# Face Masks Use in the Public Domain and its Determinants During the SARS-Cov-2 Epidemic in Poland; a Non-Participatory Covert Observational Study

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## Abstract

**Background:** Face masks play an important role in protection from acquiring SARS-Cov-2, however, if used incorrectly they may increase transmission risk. Many countries, including Poland, currently recommend the use of masks in their pandemic control plans. The study objective was to assess the practices of the public in the case of face masks/N95 respirators utilization during the SARS-Cov-2 pandemic in Poland and to evaluate factors influencing their use.

**Methods**: This non-participatory covert observational study was conducted on 3 separate occasions, (10.05/18.05/25.05.2020). At each point, 82 medical students observed 10 consecutive individuals (2460 total) appearing in the public space in 13 Polish regions which differed regarding SARS-Cov-2 pandemic risk. A structured observation checklist served as a survey tool.

**Results**: A total of 2353 observations were included; the female/male ratio was similar (1.02-1.13-1.03 respectively) at the 3 occasions, as well as the age distribution, with those aged 21-60 years predominant (70.8%-71.9%-70.2% respectively). Most of participants (73.6%; 552/750) were using facial masks at the first time point, which decreased in the 2$^{nd}$ and 3$^{rd}$ week (544/818; 66.5% and 516/785; 65.7% respectively). A predominance of cloth masks was observed at all time points (64.7%-62.3%-62.6% respectively) followed by medical masks (23.4%-28.5%-26.9% respectively). Female gender (OR=1.75-1.47-1.53 respectively), age >40 years (OR=1.46-1.48 respectively), a closed space (OR=2.56-2.63-2.36 respectively) were each associated with higher mask usage. Those playing sports were about two times less likely to use facial masks (OR=0.64-0.54-0.54 respectively) than when compared to other activities. The percentage of those using masks correctly decreased gradually over time (364/552; 65.9%; 339/544; 62.3% and 304/516; 58.9% respectively); more females wore masks correctly ($p<0.05$). Breaches in nose covering (47.3%-52.7%) and hanging masks around the neck (39.2%-42.6%) were the most common incorrect practices while wearing a mask.

**Conclusions**: Cloth masks were predominantly used in the public space. Practices regarding the facial masks usage were found to be inadequate, especially among young males, and tended to decrease over time. Awareness campaigns regarding the need of the proper use of face masks by utilizing all communication channels available would be helpful during this pandemic to increase compliance.


## 1. Background

The severe acute respiratory syndrome coronavirus 2 (SARS-COV-2) pandemic that begun in the Chinese province of Hubei quickly became a global threat [1]. As of July 16$^{th}$ 2020, the virus has infected more than 13.8 million individuals worldwide and caused almost 589,000 deaths [2]. With no effective pharmacological interventions or vaccine available in the nearest future, other modes of prevention are the best approaches to control the disease spread [3, 4].

Emergency lockdowns have been initiated across the globe as the most effective way to limit disease spread and successfully helped to decrease the number of new cases [5-7]. Current strategies to transition out of lockdown, carried out in many countries, need to take into account the role of both symptomatic and asymptomatic individuals in spreading SARS-CoV-2 from person-to-person through close contact [8,9]. To tackle such problems, it is necessary to implement non-medical measures, such as the promotion of personal protection practices, e.g. use of face masks [4, 10, 11].

According to a current systematic review, face masks are associated with protection, even in non-health-care settings, with either disposable surgical masks or reusable cotton ones [11]. Wearing masks in public places is increasingly seen as having an important contribution to containing the viral spread, especially when physical distancing is not possible or unpredictable. These situations include stores and shopping areas, workplaces, health care facilities (i.e. surgeries, hospitals, care-homes etc.), public transport and busy sidewalks, as well as also households. If used widely and correctly and on a risk basis, face masks, including cloth masks, can reduce viral transmission: the use benefits increase where exposure risk is high and are marginal where it is low [10,11].

