Original Article

Assessment of the Importance of COVID-19 Prevention Measures and Their Applicability in the Daily Life of Pregnant Women and Mothers of Infants

Ordinal Factor Analysis and Latent Class Analysis

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Abstract: The COVID-19 pandemic has posed significant challenges to (expectant) mothers of infants in terms of family health protection. To meet these challenges in a health literate manner, COVID-19 protective measures must be considered important and must also be implemented appropriately in everyday life. To this end, *N* = 343 (expectant) mothers of infants indicated (a) how important they considered 21 COVID-19 infection prevention measures, and (b) how well they succeeded in implementing them in their daily life (20 measures). We performed data analysis using exploratory factor analysis for ordinal data and latent class analysis. One- and two-dimensional models (CFI = .960/.978; SRMR = .053/.039) proved to appropriately explain maternal importance ratings. The items on successfully applying COVID-19 measures in daily life can be modeled by the 5 factors hygiene measures, contact with other people, public transportation, staying at home, and checking infection status (CFI = 0.977; SRMR = .036). Six latent classes can be distinguished. Despite the largest class (39 %), classes are characterized by selective or general applicability problems. Classes reporting problems in the applicability of the measures rated them as generally less important (η = .582). Assessing and modelling importance and applicability of COVID-19 prevention measures allows for a psychometrically sound description of subjective perceptions and behaviors that are crucial for health literate practice in maternal daily life.

Keywords: parental health literacy, COVID-19 infection prevention, latent trait modeling, latent class modelling

Einschätzung der Wichtigkeit von COVID-19-Präventionsmaßnahmen und deren Anwendbarkeit im Alltag durch Schwangere und Mütter von Kleinkindern. Strukturanalysen mittes Faktorenanalyse für ordinale Daten und Latent Class Analyse

Zusammenfassung: Die COVID-19-Pandemie stellt (werdende) Mütter von Kleinkindern vor besondere Herausforderungen. *N* = 343 (werdende) Mütter von Kleinkindern beurteilten, (a) als wie wichtig sie 21 COVID-19-Infektionsschutzmaßnahmen erachten und (b) wie gut es ihnen gelingt, diese im Alltag umzusetzen (20 Maßnahmen). Die Datenanalyse erfolgte mittels explorativer Faktorenanalyse für ordinale Daten und latenter Klassenanalyse. Ein ein- und ein zweidimensionales Modell (CFI = .960/.978; SRMR = .053/.039) erklären die Einschätzungen der Wichtigkeit angemessen. Die Items zur Umsetzung von COVID-19-Maßnahmen im Alltag können durch die 5 Faktoren Hygienemaßnahmen, Kontakt mit anderen Menschen, Nutzung öffentlicher Verkehrsmittel, Aufenthalt zu Hause und Kontrolle des Infektionsstatus modelliert werden (CFI = .977; SRMR = .036). Sechs latente Klassen können unterschieden werden. Bis auf die größte Klasse (39 %) zeichnen sich diese durch selektive oder generelle Probleme in der Umsetzbarkeit der Schutzmaßnahmen aus. Klassen, die Probleme in der Anwendbarkeit angeben, werten die Maßnahmen als weniger wichtig (η = .581). Die Erfassung und Modellierung der Wichtigkeit und Anwendbarkeit von COVID-19-Präventionsmaßnahmen ermöglicht eine psychometrisch fundierte Beschreibung von subjektiven Wahrnehmungen und Verhaltensweisen, die für eine gesundheitskompetente Alltagsgestaltung von Müttern bedeutsam sind.

Schlüsselwörter: elterliche Gesundheitskompetenz, Prävention von COVID-19-Infektionen, Item-Response-Theorie, Latent Trait-Modellierung, Latent Class-Modellierung

The COVID-19 pandemic has posed unique challenges to nearly every individual in both their personal lives and social environments (Saladino et al., 2020). Regarding society in general and the medical / healthcare system in particular, COVID-19 infection prevention has become an integral part of everyone's daily behavior. Hence, there is a constant need for trustworthy information concerning the hazardousness, transmissibility, and controllability of COVID-19 viral infections (Attema et al., 2021). A ubiquitous topic in the media was the effectiveness and importance of protective measures; adequate compliance became the responsibility of the individual and social referential systems (Aguinis et al., 2020).

