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Hygiene and Social Distancing as Distinct Public Health Related Behaviours Among University Students During the COVID-19 Pandemic

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Supplementary Materials: Data, Materials [see [Index of Supplementary Materials](#)]



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Abstract

Prevailing research on individuals' compliance with public health related behaviours during the COVID-19 pandemic tends to study composite measures of multiple types of behaviours, without distinguishing between different types of behaviours. However, measures taken by governments involve adjustments concerning a range of different daily behaviours. In this study, we seek to explain students' public health related compliance behaviours during the COVID-19 pandemic by examining the underlying components of such behaviours. Subsequently, we investigate how these components relate to individual attitudes towards public health measures, descriptive norms among friends and family, and key demographics. We surveyed 7,403 university students in ten countries regarding these behaviours. Principal Components Analysis reveals that compliance related to hygiene (hand washing, coughing behaviours) is uniformly distinct from compliance related to social distancing behaviours. Regression analyses predicting Social Distancing and Hygiene lead to differences in explained variance and type of predictors. Our study shows that treating public health compliance as a sole construct obfuscates the dimensionality of compliance behaviours, which risks poorer prediction of individuals' compliance behaviours and problems in generating valid public health recommendations. Affecting these distinct behaviours may require different types of interventions.

Keywords

COVID-19, public health compliance, social distancing, hygiene, students, descriptive norms, attitude

Highlights

- Compliance with public health measures set by authorities during the COVID-19 pandemic consists of two clearly distinct components: Social Distancing and Hygiene.
- There is significant variability among students in Social Distancing and Hygiene across countries.
- Attitudes towards regulations and descriptive norms are predictive of both behaviours, but are more strongly related to Social Distancing.
- Treating public health compliance as a simple construct obfuscates the dimensionality of compliance.

To dampen the spread of COVID-19¹, public authorities have taken a range of measures including recommendations or restrictions of behaviours, all of which require adjustments concerning different daily behaviours (Anderson et al., 2020; Hale et al., 2020; Sebhatu et al., 2020). Scholars worldwide have sought to obtain more insights into individuals' compliance with such recommendations or restrictions. Current explanations of individuals' compliance stem from surveys using demographic characteristics such

1) In the paper and in our student survey we refer to 'COVID-19' and 'COVID-19 health recommendations and restrictions' as synonymous with the SARS-CoV-2 virus for the sake of simplicity and readability.

as gender, age, employment status and education (e.g., Farias & Pilati, 2020), sometimes combined with political attitudes or personality scales (e.g., Allcott et al., 2020; Blagov, 2020; C. Clark et al., 2020; Farias & Pilati, 2020). Other studies highlight cognitive and information processing factors as important for social distancing² behaviour and compliance (Banerjee et al., 2020; Stanley et al., 2020; Wise et al., 2020).

Yet, most studies focus solely on composite measures assessing compliance with multiple types of behaviours (C. Clark et al., 2020; Harper et al., 2020; Plohl & Musil, 2020) without distinguishing between different types of public health measures or behaviours. This may be problematic since adjustment concerning a range of different daily behaviours cannot simply be understood as a sole behavioural construct, as stressed in a pre-COVID review of 26 papers on the determinants of compliance during pandemics (Bish & Michie, 2010). Next to more novel behaviours that require learning (e.g., keeping distance from others) there are established behaviours that only have to be changed in intensity or frequency (e.g., improving hygiene behaviours). Where some behaviours require conscious deliberation (e.g., deciding not to visit family), others are part of natural routines for most people (e.g., hand washing). Some behaviours that need to be stopped are so habitual that they are hard to change, like touching your face (Verplanken & Wood, 2006). Other behaviours go against deep-rooted human desires such as avoiding physical contact with others. There is also a distinction between the degree to which compliance with certain measures can be affected individually. Keeping distance is not independent of the behaviours of proximate others. It is thus likely that predictors of compliance differ across different types of protective behaviours (Bish & Michie, 2010).

In sum, studies that focus on public health compliance as being a sole and coherent construct may obfuscate the potential dimensionality of COVID-19 compliance, and as a result lead to undertheorized models with poor prediction of individuals' compliance, and unvalidated public health recommendations. To address this, we examine the extent to which compliance with key public health measures correlates with compliance with other measures in a large cross-national study of university students' self-reported perception of and self-reported compliance regarding COVID-19 recommendations and restrictions. The importance of cross-national studies was highlighted in a recent review on how social and behavioural science can support COVID-19 pandemic response (Van Bavel et al., 2020). We seek to explain students' public health related compliance behaviours during the COVID-19 pandemic by examining the underlying components of such behaviours, then investigate how these components relate to individual attitudes towards public health measures, descriptive norms among friends and family, and key demographics.

2) By social distancing behaviours we refer to "a constellation of behaviours that decrease close physical contact among non-household members" (Bourassa et al., 2020; Koo et al., 2020). For details of how we measure social distancing behaviours, see Method and Results sections.