In the beginning of the pandemic, mask-wearing was controversial amongst leading health organizations, such as the World Health Organization (WHO) [12]. However, convinced by the evidence, the WHO has broaden its recommendations for the use of masks during the SARS-Cov-2 pandemic since June 5$^{th}$, 2020 and is now advising that in areas where the virus is spreading, people should wear masks when social distancing is not possible [13]. The US Centers for Disease Control and Prevention (CDC) has also modified previous recommendations, suggesting that, together with infected persons and health care workers, healthy people “should wear cloth face coverings in public settings when around people outside of their household” [14,15].

The European Centre for Disease Control (ECDC) recommends the use of face masks in the community, especially when visiting busy, closed spaces [16]. Regarding Europe, the formal guidance from the ECDC has informed official advice in many countries. As more was understood about asymptomatic transmission of SARS-CoV-2, governments had been more inclined to mandate mask wearing and facilitate access. The latter was possible through various initiatives such as the provision of templates or instructions for citizens (on how to make their own cloth face masks at home), boosted domestic production or access to shops selling fabric, as well as masks sold in supermarkets [17].

Different regulations on mask wearing have been in place in Europe since the beginning of the epidemic. In many countries it was mandatory outside the home as part of physical distancing measures under lockdown, this refers to Poland [18], Slovakia and Czechia [17]; the latter ones required masks in late March. In some other countries mask wearing has been introduced as a part of transition measures universally or in certain circumstances, such as on public transport or where physical distancing is not possible. In the remaining countries mask wearing is recommended, but not mandatory as part of transition measures [17].

In Poland the obligation to wear protective masks was not introduced in the initial period of the pandemic. On April 16$^{th}$, 2020, 6 weeks after the country’s first laboratory confirmed SARS-Cov-2 case had been reported, a new control measure was announced, making it obligatory to cover one's nose and mouth in public spaces; any form of face covering was acceptable. Failure to comply with this regulation, could result in a fine of up to PLN 500 to PLN 30,000 [18].

According to the National Police Headquarters, between April 15th and May 31st 2020, around 13,000 citizens were fined for not using a mask in the public space, 40,000 were instructed on correct mask use; around 5,000 applications were made to the court to fine individuals for not wearing a mask [19]. A relaxation of previous universal measures regarding mask wearing was announced on June 5, 2020, limiting it to be used in shopping areas, health care facilities, care-homes, public transport and churches [20].

In some Asian countries, such as China, South Korea, Hongkong, Taiwan and Japan mask-wearing is widely accepted [21]. In contrast, wearing masks has not been broadly practiced during the influenza seasons in Poland. According to an Ipsos report [22], in the initial phase of the SARS-Cov-2 pandemic (a week after the first case had been reported in Poland) only 4% of randomly selected Poles stated they wear masks in the public settings to protect from coronavirus. Two weeks later, the percentage increased 5-fold (20%). Interestingly, five weeks later, two weeks after making it obligatory to cover one's nose and mouth in public in Poland, 78% of respondents stated they use face masks “always” or “sometimes”.

Reports on the use of face masks by the general public as a preventive measure to limit SARS-Cov-2 transmission are scant, especially in European countries. Therefore, the objective of this study was to assess the use of masks/other face shields in the public space during the SARS-Cov-2 epidemic in Poland and to evaluate influencing determinants.

## 2. Methods

A non-participatory covert observational study was carried out during three occasions over a period of three consecutive weeks (10.05.2020, 18.05.2020, 25.05.2020) among the general public in Poland from the different risk areas regarding SARS-Cov-2 pandemic. The risk classification was adapted from a report made by the Ministry of Health on basic reproductive number (R) estimates [23]: high-risk areas (R>1); low-risk areas (R 0.5-1.0); very low-risk areas (R<0.5).

According to the latest census, Poland has a population of 38,383,000 [24]. The representative target sample size needed to achieve the study objectives and sufficient statistical power was calculated with a sample size calculator [25]. This arrived at 664 participants, using a margin of error of ±5%, a confidence level (CI) of 99% and a 50% response distribution.