Thus, with the emergence of COVID-19, people faced the challenge of dealing appropriately with an individually and socially highly relevant health threat, the characteristics of which were initially largely unknown. The hazards of the COVID-19 pandemic and the associated threat (Spring, 2020) posed unique challenges to pregnant women and mothers of infants. Protection from potential health threats is mandatory for pregnant women and mothers of infants under any circumstances. Besides the risks generally associated with infection in young adults, particular risks exist regarding the course of pregnancy, maternal health, and infant health (Chi et al., 2021; Elsaddig & Kalil, 2021; Field, 2021; Fry-Bowers, 2020; Wei et al., 2021). Moreover, this new and unknown infectious disease became associated with considerable health-related uncertainties and fears, especially concerning long-term sequelae for mother and child (Abuhammad, 2021; Jeličić et al., 2021). In the familial microsystem, moreover, lies a particularly high risk of reciprocal infection. Thus, strict isolation from infection hazards is necessary to protect all elements in the system. In the case of infection of the parents, one must expect a considerable and medium- to long-term impairment of parental contact and care behavior (e.g., breastfeeding) (de Vet et al., 2021). Further, because of physical distancing, children's leisure activities changed significantly, physical activity decreased, and schools and kindergartens were temporarily closed (Carroll et al., 2020). Thus, the prevention needs of siblings significantly affected family life and the stress levels of parents of infants (Lebow, 2020).

Family members are especially obliged to keep up to date with the COVID-19 pandemic and the corresponding health-protective behaviors, to evaluate and reflect on them considering their own life situation, and to implement the recommended protective measures in the best possible way (Wong et al., 2020). The skills and abilities required to validly process and use health-related information form the core elements of health literacy (HL; Nutbeam, 2000; Soellner et al., 2010). According to Sørensen et al. (2012), health-literate people can appropriately access, understand, appraise, and apply helpful and beneficial health-related information.

For the HL facet access to COVID-19-related information, broadcast media as well as newspapers, social media, messaging apps, surrounding people, and healthcare professionals were identified as the most important sources (Ebrahim et al., 2020). Regarding specific information needs related to COVID-19, family-related information on acute measures in daily life (e.g., quarantine, contacts in daily life) proved to be exceptionally high. Schulz et al. (2022) addresses the HL facet understanding COVID-19-related information by (expectant) mothers of infants in detail.

Concerning the COVID-19-specific HL-facets appraise and apply, the attitudes toward COVID-19 vaccination were the main focus of investigation (Wong et al., 2020), while everyday protective measures (e.g., hygiene behaviors, physical distancing) (Gibson et al., 2021) received little attention. Wong et al.'s (2020) study confirmed the usefulness of the health belief model (HBM; Becker & Maimann, 1975), which accounts for perceived susceptibility to and perceived severity of a COVID-19 infection, perceived benefits of and barriers to a COVID-19 vaccination, and prompts to action. Gibson et al. (2021) examined the constructs of the theory of planned behavior (TPB; Ajzen, 1985) regarding the behavioral intention of physical distancing during the COVID-19 pandemic, focusing on the intention-behavior gap. Although physical distancing is officially supported, in everyday life it is practiced very differently. A relationship between attitudes, subjective norms, and perceived behavioral control with the intention to physically distance oneself emerged. Intention was most strongly associated with protective behavior.

Issues of HL in the COVID-19 pandemic are characterized mainly by the fact that (health) policy and law essentially prescribe preventive measures, but their appropriate application is demanded of the individual (Talic et al., 2021). No less than the individual's responsibility for their own health protection, every individual has a duty of solidarity to take responsibility for the health of their fellow humans and to take the medical care system into account in their everyday actions, implementing them appropriately (Abel & McQueen, 2020).

This study examines the importance appraisal of the recommended COVID-19 protective measures. According to Sørensen et al. (2012, p. 9), health-literate appraisal is defined as "the ability to interpret, filter, judge, and evaluate" the retrieved health information. These information-processing steps and underlying skills are considered crucial for appraising the importance of COVID-19 protective measures.

In addition, the study investigates how well (expectant) mothers manage to implement the COVID-19 protective

measures in daily life. In terms of Sørensen et al.'s (2012) model, this information is associated with the HL facet apply, which is defined as "the ability to communicate and use the information to make a decision to maintain and improve health" (p. 9). Health-literate application, thus, is evident in whether one succeeds in exhibiting behavior that results in desirable health consequences – in this case, minimizing the risk of COVID-19 infections. In this sense, the appropriate appraisal of the importance of COVID-19 protective measures and the proper application in daily life can be considered indicative of COVID-19-related HL of (expectant) mothers of infants.

Study Goal and Research Questions

This study focuses on two central aspects associated with the HL facets importance/appraise ("How important do you think it is that you adhere to COVID-19 protective measures?") and applicability/apply ("How well do you succeed in implementing COVID-19 protective measures in daily life?").

We investigated the following research questions:

1. Which latent dimensions determine the (expectant) mothers' assessments of (a) the importance of adhering to COVID-19 prevention measures and (b) their appropriate applicability in daily life?
2. What are the psychometric properties of the individual items (reflecting single COVID-19 prevention measures) and scales identified?
3. Are the scales assessing the importance and applicability of COVID-19 measures associated with each other and with other maternal characteristics?

