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FIELD OBSERVATIONS AND SURVEY EVIDENCE TO ASSESS PREDICTORS OF MASK WEARING ACROSS DIFFERENT OUTDOOR ACTIVITIES IN AN ARGENTINE CITY DURING THE COVID-19 PANDEMIC

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MASK WEARING DURING OUTDOOR ACTIVITIES

ABSTRACT

We here studied some potential factors underlying variation in compliance with preventive behaviors against COVID-19 by studying mask wearing during outdoor recreational activities in a mid-size city of Argentina in 2020. The originality of present research relies on the complementation of observational (N=15,507) and survey (N=578) data, and in assessing the determinants of and disposition to the same preventive behavior across activities. In Study 1, we did eight weeks of unobtrusive systematic observation of mask wearing in outdoor recreational sites as a function of activity (walking, running, and cycling). In Study 2, we ran an online survey (concomitant with the last weeks of the observational study) to measure self-reported mask use and relevant beliefs, including self- and other-regarding motives. Behavioral observations showed that mask wearing declined over time for the three activities as predicted from a social dilemma perspective; nonetheless, compliance significantly differed across activities. Self-reported mask use was predicted by the perceived risk of contagion for the self and for others, perceived comfort costs of wearing masks, and subjective norms, but not by perceived illness severity or mask effectiveness. We discuss some implications and limitations of present findings for the development of preventive strategies to reduce COVID-19 transmission.

Keywords (5): facemasks, COVID-19, protective behaviors, norm compliance, Health Belief Model

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1. INTRODUCTION

Research shows that people´s compliance with preventive recommendations to reduce the risk of contagion of COVID-19, such as social distancing and mask wearing, varies a lot both within as well as among countries (e.g., Anaki & Sergay, 2021; Bogg & Milad, 2020; Breakwell, Fino, & Jaspal, 2021; Chen et al., 2020; de Bruin & Bennet, 2020; Franzen & Wöhner, 2021). There is consensus among researchers and experts that an effort to understand this variability is a crucial element for an effective response to the current pandemic (Betsch, 2020; Van Babel et al., 2020; West, Michie, Rubin, & Amlot, 2020).

In the present research, we studied the factors associated with a particular preventive behavior, mask wearing, across different outdoor activities, such as walking, running, and cycling, in a mid-size city of Argentina. We theoretically approached a systematic observational study in the field and an online survey by complementing core concepts of the *Health Belief Model* (Champion & Skinner, 2008; Rosenstock, 1974) with a *social dilemma perspective* in which other-regarding motives and the social interdependence of behavior were stressed (Ling & Chyong, 2020; Moussaoui et al., 2020).

The rest of the manuscript is structured as follows: 1) in the coming section, we describe the theoretical framework, goals, hypotheses, main strengths and originality of the current studies; then, 2) we present the methods and results of a systematic observational study (Study 1); after which, 3) we describe the methods and results of a survey study (Study 2); to 4) finish with a general conclusion of our main findings, their implications for increasing compliance with COVID-19 preventive behaviors, while stressing some limitations of the research described here.

The Health Belief Model, Social Dilemmas, and COVID-19 Preventive Behaviors

The Health Belief Model (HBM) is a very popular theoretical model for predicting differences in health behavior according to which people's beliefs about whether they are at risk for a disease, and their perceptions of the consequences of taking action to avoid it, affect their disposition to do something about it (Rosenstock, 1974). The model involves several core concepts such as perceived susceptibility to and perceived severity of the disease, and perceived benefits, barriers and costs associated to the relevant behaviors, and has been applied most often (Champion & Skinner, 2008) and most successfully (Janz & Becker, 1984; Mullen, Hersey, & Iverson, 1987) for health concerns that are prevention-related and asymptomatic. Indeed, there are already a number of reports on the use of the HBM to comprehend the factors that may affect people´s readiness to perform recommended preventive behaviors to reduce the risk of contagion of COVID-19 (e.g., Barakat & Kasemy, 2020; Tong, Chen, Yu, & Wu, 2020; Zareipour, Ardakani, Moradali, Jadgal, & Movahed, 2020). Furthermore, other research, even if not in strict adherence to the HBM, has tested some of its core concepts for predicting COVID-19 preventive behaviors as well (e.g., Anaki & Sergay, 2021; Hornik, Kikut, Jesch, Woko, Siegel, & Kim, 2021; Liu & Mesch, 2020; Ozdemir, Ng, Chaudhry, & Finkelstein, 2020; Rad, Mohseni, Takhti, Azad, Shahabi, Aghamolaei, & Norozian, 2021; Prasetyo, Castillo, Salonga, Sia, & Seneta, 2020). All in all, there seems to be a general tendency of empirical support of the HBM variables as reliable predictors of COVID-19 preventive behaviors.

A limitation of the HBM, nonetheless, involves its reliance on beliefs mostly focused on the individual, and not so much on others. In focusing on individuals' health-related perceptions, the HBM does not explicitly address important social and interpersonal issues (Brewer & Rimer, 2008), such as, for example, the perceived consequences of preventive behaviors on others and the interdependency of social behavior. Many authors believe that other-regarding preferences as well as the perception of social norms could be relevant factors underlying the display of preventive behaviors in this pandemic (Betsch, 2020; Hume, John, Sanders, & Stockdale, 2021; Patel, 2021). Therefore, we here propose to study the determinants of COVID-19 preventive behaviors complementing some core concepts of the HBM with a social dilemma perspective which highlights relevant social aspects of preventive behaviors (Ling & Chyong, 2020; Moussaoui et al., 2020).

Social dilemmas involve situations in which individual incentives and social goals may not be fully aligned (Dawes, 1980). In such situations, despite all-encompassing cooperation maximizes social welfare, cooperation is personally costly and therefore individuals have incentives to restrain it and free ride on others´ efforts (Nowak, 2011). Under such circumstances, it could be difficult to maintain socially beneficial behaviors, because, even if most people are not strictly selfish, aggregate results may depend on the interaction between individuals with selfish and pro-social motivations (Camerer & Fehr, 2006). More specifically, non-compliant citizens could drive others´ cooperation downwards in the absence of mechanisms that allow people to believe that compliance is common and prescribed (Bicchieri, 2006, 2016). Results from economic experiments with real incentives support these conclusions (e.g., Fehr & Gächter, 2002; Fischbacher & Gächter, 2010; Henrich et al., 2006; Milinski, Semmann & Krambeck, 2002; Wedekind & Milinski, 2000).