At 2 pm, at each time point described above, eighty two 4th year medical students observed ten consecutive individuals of >4 years of age while venturing out into public spaces (820 observations per time point) which were divided into two categories: open/enclosed space. The age frame >4 years of age was arbitrarily chosen due to the governmental regulation requiring mask use for children older than 4 and adults [18]. Two types of public spaces were chosen arbitrarily: 1. representing open space, i.e. “sidewalks/parks” and 2. representing enclosed space - “shopping centers”. Three activities were observed: walking, outdoor sport activities and shopping. Students were randomly selected to make observations outdoors (75% observations) and indoors (25% observations). All 4th year medical students from the University of Zielona Gora, Poland, participated in the study collecting the relevant data. Trained students used a validated structured checklist, as recommended by “WHO guidelines on the use of masks in the context of COVID-19” [26]. Rational use of a face mask was defined as wearing a specific type of face mask (N95 respirator, medical mask, cloth mask, face shield or other – a scarf/ bidon). The correct manner of masks use in the public was defined as the use of masks as per the WHO/ECDC guidelines [16, 26]. Observations were carried out in student residence locations without the knowledge of those observed (covert).

### 2.1 Statistical analysis

Field notes were taken at observation points. Next, data were entered to MS Excel 2013. Data quality was assured by the review of data completeness by the research team (OP and MG). Data were validated using STATISTICA PL Version 12.5 (StatSoft Inc., 2016). Our main outcome was facial mask usage. For socio-demographic variables, gender was coded as one for males, and two for females. The age variable was arbitrarily divided into 2 categories: <40 (reference category) and ≥ 40 years; a place of residence - into: a city up to 50,000 citizens and >50,000 citizens; a region regarding pandemic risk – into: high-risk (R>1) and low-risk/very low-risk areas (R≤1.0); a type of activity observed – into playing sports/other activities. A bivariate analysis assessed the demographic characteristics (age, gender, residency and region regarding pandemic risk), together with the participant location during the observation (open/closed space), and the type of activity observed, associated with the outcome variable. The categorical variable groups were compared using the chi-square test with Yates correction and Fisher’s exact test. For observations made at each of the 3 time points, standard single-outcome logistic regression models were built for the predicted outcome variable (mask usage); all models were then reduced by the use of a stepwise selection and a backward procedure [27] with the help of R software [28]. Unstandardized regression coefficients in the regression model were used to assess any change in the model. A change in coefficients was compared and used to determine any variable change. For binary data the exponent of the coefficient is interpreted as the odds ratio (OR) [29].

## 3. Results

### 3.1. General characteristics of study participants by time point

The general characteristics of study participants by each time point is presented in Table 1. Seven medical students were on a sick leave at the first time point and three at the third, which limited the observations number to 750 on May 11th and to 785 on May 25th. As some observations were excluded due to incomplete data, the total number of observations was 2353 (range: 750-818). The female/male ratio was similar (1.02; 1.13 and 1.03 respectively) at the 3 time points, as well as the age distribution, with those aged 21-60 years predominant (70.8%, 71.9% and 70.2% respectively). The female/male ratio in this study was similar to that observed in the general population (1.07) [24], as was the fraction of participants at the age of 4–20 years (16.0% in the general population of Poland). However, the fraction of those at the age >60 years was less numerous than in the general population (23.9% and 11.4% respectively [24]), possibly due to the pandemic which meant that senior citizens were asked to stay at home, as the most vulnerable to COVID-19 [30]. At each time point,

the number of observa-tions made in the open space was similar (78.1%, 73.5% and 74.5%, respectively); “walking” was the most common activity (51.5%, 47.4% and 50.7%, respectively), followed by “shopping” and “playing sports”.