Explaining Different Types of Health Behaviours

In research unrelated to pandemics, compliance or non-adherence behaviours have been studied in connection to medical recommendations for the chronically ill (for a review, see DiMatteo, 2004), while in health psychology, health-related recommendations and required behavioural changes (e.g., physical activity, sex behaviour, drinking, smoking) have been extensively studied. While compliance with COVID-19 measures revolves around health behaviours, there are three important differences between the health-related recommendations typically studied and COVID-19 recommendations. First, recommended COVID-19 related behaviours apply to everyone and not exclusively to specific subpopulations, even though certain groups are at higher risk (Brandén et al., 2020; A. Clark et al., 2020; Hashim et al., 2020; Mueller et al., 2020; Williamson et al., 2020; Zhou et al., 2020). Second, studies of health-related behaviours usually focus on one type of behaviour (e.g., smoking or drinking) or a range of closely related behaviours (e.g., eating habits). COVID-19 related recommendations cover more diverse types of behaviours not necessarily closely related, such as keeping physical distance and washing hands frequently (Alwan et al., 2020; Chu et al., 2020; Ioannidis, 2020; Jones et al., 2020; Rundle et al., 2020). Third, while previously studied behaviours have direct personal benefits, this is not the case for COVID-19 recommendations. For students, following COVID-19 measures means potentially significant changes in daily behaviours entailing giving up a lot in terms of social life, while they are in general less at risk of suffering from negative health consequences of COVID-19 infection (Brandén et al., 2020; Göttinger et al., 2020; Ioannidis et al., 2020; Swann et al., 2020; Zhou et al., 2020). Compliance with such recommendations is thus more about protecting others than oneself, i.e., leading to a social benefit instead of personal one.

The Importance of Attitudes and Descriptive Norms

The goal of COVID-19 recommendations is to bring about and maintain a change in individual behaviours that will make people less likely to get infected and infect others. For this to happen, an underlying assumption is that people will perceive these recommendations as appropriate and have favourable attitudes towards following them. Recent studies on attitudes towards COVID-19 recommendations also suggest overall high agreement and adherence with public health guidelines (Czeisler et al., 2020; Selby et al., 2020). The notion that the attitudes towards recommendations influence compliance follows from the research in social and health psychology (e.g., Stroebe, 2011). Eagly and Chaiken (1993, p. 1) define attitudes as “a psychological tendency that is expressed by evaluating a particular entity with some degree of favour or disfavour”. The concept of attitudes has been widely used in predicting different health related behaviours (e.g., Doganis & Theodorakis, 1995), usually as an integral part of wider theoretical frameworks such as the theories of Reasoned Action or Planned Behaviour

(Ajzen et al., 2007), or the Health Belief Model (Janz & Becker, 1984). We thus expect more positive attitudes (e.g., the degree to which people take them seriously and think they are appropriate) towards public policy to lead to higher compliance with COVID-19 measures.

In addition to an individual's attitude towards specific behaviours, another central factor in psychological theories of health behaviours is the role of behavioural norms in individuals' social context. Norms are powerful shapers of behaviour (Cialdini & Goldstein, 2004; Sherif, 1936) and individuals are guided by norms in their understanding of and response to situations, especially during times of uncertainty (Cialdini, 2009). A distinction can be made between injunctive and descriptive norms: Injunctive norms relate to what is seen as (dis)approved by others, i.e., what you perceive others think you ought to do, whereas descriptive norms relate to what is typically done by others, i.e., what you observe others to actually do (Deutsch & Gerard, 1955). Although the two are often correlated, they are conceptually and motivationally different (Cialdini, 2007). Bicchieri and Xiao (2009) showed that injunctive norms are of importance when in line with the descriptive norm. However, if the two contradict, descriptive norms are more important: people do what they think others would do, even when they believe this is not the behaviour that is approved (Bicchieri & Xiao, 2009; Kallgren et al., 2000; Smith-McLallen & Fishbein, 2008; Stok et al., 2014). When it comes to health-risk behaviours, descriptive norms have been indicated as particularly important (Rivis & Sheeran, 2003; Van Bavel et al., 2020). Further, descriptive norms tend to have the strongest effect on behaviour if they stem from people with which an individual identifies, such as family and friends (Abrams et al., 1990). Since non-compliance with COVID-19 measures is a health-risk behaviour, we expect descriptive norms to play an important role for the behaviours we examine. Since the COVID-19 pandemic requires behaviour change from everyone, descriptive norms can easily be formed. Together, we expect descriptive social norms, specifically the degree to which friends and family comply with COVID-19 measures, to play a role in explaining compliance with COVID-19 measures.

The Current Study

We examine the extent to which compliance with key public health measures correlates with compliance with other measures, and if these behaviours differ across and within student populations in distinct countries. We use Principal Components Analysis (PCA) to examine underlying components of compliance behaviour. Moreover, using the international setting of the dataset we examine how the different compliance components acquired in step one vary across countries. Finally, we study whether a set of individual attitudes towards public health measures, descriptive norms among friends and family, and key demographics are differently related to the compliance components unearthed using multiple regression analysis.

Method

Sample

We surveyed 7,403 students from late April to the beginning of May 2020 (week 17 through 19) at twelve universities in ten countries: Belgium, Colombia, France, Germany, India, Ireland, Italy, the Netherlands, Portugal, Spain and Sweden. We used an online survey based on the Qualtrics software, approved in advance by the Internal Review Board of the Erasmus University Rotterdam.

At the time of data collection, all countries had initiated various recommendations and restrictions regarding health-related behaviour. Eight of the countries were in complete lockdown (India, Colombia, Spain, Italy, Portugal, Ireland, Belgium, France), meaning that inhabitants could only go outside if movements could be justified. However, specific regulations differed across countries. Measures were least strict in Sweden, followed by the Netherlands. For an overview of regulations applicable across countries at the time of data collection see [Supplementary Materials](#) (Table S1).