Preventive behaviors in the current pandemic may present the inherent conflict of a social dilemma in which individual costs associated with these behaviors may represent stronger incentives than the perceived benefits of prevention (Ling & Chyong, 2020; Schmelz, 2020), at least for some (e.g., the young; Franzen & Wöhner, 2021). Considering and stimulating other-regarding motives have been proposed as potential solutions to unlocking social dilemmas and achieving socially desirable outcomes in the current pandemic (Betsch, 2020; Ling & Chyong, 2020). For instance, some nudges tested to improve compliance with preventive behaviors have been targeted at focusing people´s attention on the benefits conferred to others (Hume et al., 2021). In the same vein, Bicchieri (2006) proposed that social norms (beliefs about common behaviors as well as about behavioral prescriptions and sanctions for noncompliance) may serve to better align individual and social incentives in social dilemmas. Indeed, people may choose to perform socially-beneficial individually-costly behaviors if they believe others are behaving that way (Fischbacher, Gächter, & Fehr, 2001; Fischbacher & Gächter, 2010; Bicchieri, 2016). Patel (2021) has recommended this descriptive-norm nudge to increase people´s willingness towards COVID-19 vaccination. However, normative messages may not be a silver bullet to instigate preventive behaviors (Bilancini, Boncinelli, Capraro, Celadin, & Di Paolo, 2020), and much still needs to be learned about the extent to which and how people´s preventive behaviors could be motivated out of social concerns.

In the present studies, we focused on studying demographic as well as belief-related factors associated with COVID-19 preventive behaviors, in particular mask wearing, while people did outdoor recreational activities such as walking, running, and cycling. There has been concern that outdoor activities may involve contagion risks which can be reduced with appropriate behaviors (Arias, 2020; Bloken, Malizia, van Druenen, & Marchal, 2020; Setti et al., 2020). Moreover, to our best knowledge, most research on COVID-19 preventive behaviors have not assessed the frequency and determinants of the same behavior across different activities (see relevant references above), implicitly disregarding relevant variation that may arise as people perceived different risks, costs, and benefits in different situations. In more detail, in Study 1, we went to public recreational sites in Bahía Blanca (Argentina) to unobtrusively measure people´s use of facemasks while they were walking, running, or cycling. This study provided hard behavioral data on compliance with mask wearing across weeks. During the studied period, authorities required citizens to wear masks for doing outdoor activities. We hypothesized, however, that, without enforcement, compliance would decline over time, following a pattern common to social dilemmas (Fehr & Gächter, 2002; Henrich et al., 2006; Nowak, 2011).

It is relevant to highlight here that the present observational study contrasts against most research on preventive behaviors during the current pandemic which has relied mainly on self-reports (see Freeland et al., 2020). This research tendency has seemingly continued in 2021 (e.g., see Rad et al., 2021; Rader, White, Burns, Chen, Brilliant, Cohen, Shaman, Brilliant, et al., 2021; Roberts & David, 2021). However, the potential issue of social desirability biases should incline researchers to consider self-reports on health behaviors with caution. We are not the first to highlight the issue of social desirability in COVID-19 survey research (de Bruin & Bennet, 2020; Haliwa, Lee, Wilson, & Shook, 2020). The main issue with self-reports on health behavior is that survey respondents might feel inclined to over-report pro-health-related behaviors as a self-serving conscious or unconscious strategy (Contzen, Pasquale, & Mosler, 2015; Kristiansen & Harding, 1984; van de Mortel, 2008). In addition, the social responsibility prescribed for COVID-19 preventive behaviors could add another layer of social pressure inclining respondents to bias their reports of preventive behaviors. Indeed, socially desirable responding is most likely to occur in response to socially sensitive issues (King & Brunner, 2000). Hence, an important strength of Study 1 was the obtention of observational data on the level of preventive behaviors across time, allowing us to assess its relationship with demographic variables and epidemiological data. Furthermore, observational data was used as a reliable source to validate behavioral self-reports in Study 2, thus, providing a type of validity for survey self-reports that has been mostly lacking from research on COVID-19 preventive behaviors (de Bruin & Bennet, 2020; Freeland, et al., 2020; Haliwa et al., 2020).

In Study 2, we surveyed people about the frequency of mask wearing during outdoor activities while also asking about relevant beliefs to test them as potential predictors of the target preventive behaviors. We asked about some core concepts from the HBM (Rosenstock, 1974; Champion & Skinner, 2008) such as, perceived illness susceptibility and severity, as well as, perceived costs and benefits of mask wearing. In addition, to complement these concepts from the HBM, which only focuses on the perception of consequences directly relevant for the individual (Brewer & Rimer, 2008), we included a social dilemma perspective in which subjective norms and other-regarding motives were surveyed as potentially relevant predictors of preventive behaviors (Ling & Chyong, 2020; Moussaoui et al., 2020).

2. STUDY 1

In this study, we collected systematic observational data on people´s compliance with the norm of wearing a facemask during outdoor activities across weeks. The goal was to estimate the variation in mask wearing across activities and time, and assess its association with demographic (age and sex) and epidemiological data (local and nation-wide numbers on COVID-19 cases and deaths). At the same time, observational data on mask wearing were used to validate self-reported mask wearing from the survey (this is explained in detail in the *Methods* section of Study 2).

In Study 1, we took measures of mask wearing for 8 weeks, beginning in the first week local authorities allowed citizens to go out for outdoor recreational activities after the initial months of strict lockdown for the COVID pandemic in Argentina. In order to do outdoor recreational activities, local authorities had set up a webpage in which people had to register before leaving their homes. Importantly, through this webpage as well as other means (e.g., radio and tv spots), authorities made clear that mask wearing was mandatory for outdoor recreational activities. Considering mask wearing as a preventive behavior with the features of a social dilemma (personal costs and benefits to third parties), we expected the proportion of people wearing masks to decline with time, in particular if this norm was not enforced by authorities. The fact that we collected data from the first week outdoor recreational activities were allowed after the initial lockdown was an important feature of the present study because it allowed uncertainty about actual enforcement. Enforcement uncertainty should incline citizens to comply with mask wearing to some degree in the beginning, while the accumulation of experience of non-enforcement predicted lower compliance over time.