**Table 1. Respondent characteristics and mask usage by selected variables at three time points. Poland 2020; n=750-818.**

| Variable | | 11.05 | | | | | 18.05 | | | | | 25.05 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total | | Mask usage | | | Total | | Mask usage | | | Total | | Mask usage | | |
| | | N* 750 | % | n | % | p | N* 818 | % | n | % | p | N* 785 | % | n | % | p |
| Gender | Female | 371 | 49.5% | 294 | 79.2% | 0.0005 | 434 | 53.1% | 318 | 73.3% | <0.0001 | 398 | 50.7% | 284 | 71.4% | 0.( |
| | Male | 379 | 50.5% | 258 | 68.1% | | 384 | 46.9% | 226 | 58.9% | | 387 | 49.3% | 232 | 59.9% | |
| Age | >4 - 20 years | 130 | 17.3% | 89 | 68.5% | 0.008 | 146 | 17.8% | 82 | 56.2% | <0.0001 | 139 | 17.7% | 71 | 51.1% | <0 |
| | 21 - 60 years | 531 | 70.8% | 388 | 73.1% | | 588 | 71.9% | 392 | 66.7% | | 551 | 70.2% | 367 | 66.6% | |
| | > 60 years | 89 | 11.9% | 75 | 84.3% | | 84 | 10.3% | 70 | 83.3% | | 95 | 12.1% | 78 | 82.1% | |
| Residence | Town ≤ 50,000 inhabitants | 395 | 52.7% | 302 | 40.3% | 0.06 | 445 | 54.4% | 296 | 36.2% | 0.99 | 387 | 49.3% | 264 | 33.6% | 0.1 |
| | Town > 50,000 inhabitants | 355 | 47.3% | 250 | 33.3% | | 373 | 45.6% | 248 | 30.3% | | 398 | 50.7% | 252 | 32.1% | |
| Region | R* < 0.5 | 220 | 29.3% | 160 | 72.7% | >0.65 | 269 | 32.9% | 164 | 61.0% | >0.004 | 277 | 35.3% | 171 | 61.7% | >0 |
| | R 0.5 - 1.0 | 410 | 54.7% | 302 | 73.7% | | 428 | 52.3% | 306 | 71.5% | | 389 | 49.6% | 268 | 68.9% | |
| | R > 1.0 | 120 | 16.0% | 90 | 75.0% | | 121 | 14.8% | 74 | 61.2% | | 119 | 15.2% | 77 | 64.7% | |
| Observation | Open space | 578 | 78.1% | 407 | 70.4% | <0.0001 | 585 | 73.5% | 359 | 61.4% | <0.0001 | 577 | 74.5% | 351 | 60.8% | <0 |
| | Closed space | 162 | 21.9% | 141 | 87.0% | | 211 | 26.5% | 179 | 84.8% | | 198 | 25.5% | 159 | 80.3% | |
| Activity* | Walking | 353 | 51.5% | 261 | 73.9% | <0.0001 | 351 | 47.4% | 235 | 67.0% | <0.0001 | 368 | 50.7% | 243 | 66.0% | <0 |
| | Playing sports | 154 | 22.4% | 97 | 63.0% | | 170 | 23.0% | 91 | 53.5% | | 150 | 20.7% | 73 | 48.7% | |
| | Shopping | 179 | 26.1% | 152 | 84.9% | | 219 | 29.6% | 179 | 81.7% | | 208 | 28.7% | 167 | 80.3% | |

* the number is smaller than the number of the total observations due to the difficulties in classifications**basic reproductive number

### 3.2. Mask usage determinants by time point

The percentage of those using masks was 73.6% (552/750) at the first time point, decreasing a week later (66.5%; 544/818) and then - two weeks later (65.7%; 516/785). Table 1 and Figure 1 present masks usage by the public at the three time points by selected variables. Significantly more females than males used masks (p<0.01 for the three time points). A decreasing trend was observed in relation to mask use at three time points for both: the general public and females. In the case of males, a decrease in usage was seen during the second observation (68.1% vs 58.9%), however, the percentage of those using masks increased slightly (59.9%) a week later. There were statistically significant differences regarding age groups at all three time points (the first time point: 21-60 years vs >60 years: p=0.02; 4-20 years vs >60 years: p<0.01; the second time point: 4-20 years vs 21-60 years: p=0.02; 21-60 years vs >60 years: p<0.01, 4-20 years vs >60 years: p<0.01; the third time point: p<0.01 for all between-group comparisons) except the comparison between 4-20 years old compared to 21–60 years old at the first time point (p=0.29) Fewer younger individuals used masks in the public than the older ones (for all time points: 68.5%, 56.2% and 51.1% among those 4-20 years old respectively vs 84.3%, 83.3% and 82.1% among those >60 years old respectively); chi square for trend by time point: p=0.02; p=0.001 and p<0.00001 respectively (Figure 2). The decrease of mask usage over time was more evident among 4-20 year old participants than among the other age groups. Masks usage in both - enclosed and open space decreased among study participants during the 3-week observation (87.0%, 84.8%, 80.3%, and 70.4%, 61.4%, 60.8%, respectively at the 3 consecutive time points). A statistically significant difference (p<0.01) was observed between masks use in the open/ enclosed locations at the three time points; Table 1, Figure 1.