Students have been shown to be a key group for studies on compliance behaviours for several reasons: with former general lockdown measures across the world having been relaxed, infection levels have started to rise in late summer of 2020 and in Europe as well as the United States, new cases are mostly found among the younger generation and have been linked to student gatherings and parties ([Murillo-Llorente & Perez-Bermejo, 2020](#); [The Economist, 2020](#); [Wilson et al., 2020](#)). Students are epidemiologically important in respect to their demographics and social behaviours: most are young, live in shared housing, and meet many others on a daily basis. This makes them susceptible to super-spreading events ([Lau et al., 2017](#)). The World Health Organisation highlights young people's compliance with COVID-19 related measures as 'a priority' ([The Economist, 2020](#)). Hence, scientific knowledge of students' health behaviours is crucial, especially given that universities around the world are partly or fully open for study in fall 2020 and early 2021 ([Liu et al., 2020](#)).

The survey could be completed in English, Dutch, French or Spanish. Translations were made by a native speaker, reviewed by another native speaker and if necessary adapted after consultation between both translators. A pre-test was conducted with Dutch students³. Only fully completed surveys were used for analyses. An informed consent had to be signed at the start of the survey. 44 students did not sign the consent, leading to a total of 7,359 completed questionnaires. The number of missing values was low (.02%). Therefore, pairwise deletion was used depending on the analyses conducted.

Descriptive sample statistics are presented as [Supplementary Materials](#) (Table S2). The sample consists of both undergraduate and graduate (but not postgraduate) students

3) When we refer to students from a specific country in this paper, we mean students studying in that country, e.g., with Dutch students we refer to students that study in the Netherlands.

across disciplines (e.g., economics, business, social sciences, humanities, science, engineering, and medicine). Response rates varied between 7% (Belgium) and 31% (France), with an overall response rate of 8.5%, excluding Netherlands and India where exact response rates could not be computed. Average age (Standard deviation, *SD*) is 22.8 (5.9). More women (61.3%) than men (38.7%) participated in the survey, consistent with the average rate of university studies in most of the countries studied (World Economic Forum, 2020). 54.1% of the students were in a relationship at the time of completing the survey. 12.9% had lived in the country of their university for less than five years; we infer that these are international students. In the Netherlands and Ireland, the percentage of international students was relatively high (NL: 30.5%, IRE: 30.0%).

Measures

In this section we describe all measures used for analyses. Descriptive statistics for all variables and the anticipated outcome variables of the PCA are presented as [Supplementary Materials](#) (Table S3) including mean, standard deviations and correlations.

Compliance

Compliance was measured using nine items revolving around different behaviours related to the recommendations and restrictions by governments. The behaviours investigated are listed in [Table 1](#). Items were preceded by the following introductory text: *'In the past two months, which of the following measures did you follow and to which extent? Please indicate to what extent you disagree or agree with these statements.'* Answers were given on a scale of 1 (completely disagree) to 5 (completely agree). Due to the novel situation, we were not able to use existing validated questionnaires. The items were constructed ad hoc and reviewed by all authors involved in the study. Simple scales were used to reduce problems with cross-country translation equivalence (Steenkamp & Baumgartner, 1998).

Pearson's correlations of the compliance items are presented for the full dataset in [Table 1](#). Inter-item correlations are positive but mostly low, suggesting that investigated compliance behaviours show relatively small covariation. In other words, knowing one student's compliance with one specific behaviour does not allow for a high prediction of compliance with another specific behaviour. Item means in [Table 1](#) are relatively high and variability (standard deviations) is small, indicating negatively skewed distributions: More students indicated (completely) agreeing than (completely) disagreeing to perform the behaviours studied.

Table 1*Correlation Table Compliance Items (Total Sample, N = 7,309)*

Item	M	SD	1	2	3	4	5	6	7	8
1. I avoided touching my face	3.17	1.26								
2. I coughed and sneezed into my elbow and/or used a handkerchief	4.46	.84	.27							
3. I washed my hands more often and longer	4.23	.86	.31	.25						
4. When not at home I kept the advised distance between myself and others	4.36	.87	.19	.18	.15					
5. I did not meet with others unless it was strictly necessary	4.13	1.07	.11	.03	.04	.31				
6. I only went outside if it was strictly necessary	3.91	1.17	.15	.07	.03	.28	.59			
7. I did not shake hands	4.76	.62	.09	.13	.11	.33	.25	.21		
8. I did not visit others/have not had visitors	3.82	1.27	.13	.08	.05	.27	.63	.51	.22	
9. I have not visited elderly people or people who are vulnerable for health reasons	4.56	.92	.08	.11	.05	.11	.18	.17	.13	.29

Note. Compliance was measured at a scale from 1 (lowest agreement) to 5 (highest agreement). All correlations are significant at 1% significance level.

Students report complying most with ‘not shaking hands’ and least with ‘avoiding touching their face’. Most variation was present for ‘visiting others/having visitors’, indicating that students differ most in their agreement with performing this behaviour. The least variation was found for ‘not shaking hands’, meaning that students answered relatively uniformly for this question.