Methods

The protocols of present studies (both Studies 1 and 2) were reviewed and approved by the Bioethics Committee of the Municipal Hospital of Bahía Blanca (Hospital Municipal de Agudos "Dr. Leónidas Lucero").

The local government in Bahía Blanca allowed outdoor recreational activities from May 25th 2020 after more than 2 months of strict lockdown (Figure S1 in *Supplementary Online Materials* shows a timeline of local events in the pandemic and the number of new daily cases of COVID-19 in Bahía Blanca). Since the first week this permission was in place, we went to different outdoor recreational sites to register the frequency of facemasks use. Each of the five co-authors went to one of five recreational sites selected for their known use for outdoor recreational activities at different times and days of the week to register whether people adhered to the required wearing of facemasks during outdoor activities (Figure S2 in *Supplementary Online Materials* shows a map of the city with the sampling sites marked in color). The selection of days and times was made considering observers´ convenience, also trying to cover busy hours in order to capture mask use when it was most consequential (i.e., when it was most crowded). Systematic observations began on Thursday May 28th and ended on Wednesday July 8th, covering six weeks for the first round of observations. The second round went from October 22nd to November 4th, covering another two weeks. These two rounds of observations were intended, first, to have more or less continuous monitoring of the target behaviors during the first weeks since outdoor activities were allowed, and, second, to have an idea on whether compliance changed in the longer term.

Observation sessions lasted from 30 to 60 min. During sessions, observers used a paper notebook with a grid in which they wrote down the place, date and start and end times of the session. Once in site, observers selected a path, if there was more than one, and began walking and registering the people they passed by (i.e., only those who were going in the opposite direction). For each registered person, records involved the size of the group (1: if they were alone), the activity they were doing (walking, running, or cycling), an estimated age (baby –if does not walk and looks younger than 12 months-, child –Up to 12 years old-, adolescent –up to 18 years old-, young adult –up to 30 years old-, adult –up to 60 years old- and elderly), an estimated gender (woman/man), and, of most importance, whether they were wearing a facemask, and, if they were wearing it, how they were using the mask (covering mouth and nose, covering only the mouth, or covering neither the nose nor the mouth). To minimize sampling biases in case the flow of people was excessive to register everyone, there was a rule by which observers would register the person who was approximately 10 meters away at the moment of raising the head to score. Also, as far as possible, we avoided registering the same person more than once in the same session. Last, we took note whether at any point in the route we saw police presence nearby the recreational area (within 50 m of the place where an observation was recorded), though we almost never saw the police or any other formal authority around.

In total, we recorded 15,507 people walking, running, or cycling during 80 hours of data collection in the 8 weeks that the sampling lasted. We also kept track of the number of infections and deaths associated with COVID-19 both nationally and locally during the studied period.

Statistical analyses

Analyses were done with *STATA 13*. We did *Probit* regressions with facemask wearing (1: yes; 0: no) and appropriate use of facemask (1: covering nose and mouth; 0: without mask, or with mask below the mouth, or with mask covering only the mouth) as outcome variables, and several predictors: time (week number, from 1 -first week of sampling by the end of May- to week 23 -eighth week of sampling in November), activity (we created a dummy variable for each activity, walking, running, and cycling), group size, estimated age, and estimated gender (1: female; 0: male). Data and *STATA* codes for the analyses can be found in the following *Open Science Forum* (OSF) link: https://osf.io/3qsu7/?view_only=6d59937019f446d682ece94dde9cb779

Results & Discussion

From the 15,507 observations throughout the 8 weeks of the study, 71% of the records involved people walking, 15% people running, and 12% people cycling. Around half of the sample was attributed female gender (53%), and we recorded %0.005 babies, 5% children, 7.2% teenagers, 26% young adults, 54% adults, and 7.6% older adults (with a few missing cases).

Figure 1 shows the proportion of people wearing a facemask while walking, running, and cycling across weeks. A *Probit* regression with walking and running as dummy variables (using the cycling dummy as reference category) showed that mask wearing was significantly more likely for those walking ($B = .65$, $p < .001$) and marginally less likely for those running ($B = -.07$, $p = .08$) relative to those cycling (walking-vs.-running, $\chi^2 = 592$, $p < .001$). A similar analysis with appropriate use of the mask showed more appropriate use for those walking ($B = .56$, $p < .001$) and less appropriate use for those running ($B = -.44$, $p < .001$) relative to those cycling (walking-vs.-running, $\chi^2 = 448$, $p < .001$).

FIGURE 1

Separate regressions for each activity showed that wearing a mask and wearing it appropriately significantly decreased across weeks for the three activities (wearing a mask while walking, B = -.04, p < .001; wearing a mask while running, B = -.07, p < .001; wearing a mask while cycling, B = -.05, p < .001; appropriate use of mask while walking, B = -.02, p < .001; appropriate use of mask while running, B = -.03, p < .001; appropriate use of mask while cycling, B = -.04, p < .001). As shown in Figure 1, as mask wearing declined over time, COVID cases and the associated death toll increased both locally and nation-wide (the last two weeks of the study -October and November 2020- involved the period of time in which the first local peak of contagion was registered; https://gobiernoabierto.bahia.gob.ar/coronavirus/salud/; see further details about the COVID-19 timeline in Bahía Blanca in Figure S1 in *Supplementary Online Materials* at the OSF link).

Wearing a mask while walking was positively predicted by being a female (B = .26, p < .001) and being older (B = .19, p < .001), and negatively predicted by group size (B = -.04, p = .016). Qualitatively similar findings were obtained when the dependent variable was appropriate use of the facemask instead, with the exception of group size which became non-significant (gender, B= .17, p < .001; age, B = .05, p = .003; group size, B = -.02, p = .24). Wearing a mask while running was positively predicted by being female (B = .25, p < .001), and negatively predicted by group size (B = -.17, p < .001), whereas age was not a significant predictor (B = -.03, p = .40). In the case of appropriate use of the facemask while running, whereas that behavior was marginally more frequent in females (B = .12, p = .08), it decreased with age (B = -.13, p = .01) and group size (B = -.28, p < .001). Last, wearing a mask while cycling was (negatively) predicted by group size only (B = -.06, p = .04; gender, B = .10, p = .10; age, B = -.01, p = .62), whereas the only significant predictor of an appropriate use of the mask while cycling was age (B = -.07, p = .026; gender, B = .04, p = .61; group size, B = .04, p = .29).