Methods

Study Design

We conducted the study as part of the DFG research group "Health Literacy in Early Childhood Allergy Prevention: Parental Competencies and Public Health Context in a Shifting Evidence Landscape" [FOR 2959; GZ: AP 235/3–1]. The study of HL regarding the prevention of COVID-19 infections was carried out as a DFG-funded amendment to the subproject "Structural Modelling and Assessment of Health Literacy in Allergy Prevention of New Parents" [GZ: WI-3210/7–1]. The German Psychological Society gave a positive ethical vote for this amendment (registration number: MAW 112018). We integrated the COVID-19 survey items into the survey design according to the preregistration of the baseline study on parental early-childhood allergy prevention published at the Leibniz Institute of Psychology (ZPID; Wirtz et al., 2021).

We conducted the cross-sectional data collection on maternal allergy-, health- and COVID-19-related characteristics was conducted from July 2021 to February 2022 using an online questionnaire. The data collection was divided into three parts to be completed in approximately equal time (about 45 minutes). The sample was recruited using a variety of recruitment approaches (e.g., nationwide contact with healthcare professionals or daycare providers, cooperation with a health insurance company, pediatricians, and gynecologists). An expense allowance of EUR 30 was paid for full participation in the survey. Schulz et al. (2022) report on the acquisition of the study sample in greater detail.

Instruments and Variables

First, we identified the key measures recommended for protection against COVID-19 infections by public sources responsible for communicating national standards on current recommendations (e.g., Robert-Koch-Institute: www.rki.de; Federal Ministry of Health: www.zusammengegencorona.de; Health Portal Austria: www.gesundheit.gv.at). In addition, we examined informational materials designed to inform the adult population about COVID-19 in general (Schulz et al., 2022). We then conducted accompanying, guided interviews with parents of infants aged 0–3 years (n = 5, average duration: 36 min, range: 23–47 min), reflecting on everyday situations in which they applied protective measures. The parents were encouraged to specify behaviors they considered negligent or excessive in terms of COVID-19 prevention in the daily life of young families. We identified a total of 30 protective measures whose relevance was assessed by experts from the field of public health, allergology, and epidemiology (e.g., members of the national task force COVID-19). Pretested the remaining 21 items (n = 4 parents) to check their comprehensibility and feasibility. The wording of the entire original assessment can be found in the Electronic Supplement Materials (ESM 1).

The assessment instruction reads as follows: "We would like to ask you to recall the situation at the beginning of 2021. At that time, no vaccination against COVID-19 was available for the general population, and the infection numbers were high. How would you have answered the questions back then, in January or February 2021?" The Likert-scaled response format for importance of adhering to COVID-19 was 1 = *extremely important,* 2 = *important*, 3 = *rather important*, 4 = *rather unimportant*, 5 = *unimportant,* 6 = *extremely unimportant*. The rating responses

on succeeding in implementing COVID-19 measures were formulated as 1 = *very good*, 2 = *good*, 3 = *rather good*, 4 = *rather poor*, 5 = *poor*, 6 = *very poor*. We considered retrospective assessment to be appropriate, because any appraisal of COVID-19 prevention would have been based on a systematically different individual assessment background because of the onset of widespread adult vaccination. A standardized time reference was considered to be most appropriate to avoid difficulties in comparing the assessment of protective measures based on whether vaccines have already been supplied or not. Moreover, the survey was conducted from early summer to winter, so that seasonal risks of infection and, in particular, legal changes in the protective measures had to be assumed to have influenced assessment reference. COVID-19 vaccination as a preventive measure was included only in the importance/appraise assessment, as vaccination is a measure that does not belong to the typical actions that take place in daily situations or the organization of daily life routines.

Statistical Analysis

To analyze the dimensional structure, we carried out ordinal exploratory factor analysis (EFA) using the weighted least squares mean variance (WLSMV) algorithm (Flora & Curran, 2004). WLSMV estimation assumes that the ordinally measured data result from a latent multivariate normal distribution. All estimates thus refer to the most plausible latent model structure underlying the manifest measured values, which allows one to avoid scaling artifacts (e.g., because of floor and ceiling effects; Ulrich & Wirtz, 2004). The EFA determines the model parameters that provide the best fit between (a) the model-based and (b) the empirical item associations (variance-covariance matrix). Because the χ^2-test of the model-fit value has proven to be overly sensitive with increasing sample size, our model testing focused on alternative measures that consider the empirical relevance of the differences (Schermelleh-Engel, Moosbrugger & Müller, 2003). The confirmatory fit index (CFI) and Tucker-Lewis index (TLI) indicate an acceptable model fit if their values exceed .95 (good model fit: CFI, TLI > .97). Using the WLSMV algorithm, the standardized root mean square residual (SRMR; good fit: < .05; acceptable mode fit < .05) proved to be a more valid fit indicator than RMSEA, especially for large samples (Shi et al., 2020). At the local item level, it has to be ensured that each item is sufficiently closely associated with the factor to which it is assigned: factor loadings > .63 or indicator reliabilities > .40.