Independent Variables

Attitudes — Attitudes to public health measures is captured by two individual items revolving around the extent to which students report taking measures seriously and how they feel about the amount of measures taken in their country. ‘Taking Measures Seriously’ was captured by the following question: ‘*To what extent do you take the Government measures seriously?*’. Students could answer on a 7-point scale (1: ‘Not at all’ to 7: ‘Extremely’). Opinions on the amount of measures taken was assessed by the following question: ‘*Do you think that the Government is taking too few or too many measures to prevent the spread of the coronavirus?*’. Answers could be given on a 7-point Likert scale (1: ‘Far too few’; 4: ‘Just the right amount’; 7: ‘Far too many’). With the initial scoring it was not possible to capture the strength of the relationship of perceiving measures as too few versus as too many. To allow for a different influence of the two (non-linear effects), the variable was recoded to three dummy variables: ‘Too Few Measures’ (1-3 = 1; 4-7 = 0), ‘Right Amount’ (4 = 1; 1-3 = 0; 5-7 = 0), and ‘Too Many Measures’ (5-7 = 1; 1-4 = 0).

42.75% of the students indicated too few measures were taken, 42.55% indicated the right amount of measures were taken, and 14.70% indicated too many measures were taken.

Descriptive norm – The descriptive norm was captured using one item on the degree to which friends and family of students have complied with the measures. The question that had to be answered was as follows: ‘*To what extent do your family and friends strictly follow the measures related to the coronavirus?*’. Answers were given on a 7-point Likert scale (1: ‘They do not follow the measures at all’; 7 ‘They strictly follow all measures’).

Demographic Variables

The following demographic variables were included: age (continuous), gender (0 = male, 1 = female) and relationship status (0 = not in a relationship, 1 = in a relationship).

Data Analysis

To study the dimensionality of compliance we investigate how the nine compliance behaviours relate to each other and whether it is possible to create composite measures of students’ public-health related behaviour. We use PCA to identify orthogonal components explaining most of the variance in the data by reducing dimensions of the original set of items, while preserving as much information as possible. Parallel Analysis is used to determine the number of components that should be retained (Horn, 1965), a suitable method when 95th-percentile eigenvalues (EVs) are used (Glorfeld, 1995; Hayton et al., 2004). The parallel analyses are based on O’Connor’s (2000) syntax, estimated with Monte Carlo simulation, 100 iterations. Components with EVs greater than the randomly generated 95th-percentile EVs are retained (Hayton et al., 2004). These analyses inform which items underlie the extracted dimensions, and therefore these items can be used to construct composite scores which capture the identified dimensions the best.

After obtaining the components of compliance by creating item-average scores, we examine how they correlate and how they vary across countries by studying descriptive statistics (mean and standard deviations).

Finally, we predict each compliance component using multiple regression analyses and the predictors described. The models include country dummies to control for country differences, a method recommended when the number of countries in a sample is low (< 50) (Möhring, 2012; Wooldridge, 2010, p. 132).

Results

Principal Component Analysis

The Kaiser-Mayer-Olkin measure verified the sampling adequacy for the PCA, KMO = .756 (Hutcheson & Sofroniou, 1999). Bartlett’s test of sphericity indicated that

correlations between items were sufficiently large for PCA, $\chi^2(36) = 11983.94$, $p < .001$. Parallel analysis indicated that two components should be retained that together explain 47.06% of the variance. Table 2 shows the component loadings, those with an absolute value greater than .40 (bold printed) are interpreted (Stevens, 2009).

Table 2

Component Matrix Principal Components Analysis of Compliance Behaviours

Item	Component 1	Component 2
	Social Distancing	Hygiene
1. I avoided touching my face	.37	.58
2. I coughed and sneezed into my elbow and/or used a handkerchief	.30	.62
3. I washed my hands more often and longer	.26	.67
4. When not at home I kept the advised distance between myself and others	.59	.17
5. I did not meet with others unless it was strictly necessary	.77	-.35
6. I only went outside if it was strictly necessary	.72	-.29
7. I did not shake hands	.50	.10
8. I did not visit others/have not had visitors	.76	-.30
9. I have not visited elderly people or people who are vulnerable for health reasons	.40	-.03

Looking at the items that cluster on the same components in Table 2, it is apparent that component 1 represents types of behaviour that are all related to social distancing, e.g., being in physical contact with other people. This component thus seems to well capture Social Distancing compliance⁴. Items that load on Component 2 all seem to be related to hygiene behaviour (washing hands, coughing into the elbow and not touching the face). Therefore, we suggest that this component captures Hygiene compliance. Social Distancing comprises items 4-9 of Table 2, and Hygiene comprises Items 1-3. In the rest of the paper we will refer to Social Distancing and Hygiene to indicate compliance with behaviours that these components capture. It is important to note that by “Hygiene” in this paper we refer only to compliance with the hygiene behaviours described in the three items used to measure it, that is, ‘washing hands’, ‘touching one’s face’, and ‘coughing/sneezing into the elbow’.

We also conducted PCAs on the separate country samples. In eight out of ten countries, parallel analysis confirms that two factors should be retained. In two countries, the parallel analysis indicates that one component should be retained: Spain and Ireland. Looking closely at these country sub-group samples, our interpretation is that the one-factor structure arises in the Spanish sample due to Spanish students indicating high

4) It should be noted that Social distancing has and can be used interchangeably with Physical Distancing. In our paper we refer to Social Distancing, because of its extensive use in literature and media and to avoid confusion that physical distancing only refers to “keeping the advised distance between self and others”.

compliance on both social distancing and hygiene items, meaning that all items load highly ($> .40$) on the first component. For Ireland, the interpretation is less clear since all items except avoiding 'touching one's face' and 'washing hands' load highly ($> .40$) on the first component. These two hygiene-related items load highly on the second component, which seems to hint at a two-factor structure. The somewhat divergent pattern in the Irish sub-sample may be caused by the relatively small sample size of Irish students ($N = 100$).