In sum, the only general findings across activities were that wearing masks and wearing them appropriately decreased across weeks. In addition, going outdoor for recreational activities in groups of people usually predicted fewer cases of mask wearing, and fewer cases of appropriate use of the mask than going alone. Women wore masks more frequently than men both for walking and running, and whereas an older age predicted wearing a facemask and using it appropriately while walking, that pattern did not occur in the other two activities.

3. STUDY 2

The goal of this second study was to aid the understanding of the factors leading to compliance with the norm of mask wearing during outdoor activities. More specifically, we tested variables from the HBM (Champion & Skinner, 2008), such as perceived COVID-19 contagion risk, disease severity, the effectiveness of masks as a prevention measure, and costs of wearing masks, as predictors of mask wearing while walking, running, and cycling. To encompass other-regarding motives as potential predictors of the target preventive behaviors, we also asked for perceptions of illness susceptibility and severity for third-parties as well as of mask effectiveness to protect others. Last, we also tested whether subjective norms (personal, descriptive, and prescriptive) were significant predictors of mask use.

Methods

Participants

We relied on a non-probabilistic convenience sample. The recruitment of participants to the online survey was done through emails and social media. We sent an invitation email to a database of 5,000 email addresses including students (undergrads and postgrads), former students, teaching assistants, and professors from the Universidad Nacional del Sur and other tertiary-level education institutions in Bahía Blanca. At the same time, each of the authors shared the survey link in her or his social media (e.g., Whatsapp, Facebook, and Instagram). The survey was filled in by 578 respondents in a period of 14 days (last week of October and first week of November 2020), time which coincided with the last two weeks of behavioral field observations from Study 1.

Instrument

The responses analyzed here are only a part of the survey questions, which also included topics, such as vaccination intent and political preferences, not reported here. The original survey was in Spanish, and an English translation of the survey questions relevant for present goals can be read in *Supplementary Online Materials*. The main outcome variables in the survey were respondents´ frequency of mask use during outdoor recreational walking, running, and cycling. Respondents answered about the frequency of mask use during the mentioned activities in a 10-point scale from "never" to "always", both in general during the pandemic and in the last week in particular. Before questions on mask use, respondents were asked to report whether they had gone walking, running, and cycling during the COVID-19 pandemic in general and during the last week in particular, and, in case they did so, they were asked to report where in the city (to check for the sampling sites of Study 1).

We also asked for different types of beliefs as potential predictors of mask wearing. Belief questions were asked separately for each activity (walking, running, and cycling) unless indicated.

Perceptions of risk of contagion and mask effectiveness: participants were asked to rate in a 10-point scale from "no risk" to "very risky" their perceived risk of COVID-19 contagion if they did the activity without facemask. We also asked respondents to estimate the risk of contagion if they did wear a mask, and the difference between the reported risk with and without mask was taken as an index of a perceived benefit of wearing a mask, hereafter called "effectiveness". We also asked respondents to estimate the risk of contagion for third parties who passed by a person unknowingly ill of COVID-19 doing an outdoor activity with or without a mask. The risk and effectiveness for the self is referred to as "risk_1" and "effectiveness_1", respectively, whereas the risk and effectiveness for others is referred to as "risk_2" and "effectiveness_2", respectively.

Perceived illness severity: In 10-point scales from "no risk" to "very risky", we asked for the expected severity of several potential negative consequences of getting COVID-19, which included consequences for their own health and life risk, for their home economy, for their loved ones´ health, and for others´ health. Severity questions did not differentiate among activities.

Perceived costs of wearing a mask: In terms of the barriers for wearing a mask, we asked respondents to express their beliefs about the comfort and health adverse consequences of mask wearing. Questions asked to report in 10-point scales from "not uncomfortable at all" to "very uncomfortable" to estimate mask comfort during a given activity, and from "not at all dangerous" to "very dangerous" to estimate the perceived health risk of wearing a mask.

Subjective norms: we measured beliefs about the likelihood of informal and formal sanctions for not wearing masks during outdoor activities, common behaviors, normative expectations, and we also elicited personal norms. Respondents expressed in a 10-point scale from "very unlikely" to "very likely" the perceived likelihood of their attention being called by a formal authority or by a common citizen for not wearing a mask while doing outdoor activities (the estimation of formal and informal sanctions did not differentiate among activities). Empirical and normative expectations were elicited by asking respondents to estimate how many people wore a mask out of every 10 people walking, running, and cycling, and how many believed not wearing a mask while doing the activity was morally reproachable, respectively. Personal norms involved replying in a 10-point scale from "not at all" to "very much", the extent to which respondents thought not wearing a mask while doing the activity was morally reproachable.

We presented the survey in four different orderings of questions across participants: whether questions of risk perception were presented before/after questions of subjective norms, and whether questions of descriptive norms were presented before/after questions of prescriptive norms. Frequency of mask wearing was always asked before questions about risk, norms, severity, and costs. Questions about illness severity and costs of wearing masks were always asked after questions about risk and norms. Last, we asked about age, gender, and education.

Analysis plan

First, we presented the descriptive statistics of the raw variables from the survey as a function of activity. Second, we grouped (averaged) many raw variables into fewer theoretical relevant groups (mask wearing, contagion risk for the self, contagion risk for others, severity for the self, severity for other, self-protective effectiveness, other-protective effectiveness, costs, and norms), and report their descriptive statistics (which did not discriminate among activities) as well as their Cronbach´s alpha to assess internal consistency. Because the distinction between self and others attempted to track respondents´ concern for the self and loved ones versus others in society in general, severity for the self also involved considerations of severity for close others.

Third, we were interested in assessing whether respondents´ report of the frequency of mask use as a function of activity presented a similar pattern to that obtained from unobtrusive field observations in Study 1. This was intended as a validation of the main outcome variables in the survey. Because some people reported going out just for one of the target activities, while others reported doing two or even the three activities, different non-parametric tests on mask wearing were done for each of these cases (*Wilcoxon Matched*-paired tests for repeated measures, and *Mann-Whitney U* tests for between-subject comparisons).