Latent class analysis (LCA) assumes that (a) each respondent belongs to one of k nominal latent classes, and (b) that each of the k latent classes is characterized by a typical response behavior (McCutcheon, 1987). Members of the same class are assumed to have identical expected response profiles. In the present data set, we examined 20 6-level items, so that the contingency table to be analyzed is defined by 20^6 possible cells. With N = 382 data sets, a cell count of k = 2 is already highly improbable (problem of sparse tables). The combination of the Newton-Raphson (fast but inaccurate search) and the expectation-maximization (EM) algorithm (accurate but slow search) implemented in the MPlus 8.3 software (Muthén & Muthén, 2017) allows identification of stable and valid solutions in the case of (quasi-) interval data (Vermunt, 2008). The model with the lowest AIC or BIC value is considered optimal. In the case of multicategory response scales, the BIC is the preferred measure, as it tends to avoid overparametrization (Lipovetsky, 2021). The entropy indicates the quality of the assignment of the respondents to the identified classes: The closer the value of entropy is to 1, the higher the accuracy of the assignment (e.g., entropy > .84 implies correct assignments > 90%; Wang et al., 2017).

Results

Sample Characteristics

Mothers of infants aged 0–3 years (n = 281, mean age of infants: 16.1 months) and pregnant women (n = 62, mean week of gestation: 24.8) constituted the total sample of N = 343. The mean age of the women was 32.2 years (range 17 to 50 years). With a proportion of 53% of (expectant) mothers with a higher education entrance qualification, the sample accurately reflects the situation regarding school education in the overall female population in Germany in the age range 25–44 years (Bundesinstitut für Bevölkerungsforschung, 2021). According to the McArthur Scale, socioeconomic status is slightly higher in the sample (5.87) than in the reference standard sample of women aged 18–44 years (5.45; Hoebel et al., 2015). Sample characteristics are shown in detail in ESM 2.

Structural Analysis in the Domain "Importance to Comply with COVID-19 Protection Measures"

For the 21 items of the domain importance to comply with COVID-19 protection measures, the EFA yielded satisfactory to good model fit values for a single factor solution (TLI = .956; CFI = .960; SRMR = .054; ESM 3). The first

Table 1. Descriptive item and scale statistics and factor loadings λ_i of the 1- and 2-DIM EFA for the items on "importance of COVID-19 protection measures."

		Importance of COVID-19 protection measures							
			1-DIM			2-DIM			
		M (*SD*)	$r_{it,total}$ [a)]	λ_i	$r_{it,F1}$ [b)]	$r_{it,F2}$	$\lambda_{i,F1}$	$\lambda_{i,F2}$	$r_{I,A}$ [c)]
Wash hands[d)]		1.81 (0.99)	.550	**.661**	.599		**.895**	(−.173)	.638
Use mouth-nose protection		2.19 (1.43)	.780	**.852**	.810		**.780**	(.142)	.538
Keep minimum distance 1.5 m		2.20 (1.20)	.764	**.827**	.756		**.665**	(.223)	.393
Inform on legal measures		2.25 (1.15)	.598	**.633**	.610		**.501**	(.179)	.348
Test before visiting people at risk		2.30 (1.46)	.642	**.696**	.617		**.403**	.339	.755
Avoid travel		2.48 (1.50)	.753	**.806**		.742	(.247)	**.600**	.503
Contact only people adhering to measures		2.61 (1.53)	.843	**.878**		.819	(.248)	**.674**	.642
Meet only with the same people		2.62 (1.40)	.777	**.859**		.782	(−.002)	**.879**	.595
Use online communication		2.65 (1.52)	.651	**.714**		.676	(−.151)	**.876**	.638
Use disinfectant		2.69 (1.49)	.664	**.711**	.674		**.776**	(−.006)	.779
Avoid public transportation		2.74 (1.65)	.691	**.759**		.679	(.228)	**.570**	.429
Meet as few people as possible		2.80 (1.45)	.825	**.898**		.831	(.027)	**.893**	.639
Ventilate regularly		2.82 (1.34)	.688	**.735**	.697		**.703**	(.092)	.618
Avoid shopping at peak times		2.87 (1.52)	.762	**.802**		.771	(.160)	**.676**	.578
Work in the home office		2.94 (1.75)	.681	**.738**		.715	(−.156)	**.902**	.570
Vaccinate as soon as possible		2.97 (1.85)	.690	**.732**	.662		**.446**	.335	
Avoid public places		2.97 (1.54)	.806	**.870**		.810	(.170)	**.735**	.547
Use online shopping		3.05 (1.60)	.477	**.533**		.490	(−.025)	**.575**	.680
Avoid childcare by grandparents / friends		3.08 (1.55)	.613	**.652**		.586	.340	**.354**	.560
Use mouth-nose protection at spontaneous contacts		3.89 (1.48)	.637	**.698**	.635		**.583**	.168	.725
Use Corona app		4.15 (1.69)	.615	**.695**		.609	(.126)	**.600**	.787
Reliability	McDonald's ω		.948		.902	.933			
	Cronbach's α		.947		.898	.932			