To check whether compliance behaviours can be understood as a similar two-dimensional construct across countries, we compared item loadings on the first two principal components of each country with the pattern of loadings extracted for the whole sample. This is done by following the procedure advised by researchers dealing with evaluation of degree of cross-cultural replication (McCrae et al., 1996; Van de Vijver & Leung, 1997). The procedure involves orthogonal Procrustes rotation, followed by computation of congruence coefficients which quantifies in which degree components are replicated. Values on the diagonal of the resulting matrix are known as Tucker's phi coefficient of agreement (Van de Vijver & Leung, 1997). The results presented in Table 3 indicate high cross-cultural equivalence.

Table 3

Tucker's Phi Coefficients

Country	Component 1 Social Distancing	Component 2 Hygiene
Belgium	1.00	1.00
Colombia	0.98	0.99
Spain	0.76	0.43
France	1.00	0.96
India	0.98	0.99
Ireland	0.97	0.90
Italy	0.99	0.99
Netherlands	0.99	0.99
Portugal	0.98	0.98
Sweden	0.99	0.99

The structure was equal for all countries ($> .95$, good similarity), except for the second component in the Irish sample ($> .85$, fair similarity), and the loadings of both components in the Spanish sample ($< .85$, no similarity) (Lorenzo-Seva & ten Berge, 2006). The latter finding is in line with the one-dimensional structure found in Spain using Horn's parallel analysis. Component matrices per country are presented as Supplementary Materials (Table S4).

Using the outcomes of the PCA, composite continuous scores can be created by taking the average of the items that belong to each component. By doing so we created two composite measures of different types of compliance: Social Distancing (Item 4-9) and Hygiene (Item 1-3). Internal consistency of items included in the Social Distancing construct was good ($\alpha = .73$) while internal consistency of the Hygiene construct was weaker ($\alpha = .52$). This lower reliability likely results from the small number of items related to Hygiene included in the survey.

Relating the item-average composite measures of Social Distancing and Hygiene to each other strongly supports that these are two distinct behaviours that are only weakly correlated ($r = .21$).

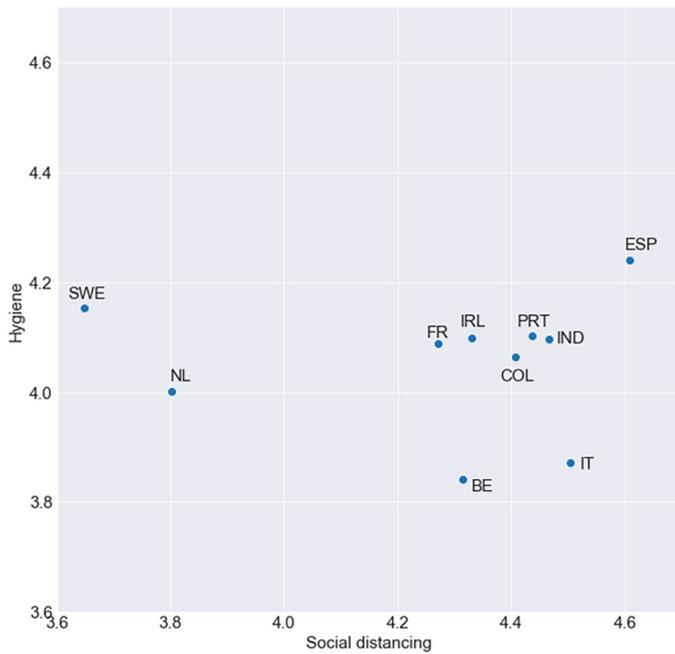
Social Distancing and Hygiene Across Countries

Using the measures of students' average compliance with Social Distancing and Hygiene obtained from the PCA, we examine how these behaviours vary between students in different countries. Finally, we calculate how much of the variation in compliance is dependent on the country that the student lives in.

To compare the extent to which students comply with measures in each country we compare the average scores of Social Distancing and Hygiene among all students in a country in [Figure 1](#), with average Hygiene on the y-axis and average Social Distancing on the x-axis, and country means and standard deviations provided in [Table 4](#) below. The figure reveals several groupings of countries with similar compliance. This suggests that student populations across countries cannot simply be placed on a continuum of compliance with both Social Distancing and Hygiene, but that compliance with each type of behaviour is distinct across countries. The right corner of [Figure 1](#) however shows that for students in Spain, high levels of Social Distancing are correlated with high levels of Hygiene, in line with the one-factor structure of the compliance measure found in this sample. We observe a cluster of countries where students report similar scores on both behaviours: Colombia, France, Ireland, India and Portugal. Sweden and the Netherlands are both 'outliers' in terms of relatively lower Social Distancing. Students in Sweden exhibit on average a higher level of Hygiene compared to students in all other countries except Spain. Students in Italy and Belgium comply strictly with Social Distancing, but more weakly with Hygiene. Results of one-way ANOVA tests of the mean differences between countries are presented in the [Supplementary Materials](#) (Table S5).