Fourth and last, to search for the main predictors of mask wearing, we did hierarchically organized regressions with both raw and composite variables (for raw variables we ran an independent set of hierarchical organized models for each activity). The entering order of factors in the regressions was as follows: socio-demographic controls, contagion risk, illness severity, benefits (mask effectiveness), costs, and norms. For each hierarchical regression, we reported whether the addition of each subsequent level of variables significantly improved the variance explained by the previous level. The alpha value was set at .05. Data and *STATA* codes for the reported analyses can be found at the at the following *OSF* link: https://osf.io/3qsu7/?view_only=6d59937019f446d682ece94dde9cb779OSF

Results & Discussion

Descriptive statistics

The online survey was responded by 578 individuals. Respondents´ mean (± 1 SD) age was 33 ± 11 years old, ranging from 18 to 76; 64% self-identified as women, and 34% as men (very few preferred not to respond the gender question); and, relative to respondents´ highest level of achieved education, 59% reported complete tertiary studies (which included university degrees), 35% reported incomplete tertiary studies, 4% reported complete secondary education, and the remaining 2% involved 4 respondents with incomplete secondary education, 2 who never went to school, and 1 who did not want to answer.

In Table 1, we presented the descriptive statistics for the raw variables in which self-reports discriminated among activities. Mask wearing in general highly correlated with mask wearing during the last week for the three activities (for walking, $r = .87$, $n = 382$; $p < .001$; for running, $r = .94$, $n = 84$; $p < .001$; and for cycling, $r = .91$, $n = 149$; $p<.001$). Therefore, we only reported mask wearing for each activity in general (see Table 1). Self-reported mask wearing across activities showed a similar pattern to that observed in the field (Figure 1, Study 1): people walking showed the highest frequency of mask use, followed by bike riders, and then by runners. This ordering of mask wearing across activities was evident to respondents as indicated by their estimation of how common each behavior was (descriptive norm). Relative to the perceived risk of contagion for a person doing the activity without mask (risk_1), respondents perceived more risk for walking than running than cycling (further discussion of these findings can be found in the sub-section *Determinants of risk perceptions* in *Supplementary Online Materials* at the *OSF* link). In terms of the risk of contagion for someone passing by an unknowingly sick person doing the activity without mask (risk_2), respondents perceived greater risk for passing by a person walking or running, than a person cycling. Mask effectiveness for self and others´ protection was estimated to be higher for walking, than for running, than for cycling, following the same ordering across activities as risk perception. In terms of the perceived comfort and health costs of wearing a mask, respondents´ perceived them to be higher for running, than for cycling, than for walking. Interestingly, considering perceived risk of contagion, mask effectiveness, and mask costs, only the latter presented an ordering pattern across activities coincidental with the pattern of mask use (i.e., walking > cycling > running). The mentioned pattern was also reflected in the estimated descriptive norms. Prescriptive and personal norms, however, showed that respondents believed that others and themselves, respectively, found walking without mask to be more reproachable than running or cycling without mask (we further explored and discussed the determinants of respondents´ personal norms in *Supplementary Online Materials* at the OSF link).

TABLE 1

To simplify the presentation of pair-wise correlations, we report associations among composite variables (i.e., without discriminating among activities; see Table 2). The variable "Mask use", which was obtained by averaging the frequency of mask wearing across activities, included both the general report of the frequency of mask use as well as the reported use for the last week, and showed an excellent internal consistency (see Cronbach´s alpha in Table 2). The main finding was that the frequency of mask wearing significantly correlated with all the composite scores of the main potential predictors considered (see Table 2). To better understand the predictive relationship of these factors with mask wearing as outcome variable, we reported hierarchical regressions below.

TABLE 2

Validation of self-reported mask use

Because some people reported going out just for one of the target activities, while others reported doing two or even the three activities, different tests (repeated measures vs. between-subject) on mask wearing were done to compare the frequency of mask use between pairs of activities. For the within-subject comparison, *Wilcoxon* tests showed that all differences in mask wearing between activities were significant (higher frequency of mask wearing for walking than running, $z = 8.38$, $n = 139$, $p < .001$; higher for walking than cycling, z = 9.19, n = 201, $p < .001$; higher for cycling than running, z = 2.95, n = 90, p = .003). For the between-subject comparison, wearing a mask while walking was reported to be more frequent than in the other two activities (vs. running, $\chi^2 = 15.36$, n = 379, $p < .001$; vs. cycling, $\chi^2 = 13.31$, n = 313, $p < .001$); however, there were not significant differences in the frequency of mask wearing between those reporting to have gone running and those gone cycling ($\chi^2 = 1.76$, n = 214, p = .18). Similar results were found when the same analyses were done only with respondents who reported going for outdoor activities in sites sampled in Study 1 (see *Supplementary Online Materials*). Importantly, people reported wearing masks more frequently when walking than when cycling, and when cycling than when running in Study 2 in agreement with observational data collected in the same weeks (Study 1). In addition, self-report and behavioral data both showed that the quantitative difference in mask wearing between people walking and people doing the other two activities was larger than between those running and those cycling (see the last two weeks in Figure 1 and mask use in Table 1). In sum, the mentioned similarities in the frequency of mask use between self-reports and observational data provided some confidence that self-reports tracked objective behavioral data from the field in some meaningful way.

Predictors of mask wearing

In this sub-section, we reported hierarchical regressions of mask use as outcome variable and socio-demographic controls (age, gender, and education), contagion risk, illness severity, mask effectiveness, costs of wearing masks, and subjective norms about mask wearing as predictive factors. We reported a general regression with composite variables (see Table 3) as well as independent regressions for each activity with raw variables (see Table 4).

TABLE 3

The hierarchical regression in Table 3 showed that, in its first step which included socio-demographic controls, the only significant predictor was age, meaning that older people reported more frequent use of masks during outdoor activities. As expected considering the available information on risk groups for COVID-19 (e.g., see Franzen & Wöhner, 2020), age significantly predicted the estimated severity of the illness for the self (standardized B = .184, $p < .001$; but not the estimated severity for others´ health, standardized B = -.01, p = .81). Age also predicted subjective norms (standardized B = .11, p = .012), but not perceptions of risk of contagion (standardized B = .05, p = .20) or mask effectiveness (standardized B = .03, p = .49). The following steps of the regression showed that the addition of perceived contagion risk, estimated costs of wearing a mask, and subjective norms made a significant contribution in the explanation of mask wearing variance, whereas the estimated severity of getting ill and the perceived effectiveness of wearing a mask did not add significant explanatory value.