Note. **Bold** = main loadings. [a)]r_{it} = corrected item-total correlation, [b)]F_i = factor i, [c)]correlation of importance (= I) and ability (= A) ratings; all values significant ($p < .001$), [d)]response formats: 1 = *very important* to 6 = *very unimportant*.

factor explains a high proportion of the data information, 58% (internal consistency: ω = .948; α = .947). Table 1 shows the items in ascending order according to their average rated importance. "Wash hands" (*M* = 1.81) was rated the most important item, followed by "Using mouth-nose protection" (*M* = 2.19). "Using mouth-nose protection at spontaneous contacts" (*M* = 3.89) and "Using the Corona app" (*M* = 4.15) finish the ranking. The appropriateness of the one-factor solution is also reflected in the satisfactory to high loadings of the items, which mostly exceeded the usual cut-off value (λ_i = 0.5) considerably. Hence, 21 items are sufficiently to highly associated with the underlying latent trait "importance to comply with COVID-19 protection measures." Thus, (expectant) mothers differ only in their general assessment of importance, reflected similarly in all items.

Although the unidimensional structure assumption exhibits a good data fit, the two-dimensional solution yields noticeably better global model fit values: CFI = .978, TLI = .972; SRMR = .039). The eigenvalue of the second factor (1.21) exceeds the critical value of 1 (according to the Kaiser-Gutmann criterion, Table 1). Hence a two-dimensional structure that distinguishes the subconstructs importance of adherence to hygiene rules and importance of practicing physical distancing is considered as an alternative solution in the following. However, it should be noted that the two constructs are highly correlated (*r* = .787), and that for three items (i.e., test before visiting people at risk, vaccinate as soon as possible, avoid childcare by grandparents / friends), there is no clear factor assignment because of weak loadings or double loadings.

Structural Analysis in the Domain "Applicability of COVID-19 Protection Measures"

For the 20 items on applying COVID-19 protective measures in daily life, five latent dimensions have to be assumed according to both the global fit measures (CFI = .977, TLI = .957, SRMR = .036; ESM 3) and the Kaiser-Gutmann criterion (eigenvalues: 6.96, 1.61, 1.42, 1.29, 1.09, 0.89, ...). The five factors (GEOMIN-rotated) apply hygiene measures, avoid contact with other people, avoid public transportation, stay at home, and check infection status account for 62% of the data variance. In contrast to the importance/appraise domain, the assessment of applying COVID-19 prevention measures is characterized by a pronounced multidimensional structure. Table 2 shows the loadings of the items for the respective main factor and for the second-highest loading. The fact that the factor structure must be regarded as rather weakly explanatory is reflected in weak loadings ($\lambda_i < .5$) for eight measures and the critical double loadings (difference in loadings < −.2) for six measures. The internal consistencies of the scales are insufficient to moderate (α = .562–.777). Thus, to identify profiles that reliably describe the applicability of the individual COVID-19 prevention measures, we performed an LCA at the level of the 20 individual measures (LCA model fits see ESM 4). The BIC indicates an optimal data fit 21,707.51 for the six-class solution (Burnham & Anderson, 2002). The typical response behaviors of the identified classes can be characterized as follows (Table 2):

- Class 1 (39%): Generally good applicability of the COVID-19 prevention measures.
- Class 2 (9%): Considerably limited applicability of COVID-19 prevention measures despite avoiding public transportation and travel (factor 3) as well as meeting only with the same people.
- Class 3 (29%): Moderately limited applicability of COVID-19 prevention measures despite avoiding contact with other people (factor 2) as well as avoiding public transportation and travel (factor 3), washing hands, and using online communication.
- Class 4 (15%): Moderately limited applicability of COVID-19 prevention measures in general. Considerably limited: avoidance of contact with other people (factor 2), avoidance of public places, use of mouth-nose protection at spontaneous contacts, staying at home (factor 4), and checking infection status (factor 5).
- Class 5 (6%): Considerable to severe limitations in implementing all COVID-19 prevention measures despite using mouth-nose protection.
- Class 6 (1%): Severe limitations for any COVID-19 prevention measure.

The six classes differ most (interaction Class x Item: η > .65) for the appropriate applicability of the first three measures of factor 2 – avoid contact with other people and the item avoid public places.

Interrelations Between Importance and Applicability of the COVID-19 Protective Measures and with Sociodemographic Variables

Maternal ratings of the importance of COVID-19 prevention measures and the ability to adhere to them in everyday life are highly associated. At the level of single measures, the correlations vary from $r = .348$ (inform on legal measures) to $r = .787$ (using Corona app) (Table 1, last column). The identified latent classes for succeeding to apply the measures in daily life differ systematically concerning the importance scores: $\eta_{total} = .562$, $\eta_{hygiene} = .527$, $\eta_{distance} = .548$; Table 2). While Class 1, which can best apply the measures, also indicates high subjectively assessed importance ($\bar{x}_{total} = 1.96$), there are substantial higher limitations in the applicability and reduced compliance with the measures in everyday life, especially in Classes 5 and 6 ($\bar{x}_{total, 5\&6} = 4.60$).

