/advice-for-public. Accessed 09.05.2020

World Health Organization (2020b). *Overview of public health and social measures in the context of COVID-19.* https://www.who.int/publications/i/item/overview-of-public-health-and-social-measures-in-the-context-of-covid-19. *Accessed 25.07.2020*

Zimbardo, P. G., & Boyd, J. N. (1999). Putting time in perspective: A valid, reliable individual-differences metric. *Journal of Personality and Social Psychology, 77*(6), 1271–1288. https://doi.org/10.1037/0022-3514.77.6.1271

Zimbardo, P. G., & Boyd, J. N. (2015). Putting time in perspective: A valid, reliable individual-differences metric. In M. Stolarski, N. Fieulaine, & W. van Beek (Eds.), *Time perspective theory; Review, research and application: Essays in honor of Philip G. Zimbardo* (pp. 17–55). Springer International Publishing. https://doi.org/10.1007/978-3-319-07368-2_2