In agreement with the hierarchical regression with composite scores (Table 3), independent regressions for each of the three activities with the raw measures from the survey (Table 4) showed that the addition of variables measuring perceived risk of contagion, costs of wearing a mask, and subjective norms significantly contributed to the explanation of variance in mask wearing. In turn, the addition of variables measuring estimated severity of getting COVID-19 and the effectiveness of wearing a mask in reducing the contagion likelihood did not add significant explanatory value. In more detail, risk of contagion for the self if not wearing a mask was a significant predictor of mask wearing in all three activities; and, the perceived risk of contagion for others passing by a sick person without mask predicted wearing a mask for walking and cycling, but not for running. In turn, the estimated comfort cost of wearing a mask negatively predicted wearing a mask for the three activities, whereas estimated health costs only negatively predicted mask wearing for walking. Last, we can see that most variability in mask use explained by subjective norms came from respondent´s personal norms and empirical (descriptive) expectations about others´ use of masks, whereas the estimated likelihood of formal and informal sanctions and prescriptive norms were rarely significant.

TABLE 4

In brief, the predictors explaining a significant proportion of the variance in mask wearing were perceived risk of contagion, perceived costs of wearing a mask, and subjective norms, whereas perceived illness severity and mask effectiveness did not contribute much.

4. GENERAL DISCUSSION

The present research contributes to the understanding of the determinants of mask wearing as a behavior that may reduce the contagion risk of COVID-19 during outdoor recreational activities such as walking, running, and cycling. Present findings were obtained from an observational study which provided objective behavioral data on mask wearing across weeks as well as from a survey which allowed obtaining responses about potentially relevant beliefs. Both studies were done with samples from a mid-size city from Argentina in 2020. We believe that the present observational data is an important contribution to the literature on COVID-19 preventive behaviors which has mainly relied on self-reports (Freeland et al., 2020) with the associated validity concerns that result from the possibility of social desirability biases (Kristiansen & Harding, 1984; van de Mortel, 2008). In addition, present research contrasts against similar studies in that we assessed the same preventive behavior, mask wearing, across activities, therefore, taking into account people´s different perceptions of risks, benefits, costs, and norms across situations.

The main findings of present studies were as follows. In terms of the behavioral data, first, we observed that the frequency of mask wearing declined across weeks for the three activities measured. This behavioral pattern went in contrast to the increase in COVID-19 cases and associated death toll both locally and nation-wide. The declining compliance with mask wearing was predicted from a social dilemma perspective according to which personally costly pro-sociality may be difficult to sustain without norm enforcement or other mechanism to nudge compliance. Indeed, the snow-balling of cooperation in the context of social dilemmas is a common cross-cultural phenomenon (e.g., Henrich et al., 2006). Second, we found that people walking were the ones with the highest proportion of mask use followed by people cycling, whereas runners were the ones showing the least compliance. Third, overall, women were significantly more likely to wear masks than men, which agrees with the literature showing that women tend to be more risk averse than men (e.g., Charness & Gneezy, 2012), and may be more compliant with norms (e.g., Rivas, 2013; Grosch & Holger, 2017).

In terms of the survey results, first, reported mask use followed the same pattern across activities as that observed in the field, which provided confidence on the validity of self-reports. Second, self-reported mask wearing was significantly predicted by perceptions of risk of contagion for the self and for others. The association of preventive behaviors with perceived risk of contagion for the individual has been shown before both in the current pandemic (Anaki & Sergay, 2021; Prasetyo et al., 2020; Rad et al., 2021) as well as in the context of the H1N1 pandemic more than a decade ago (Bish & Michie, 2010). This sensitivity to perceptions of risk of contagion may seem contrary to behavioral data showing that mask wearing declined as the objective risk of contagion increased (i.e., the number of local new daily cases of COVID-19). However, previous findings from our group showed that subjective risk of contagion for doing outdoor activities without mask did not positively track the number of local COVID-19 cases (xxxx, 2020). In turn, the relevance of other-regarding risk beliefs in predicting mask wearing agreed with cross-country research showing that pro-sociality is positively associated with increased risk perception (Dryhurst et al., 2020). This suggests that other-regarding concerns may be a reasonable target to stimulate compliance, which could be a strategy particularly suited to tackle people who may not be personally worried about getting the disease, such as the young (Franzen & Wöhner, 2021).

Third, neither did perceived illness severity nor perceived mask effectiveness add significant value to predicting mask wearing in the survey data. These findings contrast with other research on COVID-19 preventive behavior (Anaki & Sergay, 2021; Hornik et al., 2021; Tong et al., 2020). Unfortunately, we can only speculate about the sources of divergence between present results and those from others, which can go from the time the surveys were taken to the many differences associated with considering samples from different countries (e.g., different implemented policies; Frey, Chen, & Presidente, 2020). For instance, differences in the consistency of information about effective protection may lead to very different rates of preventive behavior (Witte & Allen, 2000), and such consistency may change with time as we observed, for example, with changes in the *WHO*´s recommendations on the use of masks for the general public in the current pandemic. Indeed, Prasetyo et al. (2020) found that the level of understanding of COVID-19, which could be related to the available information, had an impact on the perceived effectiveness of preventive behaviors.

Fourth, personal costs of mask wearing, in particular comfort costs, resulted a significant negative predictor of mask wearing, which seems as a likely explanation of why runners were the group least disposed to wearing masks. Interestingly, comfort costs were even taken into account while considering whether not wearing a mask was morally reproachable. This is surprising under the view that moral considerations, in principle, should focus attention towards the avoidance of harm to third-parties (Gray, Young, & Waytz, 2012) more than towards personal comfort issues. This result might suggest that the people sampled in the present survey may only weakly weight others´ costs and benefits when deciding whether to wear a facemask. Indeed, the standardized coefficient of the perception of risk of contagion for others tended to be merely around half the size of the coefficient for the perception of risk of contagion for the self in predicting mask wearing across activities, and was even non-significant for predicting runners´ use of masks (see Table 4).

Last, we found that both personal and descriptive norms were the most important predictors of mask wearing. Indeed, conditional cooperation (the propensity to incur pro-social costs as long as I perceive others doing so) may underlie the observed decrease in compliance across weeks found in Study 1. Economic experiments have repeatedly illustrated cross-culturally that cooperation may be difficult to sustain without mechanisms to enforce it because free riders disincentivize conditional cooperators´ efforts (Fehr & Gächter, 2002; Henrich et al., 2006). Different strategies beyond enforcement have been suggested to address this issue in the current pandemic which could go from using *in situ* normative nudges in the form of signs or posters to the involvement of group leaders

(Neville, Templeton, Smith, & Louis, 2021; Van Babel et al., 2020) which, for instance, in the case of runners could be the person in charge of the training group.