Figure 1

Visualization Average Social Distancing (Axis x) and Hygiene (Axis y) Across Countries

**Table 4**

Country Means and Standard Deviations of Social Distancing and Hygiene

Country	Social Distancing		Hygiene	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Belgium	4.31	0.61	3.84	0.74
Colombia	4.41	0.59	4.06	0.71
Spain	4.61	0.53	4.24	0.71
France	4.27	0.69	4.09	0.69
India	4.47	0.54	4.10	0.72
Ireland	4.33	0.65	4.10	0.56
Italy	4.50	0.51	3.87	0.78
Netherlands	3.80	0.69	4.00	0.66
Portugal	4.44	0.57	4.10	0.65
Sweden	3.65	0.72	4.15	0.59
Total	4.26	0.66	3.96	0.72

We calculated the intraclass correlation coefficient (ICC) to gauge the variance in students' self-reported behaviour that can be attributed to the different country clusters, as opposed to variation between individual students regardless of country of residence⁵. Using Maximum Likelihood, the ICC of countries for Hygiene is only .024. For Social Distancing the ICC is much higher: .18. This indicates that country residence explains more of the variation in compliance with Social Distancing than with Hygiene. Two plausible reasons for this are (i) cross-national differences in regulations mainly differ regarding Social Distancing, not regarding Hygiene, and (ii) in our data, items related to Hygiene exhibited smaller variability and higher values in general.

Explaining Social Distancing and Hygiene

Table 5 presents results of multiple regression predicting Social Distancing (Models 1 and 2) and Hygiene (Models 3 and 4⁶). Models 1 and 3 are based on all variables except compliance with the other type of behaviour, which is added in Models 2 and 4, respectively. All models include country dummies (not displayed)⁷, with Dutch students as the reference group. The coefficients for 'Too Few Measures' and 'Too Many Measures' are estimated against the reference category 'Right Amount of Measures'.

We find 'Taking measures seriously' to be positively related to both Social Distancing ($B = .26, p < .001$) and Hygiene ($B = .17, p < .001$). Students that feel that 'Too few measures' are being taken to decrease the spread of COVID-19 are more likely to comply with both Social Distancing ($B = .12, p < .001$) and Hygiene ($B = .07, p < .001$), compared to students reporting 'Right Amount of Measures'. Students that report 'Too many measures' have been taken are slightly less compliant when it comes to Social Distancing ($B = -.02, p = .047$), compared to students reporting 'Right Amount of Measures'. However, this result becomes insignificant when adding Hygiene as a control variable to the model predicting Social Distancing ($B = -.02, p = .062$). With respect to Hygiene, perceiving that too many measures are taken compared to the right amount of measures does not affect compliance.

We also find that students reporting higher descriptive social norms in one's environment (having friends and family more strictly following the measures) are more likely to comply with Social Distancing ($B = .15, p < .001$) and Hygiene ($B = .08, p < .001$).

5) We note that ICC estimates may be unreliable due to the low number of countries in our sample (Bryan & Jenkins, 2016). For this reason, we refrain from conducting further multilevel analyses.

6) The same models estimated without international students were all but identical, except for the coefficient 'Too Many Measures' in Model 2 ($B = -.03, p = .025$ when excluding international students, $B = -.02, p = .062$ in the full sample).

7) While multilevel analysis is unreliable with only 10 countries included (Bryan & Jenkins, 2016; Maas & Hox, 2005), unreported robustness tests (available upon request) based on singular covariance matrices indicate that results remain identical as a pooled OLS with country dummies presented here.

Regarding the control variables, we find students' Age to be positively related to both Social Distancing ($B = .11, p < .001$) and Hygiene ($B = .11, p < .001$), as is Gender (being female) (Social Distancing: $B = .05, p < .001$, Hygiene: $B = .11, p < .001$). Students in a relationship are somewhat less likely to comply with Social Distancing ($B = -.04, p < .001$) but more likely to comply with Hygiene ($B = .09, p < .001$).

Table 5

Multiple Regression Analyses Explaining Social Distancing and Hygiene

Dependent Variable	Social Distancing						Hygiene					
	Model 1			Model 2			Model 3			Model 4		
	<i>B</i>	<i>SE</i>	<i>p</i>	<i>B</i>	<i>SE</i>	<i>p</i>	<i>B</i>	<i>SE</i>	<i>p</i>	<i>B</i>	<i>SE</i>	<i>p</i>
Age	0.11	0.00	< .001	0.09	0.00	< .001	0.11	0.00	< .001	0.10	0.00	< .001
Gender (1 = female)	0.05	0.01	< .001	0.04	0.01	< .001	0.11	0.02	< .001	0.10	0.02	< .001
Relationship (1 = yes)	-0.04	0.01	< .001	-0.05	0.01	< .001	0.09	0.02	< .001	0.10	0.02	< .001
Taking Measures Seriously	0.26	0.01	< .001	0.24	0.01	< .001	0.17	0.01	< .001	0.13	0.01	< .001
Too Few Measures (dummy)	0.12	0.01	< .001	0.11	0.01	< .001	0.07	0.02	< .001	0.05	0.02	< .001
Too Many Measures (dummy)	-0.02	0.02	0.047	-0.02	0.02	0.062	-0.02	0.02	0.203	-0.01	0.03	0.305
Descriptive Norm	0.15	0.01	< .001	0.14	0.01	< .001	0.08	0.01	< .001	0.06	0.01	< .001
Social Distancing										0.15	0.01	< .001
Hygiene				0.13	0.01	< .001						
Adjusted R^2	0.273			0.287			0.116			0.134		
<i>N</i>	7217			7201			7221			7201		

Note. Country dummies included but not shown. Dutch students that perceive the right amount of measures are taken serve as a reference group. *B* is standardized beta.