The percentage of people wearing masks at three time points in relation to the activity performed is presented at Table 1 and Figure 1. The compliance with mask use was the highest while shopping (84.9%; 81.7% and 80.3% respectively) and the lowest during outdoor sport activity (63%; 53.5% and 48.7%,respectively). A statistically significant difference was observed in masks use between activities at the three time points (p≤0.01). The decrease of mask usage over time was more evident among those playing sports than among the other activities.

As reported in Table 1, at the 2nd time point those living in low risk areas (R 0.5-1.0) were more compliant regarding masks usage compared to regions with higher (R>1.0) and very low (R<0.5) pandemic risk (p>0.004). There were no statistically significant differences observed in masks usage at any of three time points (p>0.05) regarding the place of residence.

Multiple logistic regression analysis showed that participant age, gender, location during the observation and type of activity were independent predictors for mask usage (Table 2). During the 2nd and 3rd observation point older participants were more likely to use masks (OR=1.46; OR=1.48, p=0.03; p=0.02 respectively) as compared to those of a younger age group. Females were also more likely to wear masks (for 3 time points: OR=1.75; OR=1.47; OR=1.53, p= 0.002; p=0.02; p=0.01 respectively) compared to males. Participants observed in the closed space were more likely to use masks than those in an open space (OR=2.56; OR=2.63; OR=2.36, p=0.0006; p<0.0001; p<0.0001, respectively). Interestingly, playing sports was a predictor for not wearing a mask (OR=0.64; OR=0.54; OR=0.54, p=0.002; p=0.001; p=0.002, respectively).

**Table 2. Logistic regression model: association of the mask usage with selected variables by time point (odds ratio (OR) estimates and 95% confidence intervals (CIs) of OR estimates); Poland, 2020; *n*=750-818**

| Variable | Time point 1 | | Time point 2 | | Time point 3 | |
|---|---|---|---|---|---|---|
| | OR* | CI | OR | CI | OR | CI |
| Age: >40 | - | - | 1.46 | 1.05-2.05 | 1.48 | 1.07-2.06 |
| Gender: female | 1.75 | 1.23-2.56 | 1.47 | 1.06-2.04 | 1.53 | 1.10-2.13 |
| Area: closed space | 2.56 | 1.54-4.55 | 2.63 | 1.69-4.00 | 2.36 | 1.56-4.17 |
| Activity: sport | 0.64 | 0.43-0.97 | 0.54 | 0.37-0.79 | 0.54 | 0.43-0.97 |

*Odds ratio (OR) = ratio between the two categories tested in each variable, controlling for other variable.

### 3.3. Correct mask usage by time point

The percentage of those using masks correctly decreased gradually by time point (65.9%; 364/552, 62.3%; 339/544 and 58.9%; 304/516 respectively). A statistically significant between-gender difference was noted in the 1st and 3rd week of observation, with females more frequently using masks correctly (1st week: 205/294; 69.7% vs 159/258; 61.6%, 2nd week: 197/318; 61.9% vs 142/226; 62.8% and 3rd week: 186/284; 65.5% vs 118/ 232; 50.9%; p=0.045; p=0.83; p=0.0008 respectively). The differences in the correct manner of masks use were not significant regarding age, location and activity (p>0.05).