Socioeconomic state and education (university entrance qualification) are significantly correlated with the importance ratings ($r = -.174$ to $-.204$) and the classes in the domain applicability/apply (η = .206, .191). The age of mothers and child as well as pregnancy are not associated with both domains.

Discussion

The assessment of the importance of adherence with COVID-19 protective measures by (expectant) mothers proved to be essentially psychometrically homogeneous. The good fit of the unidimensional model suggests that a general attitude of (expectant) mothers is similarly reflected in all 21 individual measures. The data structure can be modelled adequately using the individual response level of the respondents and the significantly varying item-specific assessment levels – from $M_{\text{Washing hands}} = 1.81 \approx$ "important" to $M_{\text{Using the Corona app}} = 4.15 \approx$ "rather unimportant." The results for the two highly correlated factors in the alternatively calculated two-dimensional model are virtually identical. If we consider the assessment as indicative for the HL-Facet appraise, this suggests that (expectant) mothers have formed a general judgment about the importance of COVID-19 protection (individual level of assessment of importance) and also

Table 2. Results of exploratory factor analysis (EFA; 60% variance explained; GEOMIN-rotated) and latent class analysis (LCA; 6 classes) of the 20 items in the domain "applying COVID-19 prevention measures."

	Applying COVID-19 prevention measures										
	EFA		LCA[b]							Class x item[c]	
	Factor loadings		Total	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6	$F_{5.233}$	η
	Main factor	Second highest [a]	*N* = 343	*N* = 135 39%	*N* = 32 9%	*N* = 100 29%	*N* = 51 15%	*N* = 21 6%	*N* = 4 1%	5 classes	5 classes
Factor 1 – Apply hygiene measures (SSL[d] = 2.51; ω [e]= .736/α = .731)											
Wash hands	.668	.290 [F3]	1.76	1.27	**2.56**	1.94	1.75	2.05	5.75	27.14***	.493
Ventilate regularly	.646	.172 [F4]	3.13	2.29	4.72	**3.44**	**3.20**	3.95	5.75	47.06***	.598
Use disinfectant	.566	.337 [F3]	2.44	1.67	3.87	**2.64**	2.35	3.76	6.00	37.09***	.552
Use mouth-nose protection at spontaneous contacts	.448	.227 [F2]	3.73	2.70	5.06	4.11	4.02	5.33	6.00	41.73***	.575
Keep minimum distance 1.5 m	.426	.369 [F4]	2.61	2.04	**3.50**	**2.80**	**2.61**	**3.48**	5.25	32.63***	.528
Factor 2 – Avoid contact with other people (SSL = 2.16; ω = .781/α = .777)											
Meet as few people as possible	.921	.077 [F5]	2.47	1.71	**2.97**	2.13	3.63	4.71	5.75	111.96***	.755
Meet only with the same people	.673	.136 [F3]	2.18	1.50	2.16	1.80	**3.41**	4.62	6.00	135.77***	.785
Contact only people adhering to measures	.360	.207 [F5]	2.56	1.73	4.31	2.24	**3.00**	5.00	6.00	17.54***	.783
Avoid childcare by grandparents/friends	.356	.309 [F5]	2.73	2.11	3.53	**2.64**	**3.24**	4.19	5.50	16.55***	.405
Factor 3 – Avoid public transportation & travel (SSL = 1.36; ω = .738/α = .728)											
Avoid public transportation	.747	.065 [F2]	1.73	1.34	1.69	1.42	2.43	**3.29**	6.00	28.89***	.505
Avoid travel	.611	.108 [F2]	1.73	1.31	1.56	1.65	1.98	4.10	3.75	40.52***	.569
Avoid public places	.517	.463 [F2]	1.98	1.30	2.13	1.78	**2.92**	4.10	5.50	79.40***	.696
Use mouth-nose protection	.388	.289 [F1]	1.71	1.30	2.22	1.60	1.78	**3.43**	3.75	41.47***	.574
Factor 4 – Stay at home (SSL =1.53; ω = .680/α = .666)											
Work in the home office	.729	.048 [F2]	2.95	2.05	3.94	**3.09**	3.61	4.33	6.00	17.54***	.415
Use online communication	.608	.121 [F5]	2.13	1.45	**3.09**	2.12	**2.73**	**3.24**	4.50	25.57***	.482
Avoid shopping at peak times	.472	.182 [F2]	2.65	1.85	**2.78**	**2.62**	3.78	4.43	5.50	37.31***	.636
Use online shopping	.406	.264 [F3]	2.34	1.64	**3.47**	**2.59**	2.31	3.86	**2.75**	23.45***	.466
Factor 5 – Check infection status (SSL =1.14; ω = .601/α = .562)											
Test before visiting people at risk	.841	.052 [F2]	2.46	1.64	3.97	**2.67**	**2.57**	3.76	4.75	29.54***	.509
Use Corona app	.459	.251 [F4]	3.74	2.71	5.03	4.00	4.45	5.05	6.00	23.25***	.465
Inform on legal measures	.285	.253 [F1]	2.26	1.80	**3.06**	**2.56**	2.18	**2.67**	**2.75**	15.51***	.394
Importance of COVID-19 measures											
Total score				1.96	3.89	2.72	3.38	4.60		117.57***	.582
Hygiene score				1.83	3.74	2.58	2.94	4 .23		94.13***	.527
Physical distance score				2.07	4.00	2.83	3.68	4.88		102.53***	.548