By adding Hygiene and Social Distancing as control variables in Models 2 and 4 of Table 5, we observe that both types of compliance are positive and significant predictors of each other but that the direction and strength of the relationships of the other predictor variables do not change much. Adjusted R^2 shows only a small increase for both models after adding the alternative type of compliance: from .273 to .287 for the Social Distancing model, and from .116 to .134 for the Hygiene model. The small increase in adjusted R^2 again suggests that the two types of behaviours are distinct.

Discussion

Summary of Findings

We used a continuous measure of compliance with multiple behaviours and showed that compliance with public health measures set by authorities during the COVID-19 pandemic consists of two clearly distinct components: Social Distancing and Hygiene. Despite the differences in the restrictive measures and prevalence of COVID-19 among

the ten studied countries, our findings point towards high commonalities in regard to the dimensionality of compliance. The two types of behaviours are only weakly correlated with each other, and differently predicted by individual attitudes towards public health measures, descriptive norms among friends and family, and key demographics. In other words: Social Distancing does not necessarily go hand in hand with Hygiene. This means that one cannot simply rank students as ‘more or less compliant with COVID-19 measures’ (e.g., Harper et al., 2020; Plohl & Musil, 2020). Moreover, we reveal significant variability among students in Social Distancing and Hygiene across countries. Country-samples cannot be placed on a continuum of compliance with both measures since high average levels of either Social Distancing or Hygiene do not necessarily imply a high average level of the other type of behaviour. We also show that the country of residence explains more of the variation in Social Distancing than in Hygiene. Finally, a selection of commonly used variables – attitudes and descriptive norms – were predictive of both behaviours, but more strongly related to Social Distancing. In line with previous studies, being male and being younger is negatively related to Social Distancing and especially Hygiene (Bish & Michie, 2010; Farias & Pilati, 2020). Finally, we found that being in a relationship is negatively related to Social Distancing, but positively related to Hygiene. These results indicate that compliance with public health related measures during the COVID-19 pandemic cannot be reduced to one single composite measure, and that doing so may lead to a poorer prediction of individuals’ compliance and problems in generating valid public health recommendations.

Scientific Contributions

The contributions of this study are multiple. First, we show that Social Distancing and Hygiene are two distinct types of behaviours during the COVID-19 pandemic, and potentially also during other infectious diseases. With this finding we hope to inspire future research to study the behaviours separately and develop stronger predictive models for each behaviour. Assuming that compliance is unidimensional and/or mostly composed of behaviours related to “social” distancing is wrong and can result in a missed opportunity to correctly identify possibly different antecedents of these different behavioural dimensions. Our findings show that compliance with public health measures is best viewed as a multidimensional construct and this directly implies that both dimensions should be taken into account to design effective strategies, and when investigating, theorizing and modelling compliance (and pandemic related outcomes) (e.g., Aleta et al., 2020; Bahl et al., 2020). Once identified, it is important to recognize that behaviours captured by each dimension are likely different in many aspects: Social Distancing behaviours require more conscious deliberation, while Hygiene behaviours are generally more automatic. Further, our analyses show these behaviours to be differently related to theoretically relevant predictors. While we show that Social Distancing and Hygiene levels are independent, the combination of these behaviours on an individual level affects

the individual exposure and infection risk differently. Ideally, both Social Distancing and Hygiene should be high, and one cannot compensate for the lack of the other. High Social Distancing but low Hygiene still puts a person at risk for an infection since it is unrealistic that people can completely and absolutely distance themselves from others for prolonged periods of time. Importantly, while we can assume individuals have a high control over Hygiene by performing certain behaviours, their “social” distance depends not only on their own behaviours but also on the behaviours of people they have contact with. For example, if a student A with a high Social Distancing comes across a student B with a low Social Distancing, this dyadic interaction will likely result in a less than optimal “social” distance between the two. The co-dependent nature of “achieved” Social Distancing as opposed to Hygiene – people do not affect each other’s hygiene directly – implies that while both behaviours will affect the spread of infection, their effect will be different and argues for more nuanced models of infection spread. Therefore, showing that compliance is “made up” by two behaviours gives important input for modelling the spread of disease.

Second, we show that attitudes towards public policy and descriptive norms are more predictive of Social Distancing than for Hygiene. Given that Hygiene related behaviours are less salient (less visible) than behaviours related with Social Distancing, more routinized (automatic), and less problematized and discussed in the media, it is not surprising that they were shown to be less strongly connected with attitudes and norms. It is highly possible that thinking about the recommendations and restrictions related to COVID-19 is dominated by behaviours related with “social” distancing, and therefore reported attitudes and descriptive norms are more closely related with these behaviours than with Hygiene. Social distancing behaviours are more easily (and correctly) observable. In contrast, Dickie et al. (2018) for example showed that college students consistently believed that they washed their hands more frequently than their peers. However, higher predictability of Social Distancing could partly be a result of the more reliable measurement of this construct in comparison with Hygiene (in terms of the number of items and alpha coefficient). These differences underline the importance of distinguishing between the types of compliance. Further research could study whether injunctive social norms (the perception of what one ought to do) has a similar effect on both types of compliance, since this is unaffected by the visibility of the behaviours as performed by others. Further, our findings that Social Distancing and Hygiene are distinct types of compliance motivates further research regarding the descriptive norms about each type of compliance. Psychological models should seek to identify stronger antecedents in terms of attitudes, behavioural norms towards these behaviours, for example, by relying on established health psychological research examining attitudes, behavioural norms and intentions related to, e.g., alcohol abstaining (Conner et al., 1999), healthy eating (Conner et al., 2002) or condom use (Montanaro & Bryan, 2014). With the need for compliance continuing to exist, attitudes and descriptive norms are likely to