Before closing this article, we want to mention some limitations of the research described here. First of all, it is important to have in mind that present findings cannot be directly generalized to the population from which present samples were obtained because we did not rely on representative samples. Having said that, the massive sample of the observational study provides confidence on the reliability of the behavioral results obtained, in particular, the fact that, without enforcement or other reminders, mask wearing declined across weeks, despite the increasing objective risk of contagion as the virus spread locally. It is also relevant to note that present goals were targeted, not at extrapolating the findings to a broader population, but at testing hypotheses concerning whether observed and reported behavior could be associated with factors related to the HBM and a social dilemma perspective on preventive behavior. In any case, the corroboration of present findings in other samples will serve to test the robustness of present conclusions.

Second, we need to have in mind that the estimated effect of beliefs on preventive behaviors depended on self-reports. Self-reported mask wearing could be validated with observational data which is a methodological strength of the present research. However, beliefs cannot be validated in a similar manner. Though this is a problem with most research relying on self-reports, it is relevant to have in mind that this could introduce bias for different reasons. For instance, respondents could have adjusted their belief reports based on their reported behavior to reduce cognitive dissonance (Festinger, 1962). This could lead to spurious beliefs-behavior associations. For instance, that could be the case with the high predictive effects of personal and descriptive norms on self-reported behavior in Study 2. Beliefs about common behaviors could be adjusted based on own behavior to avoid feeling misaligned with the majority. Similarly, personal norms may be biased by post-hoc reasoning to justify own behavior. In short, results from self-reports need to be taken with caution.

Last, we only considered some of the core concepts of the HBM for reasons of brevity, and presumed relevance. However, there are a number of other concepts both from the HBM as well as from other health behavior models (Glanz & Bishop, 2010 for a review) that could be worth exploring in future research. For example, due to our field work (Study 1) we became aware of a lack of cues to action (e.g., reminders of the relevant preventive behaviors) in the sampling sites, which relevance in determining mask wearing and potential to incite compliance should be further explored.

To finish, we conclude with a summary description of the main strengths and findings of the present studies. Unbiased observational data clearly showed that mask wearing for the three activities measured steeply declined across weeks and months after the initial 2020 lockdown in Argentina. Nonetheless, mask use was not homogenous across activities. Indeed, differences in mask use among people walking, running, and cycling could be traced back to differences in perceptions of contagion risks, of comfort costs of wearing a mask, and of how common mask wearing was as a function of the activity. Surprisingly, perceptions of illness severity and mask effectiveness did not predict mask use in the present sample.

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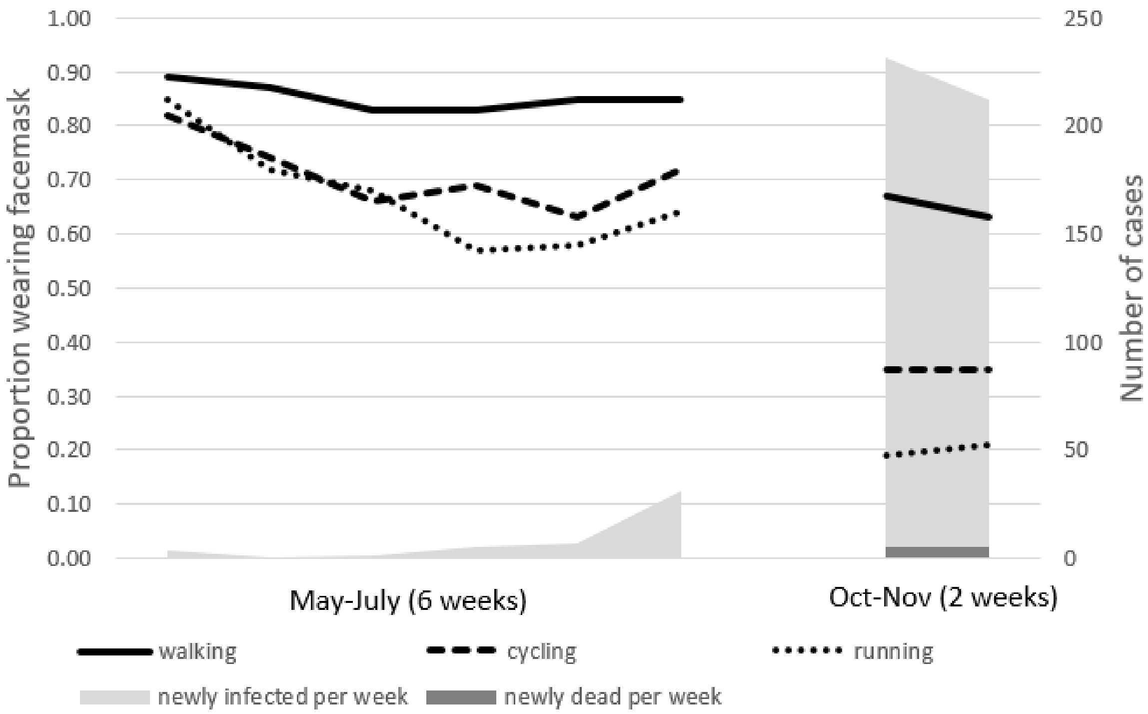
FIGURE CAPTIONS

Figure 1. The Y axis on the left shows the proportion of people using facemask as a function of week and activity, whereas the right Y axis shows the number of new COVID-19 cases and deaths on those weeks in Bahía Blanca.

FIGURES

Figure 1.