Table 2. Results of exploratory factor analysis (EFA; 60 % variance explained; GEOMIN-rotated) and latent class analysis (LCA; 6 classes) of the 20 items in the domain "applying COVID-19 prevention measures." (Continued)

	Applying COVID-19 prevention measures								
		LCA[b)]						Class x item[c)]	
	Total *N* = 343	Class 1 *N* = 135 39 %	Class 2 *N* = 32 9 %	Class 3 *N* = 100 29%	Class 4 *N* = 51 15 %	Class 5 *N* = 21 6 %	Class 6 *N* = 4 1 %	$F_{5.233}$ 5 classes	η 5 classes
Sociodemographic characteristics									
	Correlation: Importance total / hygiene / distance								
Age	(−.084) / (−.084) / (−.078)	32.36	31.75	32.96	30.57	31.56		2.43*	.167
Socioeconomic state – McArthur Scale[f)]	−.193*** / −.204*** / −.174***	6.18	5.75	5.79	5.59	5.20		3.75**	.206
% university entrance level	−.204*** / −.194*** / −.203***	54.1	40.6	48.0	29.4	28.0		$12.97^{**}_{df=4}$[g)]	.191
Pregnant (*N* = 62; 18 %)	(.021) / .001) / .022)	19.3	28.1	16.0	15.7	12.0		$(3.42)_{df=4}$[g)]	
Age of child (> 12 months; *N* = 78; 23 %)	(.022) / (.061) / (−.007)	56.9	47.8	57.1	58.1	54.5		$(0.79)_{df=4}$[g)]	

Note. [a)]According factor in brackets, [b)]Class-specific item mean values; **bold** = mean values above 2.5; underlined = mean values above 3.5; 1 = *very good* to 6 = *very poor*; [c)]ANOVA (groups = classes), *F* = test statistics, *η* = effect size, *p* < .001 for all values. To ensure sufficient group sizes for variance-analytic calculations, we grouped classes 5 and 6 together based on their similar response profiles ($N_{aggregated}$ = 21 + 4); [d)]Sum of squared loadings (GEOMIN rotated); [e)]McDonald's *ω*/Cronbach's *α*; [f)]McArthur-Scale: 1 = *low* to 10 = *high*; [g)]χ^2-test of 2 x 5 tables. ***$p < .001$, **$p < .01$; *$p < .05$.

assess the importance of the individual measures (measure-specific level of importance) in a graded manner (Abuhammad, 2021; Ebrahim et al., 2020). As a research desideratum, it seems interesting to clarify to what extent a distinction can be made between individual protection-related attitudes and the outcome of health-literate information processing. Especially regarding vaccinations, the question arises to what extent either preconceived attitudes or measure-specific information determine information processing and judgment (Cascini et al., 2021).

A much more faceted data structure emerges for the successful implementation of COVID-19 protection measures. Even the assumption of five underlying individual dimensions does not provide a satisfactory informational explanation at the level of the individual measures in some cases. An exploratory LCA identifies that 40 % of (expectant) mothers can implement the 20 measures *very good* to *good* in everyday life. However, members of the remaining classes are characterized by selectively different problem areas in applicability. The typology determined by the LCA is a promising diagnostic starting point for systematically differentiating both the behavior of (expectant) mothers and generally areas of action in which protection against COVID-19 infections is more or less successful in everyday life.

Whether (expectant) mothers can actually implement appropriate COVID-19 infection preventive behavior in daily living must consider both the subjectively perceived importance of the measures as well as barriers and support factors (Gibson et al., 2021; Lebow, 2020). The high correlation between the assessment of importance (domain importance / appraise) and the ability to implement it (domain applicability / apply; item level: $r = .348 – .787$; class level: $\eta = .582$) suggests the relevance of the successive modeling "importance / appraise → applicability / apply" postulated by Sørensen et al. (2012). Accordingly, the subjective importance appraisal should largely determine successful application. The usually highly relevant intention-behavior gap seems to be low in these measures, which are mostly routinized and usually implemented daily (Gibson et al., 2021). In addition, it would be interesting to consider the possible influence of perceived social control (Aguinis et al., 2020).