shift over time; e.g., students become fatigued with the measures and see compliance of their peers decreasing. For both future research and public authorities it would be fruitful to monitor attitudes and descriptive norms towards the measures as an important proxy and predictor of compliance. Public authorities should focus on creating interventions to improve attitudes, e.g., by using attitudinal argumentation (Ajzen et al., 2007), and descriptive norms, e.g., by stressing in their communication that the majority of the population is compliant instead of focusing on non-compliant groups. Our results should make public health authorities aware of the fact that they require inhabitants to change multiple types of behaviour that may require distinct interventions (Michie et al., 2011; Verplanken & Wood, 2006). Moreover, they tentatively suggest that interventions aimed at enhancing Social Distancing benefit more from influencing attitudes and descriptive norms than interventions aimed at enhancing Hygiene.

Third, our study is based on a rather large sample compared to existing samples previously conducted on compliance during the COVID-19 pandemic. We found a stable distinction between Social Distancing and Hygiene both in the overall sample as well as when examining the specific country-samples. It should be mentioned that for two countries (Ireland and Spain) one component emerged from the PCA, indicating that Social Distancing and Hygiene are more related for students in these countries. This is likely explained by high levels of both Social Distancing and Hygiene in Spain and by a relatively small sample size ($N = 100$) in Ireland, as the component loadings of the Irish sample do show fair similarity to that of the total sample. In general, also on a country-level we can conclude that the Social Distancing-Hygiene distinction is present and similar. Taken together, our findings provide cues to scholars and public health officials interested in modelling the individual compliance and the spread of the disease and devising applicable interventions to uphold prescribed recommendations and restrictions.

Limitations and Future Research

Results of our study should be interpreted acknowledging the timing of data collection. The end of April 2020 was still in the early phase of the COVID-19 pandemic. Public health behaviours related to Hygiene and Social Distancing may change over time, while we implicitly model Social Distancing and Hygiene in this study as stable traits. We recognize that in reality these are dynamic behaviours, showing even daily fluctuations. Future research should investigate the temporal stability of both dimensions, using not only self-reported behaviours - which are likely affected by social desirability to a certain degree - but also measures of actual behaviours. Such an approach would also reduce the common method bias of a single survey being used to measure all variables of interest self-reported by the participants at the same point in time (Podsakoff et al., 2003). Finally, we did not collect data on the place of residence of students, e.g., whether they live in a

large city or small town. Future research should investigate whether there are differences in compliance between students living in rural versus urban areas.

A strength of this study comes from the fact that we collected data on samples of students in ten different countries at a simultaneous relevant point in time. Yet, we were not able to avoid self-selection bias, which probably led to low compliance students being underrepresented. While we assume that their underrepresentation did not affect the findings about the dimensionality of compliance in any substantial degree, it is possible that due to the range restriction in our dependent variable the investigated predictor variables could have been compromised. Future data collection efforts should try to secure the participation of students such that those who are not complying highly are incentivised to participate.

We identified two distinct dimensions of compliance and investigated them using attitudes and descriptive norm variables. We hope that future research will build on our findings and use more elaborate models of behaviours of interest distinguishing between Social Distancing and Hygiene. A logical step would be to validate key constructs from central theories of health behaviours such as perceived behavioural control as in the Theory of Planned Behavior (Ajzen et al., 2007), belief in the compliance effectiveness and beliefs about personal COVID-19 threat as in the Health Belief Model (Janz & Becker, 1984). Future research should also go beyond internal beliefs and intentions towards also considering unconscious priming and situational cues in changing automatic and habitual behaviours (Stroebe, 2011). Measuring the behaviour or attitudes of close social contacts would also allow more precise insights about the mechanism of social influence in compliance behaviours. Finally, there are opportunities in widening the theoretical framework by incorporating other relevant theories from the field of social psychology (e.g., social identity theory and COVID-19; Jetten et al., 2020) for psychological science to make valuable contributions in understanding and addressing the challenges arising from the pandemic.

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Data Availability: For this article, a dataset is freely available (Wismans et al., 2020).

Supplementary Materials

Supplementary Material 1 gives an overview of the COVID-19 regulations across countries at the time data was collected. Supplementary Material 2 presents descriptive statistics for the full sample. Supplementary Material 3 shows means, standard deviations and correlations for all variables part of the regression analyses. Supplementary Material 4 consists of component matrices of principal component analyses that were conducted using country samples. Supplementary Material 5 consists of the results of One-Way ANOVA's testing the mean differences in compliance between countries. Finally, research data that was used for the study and a codebook explaining all variables in this data are part of the Supplementary Materials (for access see [Index of Supplementary Materials](#) below).

Index of Supplementary Materials

Wismans, A., Letina, S., Thurik, R., Wennberg, K., Franken, I., Baptista, R., . . . Torrès, O. (2020a).

Supplementary materials to "Hygiene and social distancing as distinct public health related behaviours among university students during the COVID-19 pandemic" [Research data and codebook]. PsychOpen. <https://doi.org/10.23668/psycharchives.4412>

Wismans, A., Letina, S., Thurik, R., Wennberg, K., Franken, I., Baptista, R., . . . Torrès, O. (2020b).

Supplementary materials to "Hygiene and social distancing as distinct public health related behaviours among university students during the COVID-19 pandemic" [Additional information]. PsychOpen. <https://doi.org/10.23668/psycharchives.4413>

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