TABLES

Table 1. Mean (±1 SD) of self-reports that discriminated among walking, running, and cycling. The three right-hand side columns show p-values corresponding to Wilcoxon Matched-paired tests.

	walking	running	cycling		walk vs. run	walk vs. ride	run vs. ride
Mask wearing	8.48 (2.63)	5.16 (3.88)	5.89 (3.70)		<.001	<.001	.003
Risk_1 (for the self)	6.26 (2.90)	5.73 (3.00)	4.62 (3.00)		<.001	<.001	<.001
Risk_2 (for others)	7.22 (2.80)	7.18 (2.88)	6.04 (3.04)		.605	<.001	<.001
Effectiveness_1 (for the self)	3.35 (3.08)	2.69 (3.19)	2.08 (3.02)		<.001	<.001	<.001
Effectiveness_2 (for others)	3.31 (2.30)	3.13 (2.37)	2.67 (2.48)		.012	<.001	<.001
Comfort cost	5.98 (2.93)	8.56 (2.17)	7.43 (2.70)		<.001	<.001	<.001
Health costs	3.55 (2.94)	5.63 (3.34)	5.02 (3.29)		<.001	<.001	<.001
Prescriptive norm	5.44 (2.16)	3.95 (2.40)	3.55 (2.35)		<.001	<.001	<.001
Descriptive norm	6.07 (1.99)	2.89 (2.29)	3.04 (2.19)		<.001	<.001	.553
Personal norm	7.01 (3.26)	5.26 (3.43)	4.78 (3.39)		<.001	<.001	<.001

Table 2. Descriptive statistics (including Pearson´s correlation coefficients) of the main composite variables of Study 2.

	Mean (±1 SD)	Cronbach´s α	N	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) Mask use	7.61 (3.05)	.97	531								
(2) Risk_1	5.54 (2.72)	.90	578	.55***							
(3) Risk_2	6.81 (2.73)	.93	578	.50***	.80***						
(4) Severity_1	4.88 (1.81)	.63	577	.19***	.34***	.31***					
(5) Severity_2	5.10 (2.91)	single item	572	.10*	.22***	.19***	.39***				
(6) Effective_1	2.71 (2.81)	.89	573	.43***	.74***	.57***	.21***	.16***			
(7) Effective_2	3.04 (2.13)	.87	578	.33***	.46***	.58***	.10*	.08*	.55***		
(8) Costs	5.96 (2.32)	.88	577	-.36***	-.38***	-.33***	-.07	.02	-.36***	-.19***	
(9) Norms	4.25 (1.45)	.79	578	.50***	.48***	.48***	.21***	.18***	.31***	.26***	-.30***

Table 3. Standardized coefficients from a hierarchical regression with mask wearing as outcome variable.

	(1)	(2)	(3)	(4)	(5)	(6)
Age	.12*	.08*	.08†	.08†	.08†	.05
Gender (F=1; M=0)	.04	-.01	-.01	-.01	.03	.03
Secondary education (c)	-.06	-.00	-.00	-.02	-.02	.00
Tertiary education (i)	-.28	-.11	-.12	-.14	-.19	-.11
Tertiary education (c)	-.35	-.13	-.12	-.15	-.19	-.11
Risk_1		.40***	.39***	.34***	.31***	.26**
Risk_2		.19**	.19**	.18*	.14*	.07
Severity_1			.02	.03	.03	.02
Severity_2			-.01	-.02	.00	-.02
Effectiveness_1				.05	.02	.02
Effectiveness_2				.03	.05	.06
Costs					-.17***	-.13**
Norms						.26***
R^2	.02†	.33***	.33***	.33***	.35***	.39***
ΔR^2		.31***	.002	.001	.022***	.046***
N	511	511	506	501	500	500

Table 4. Standardized coefficients from hierarchical regressions with mask wearing as outcome variable as a function of outdoor activity.

	Walking						Running						Cycling					
	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
Demographic controls																		
Age	.05	.02	.03	.04	.04	.006	-.03	-.008	-.015	-.01	-.006	-.01	.15†	.11†	.10	.10	.09	.07
Gender (F=1; M=0)	.04	-.01	-.01	-.006	.06	.04	-.15†	-.17*	-.18*	-.20**	-.14†	-.09	-.06	-.04	-.05	-.06	-.01	-.04
Secondary education	-.09	-.07	-.09	-.09	-.09	-.12	-.1	.07	.08	.09	-.067	.2	-.05	.05	.02	.04	.03	.04
Tertiary education (i)	-.26	-.17	-.21	-.22	-.27	-.28	-.57	-.27	-.27	-.19	-.14	-.19	-.29	-.07	-.14	-.12	-.16	.14
Tertiary education (c)	-.28	-.14	-.18	-.20	-.24	-.27	-.57	-.21	-.22	-.11	-.08	-.13	-.37	-.08	-.18	-.16	-.17	-.15
Risk																		
for the self		.37 ***	.38 ***	.34 ***	.31 ***	.21 **		.515 ***	.52 ***	.53 **	.43 **	.11		.37 ***	.38 ***	.26*	.17	.06
for others		.19**	.18**	.20**	.16*	.066		.03	.01	.13	.15	.11		.16*	.13	.12	.11	.01
Severity																		
Own health			.03	.03	.04	.004			.01	-.02	-.00	.04			.16†	.17†	.12	.05
Own life risk			-.03	-.03	-.02	.02			.04	.05	.06	.04			-.08	-.08	-.02	.03
Own economy			-.11*	-.10*	-.09*	-.07†			-.03	-.06	-.08	.004			-.04	-.02	-.01	.01
Loved ones´ health			.06	.06	.05	.015			.02	.03	-.05	-.07			.05	.04	-.00	.02
Others´ health			-.002	-.002	.01	.02			-.002	.005	.08	-.01			-.07	-.07	-.01	-.05
Effectiveness																		
For protecting the self				.04	.01	-.014				-.03	-.09	-.08				.16	.07	.03
For protecting others				-.02	-.01	-.01				-.145	-.13	-.055				.02	.01	.06
Costs																		
Comfort					-.11*	-.05					-.28 **	-.13					-.35 ***	-.26 ***
Health					-.14**	-.08†					-.00	.006					-.09	-.03
Norms																		
Informal sanction						.06						-.08						.005
Formal sanction						-.08*						-.004						-.06
Prescriptive						-.08†						-.03						-.14*
Descriptive						.27 ***						.33 ***						.15*
Personal						.32 ***						.37**						.38 ***
R^2	.01	.29 ***	.295 ***	.295 ***	.337 ***	.45 ***	.08*	.364 ***	.368 ***	.38 ***	.44 ***	.575 ***	.03	.27 ***	.282 ***	.293 ***	.422 ***	.522 ***
ΔR^2		.28 ***	.009	.001	.042 ***	.117 ***		.28 ***	.004	.013	.057 **	.137 ***		.237 ***	.011	.011	.13 ***	.1 ***
N	470	470	456	456	455	455	155	155	150	150	150	150	214	214	210	210	210	210