To examine the correlation and the possible causal determinacy of the HL-facet importance / appraise by the HL-facet applicability / apply more closely, we should consider further health psychology process models. In particular, the health action process approach (HAPA; Schwarzer, 1992) emphasizes the process leading up to intention formation and the importance of barriers that may occur in the intentional or actional phase. As in the HL model by Soellner et al. (2010), we must regard constructs such as the experience of threat or coping self-

efficacy or recovery self-efficacy. Not only an in-depth understanding of these health-psychological processes and HL-related structural assumptions may be the goal here. In addition, we should clarify the extent to which the acute and immediate threat to health posed by COVID-19 moderates these processes compared with other prevention tasks, such as early childhood allergy prevention (Dresch et al., 2021).

The high correlation between the importance/appraise and the applicability/apply assessment, despite the different construct structures (unidimensional vs. typological) that prevail in both domains, suggests that moderating features may be considerably influential. A modeling approach that shows how importance is "refracted" by moderating characteristics (e.g., social and partnership support, health risk) in the actual daily actions of (expectant) mothers could significantly enrich our understanding of health-literate information processing and action regulation (Dixon et al., 2021; Thoma et al., 2021). In addition, an alternative approach could be that the assessments of (expectant) mothers in the domain applicability/apply should be better modeled in terms of a formative rather than reflective construct understanding, since the practicability of the individual measures causally determines the overall picture of the applicability of the measures (Diamantopoulos & Winklhofer, 2001). Note that the data collection for the two facets importance/appraise and applicability/apply took place on the same questionnaire survey, which may have caused self-report-related consistency effects and cross-facet social desirability to contribute to an overestimation of the correlations between the PHL-facets. Furthermore, we must critically consider using self-assessments to measure competencies, as biasing effects such as self-serving bias, social desirability, Halo effects, or acquiescence may become influential (Dufner et al., 2019). There is also a risk of subjective overestimation because of subjective problem awareness. If a person considers the risk of COVID-19 infection to be very high and the protective measures to be very important, they may also apply a stricter standard when evaluating the success of the application (Dresch et al., 2021). The mothers were instructed to provide retrospective assessments for a time (February 2021) in which the risk of infection was high and vaccination was not yet possible to avoid the influence of varying hazard perceptions because of vaccination and seasonal settings. However, memory bias may have influenced the responses.

On the other hand, other results based on our data collection, which includes performance assessments (Schulz et al., 2022), show valid results, indicating a high motivation and seriousness of the participants in answering the survey. Nevertheless, any online survey carries a higher risk of uncontrolled interferences being less well avoided, especially in the everyday life of parents with infants.

A critically small class (4 mothers, 1%) was identified in the LCA. Class sizes below 5% are considered by LCA to indicate estimation problems. However, note here that this small class consistently showed up as a single class in the 4–8 class solutions calculated. Four mothers consistently indicated poor applicability of the measures to an extreme degree. Rather than excluding these as outliers from the study sample to meet the criteria for an LCA solutions, it seemed more valid to us to accept these four mothers as a stably identifiable subgroup.

Even though the sample cannot be considered representative, there is probably no exceptional interest in COVID-19 and positive attitudes toward the measures among the participants, since the main topic of the survey used for recruitment was early childhood allergy prevention.

In summary, the survey of assessments of the importance and applicability of COVID-19 protective measures allowed a meaningful recording of the views of (expectant) mothers during a pandemic. Regarding the HL facet importance/appraise, a checklist is now available that unidimensionally and reliably maps maternal appraisals of the importance of taking measures to protect against COVID-19 infection in daily life. The checklist for the HL-facet applicability/apply facet allows the identification of characteristic profiles. Five of the six profiles reflect typical problem constellations of mothers in implementing COVID-19 protective measures in everyday life. Except for the item "Avoid childcare by grandparents/friends," the items are generic and not parent-specific. Therefore, the application and analysis of the remaining items in other populations also appear reasonable. The use of these instruments may help us to examine and develop both HL models (Nutbeam, 2000; Soellner et al., 2010; Sørensen et al., 2012) and behavioral health models (e.g., HBM, Becker & Maimann, 1975; TPB, Ajzen, 1985; HAPA, Schwarzer, 1992) in the area of COVID-19 protection in a diagnostically more sound and reasoned manner.

Electronic Supplementary Material

The electronic supplementary material is available with the online version of the article at https://doi.org/10.1026/0012-1924/a000293

ESM 1. Original assessment of the HL-facets Appraise (p. 1–2) and Apply (p. 3–4)

ESM 2. Study sample characteristics (N = 343)

ESM 3. Exploratory factor analysis

ESM 4. LCA model fits assuming 1 to 10 latent classes for the 20 items

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