### 3.4. Type of mask usage by time point

A predominance of cloth masks was observed at all 3 time points followed by medical masks (Table 3); face shields were the type of face protection used the rarest.

The correct manner of mask use by type and time point is presented in Table 3. During the 1st week, 80.0% were correctly wearing N95 respirator mask with an increased correct use in the 2nd and 3rd week (83.3% and 94.4% respectively). An opposite trend had been observed for medical and home-made masks: 64.3%; 65.8%; 60.4% and 64.7%; 60.2%; 54.5% respectively were using those masks at the 1st, 2nd and 3rd week. There was not statistically significant between-type difference found at the 1st and 2nd time point regarding the correct wearing of a given type of a mask (p>0.11); however, more participants used N95 respirators correctly when compared to other types of masks (p = 0.0008) at the 3rd time point. At all 3 time points breaches in nose covering (89/188; 47.3%, 108/205; 52.7% and 106/212; 50% respectively) and hanging masks around the neck (80/188; 42.6%, 85/205; 41.5% and 83/212; 39.2% respectively) were the most common incorrect practices while wearing a mask, followed by touching masks by hands (9/188; 4.8%, 8/205; 3.9% and 14/212; 6.6% respectively) and incorrect mask fixation (8/188; 4.3%, 4/205; 2% and 9/212; 4.2% respectively).

**Table 3. Frequency of mask usage by type of mask used and time point; Poland, 2020; n = 750-818.**

| Type of mask | 11.05 | | | | 18.05 | | | | 25.05 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Usage | | Correct usage | | Usage | | Correct usage | | Usage | | Correct usage | |
| | n | % | n | % | n | % | n | % | n | % | n | % |
| Cloth mask | 357 | 64.7% | 231 | 64.7% | 339 | 62.3% | 204 | 60.2% | 323 | 62.6% | 176 | 54.5% |
| Medical mask | 129 | 23.4% | 83 | 64.3% | 155 | 28.5% | 102 | 65.8% | 139 | 26.9% | 84 | 60.4% |
| N95 respirator | 20 | 3.6% | 16 | 80.0% | 12 | 2.2% | 10 | 83.3% | 18 | 3.5% | 17 | 94.4% |
| Face shield | 12 | 2.2% | 11 | 91.7% | 7 | 1.3% | 6 | 85.7% | 8 | 1.6% | 8 | 100.0% |
| Other* | 34 | 6.2% | 23 | 67.6% | 31 | 5.7% | 17 | 54.8% | 28 | 5.4% | 19 | 67.9% |

*scarf/bidon

# 4. Discussion

### 4.1 Results overview

Overall, compliance with wearing face masks by the general public in Poland was good in the beginning of the study period (74%), however, it decreased (to 66%) in the 2nd and 3rd week of the observation, with a predominance of cloth masks observed. Female gender, age >40 years, and closed space were each associated with higher mask usage. Those playing sports had about two times lower chance to use facial masks. The percentage of those using facial masks in the correct manner also decreased gradually over time, mainly due to a decreasing trend observed for medical and cloth masks; significantly more females correctly used masks. Breaches in nose covering and hanging masks around the neck were the most common incorrect practices while wearing a mask.

### 4.2 Trends in facial mask use

The willingness of the general public plays a decisive role in achieving the successful implementation of protective measures [3]. However, it is still a problem to encourage the public to unconditionally and continuously follow these recommended preventive actions. The decreasing trend regarding facial mask usage by the general public in Poland through the three weeks of observation, which illustrates behavioral change, may be due to a gradual decrease in concerns about the pandemic over time, combined with a lowering in the perceived risk of infection. The strong association between respondents' risk perceptions and taking comprehensive pre-cautionary measures against influenza, MERS and SARS infections has been reported previously [31-34]. Apprehensions about relatively high administrative penalties while not complying with governmental regulation on wearing masks could also play a role in the high percentage of those observed using face masks at the beginning of this study.

The number decreased in later weeks, possibly due to less strict supervision, monitoring and regulation enforcement by the relevant services [20]. Numerous examples of political leaders, including the Polish president and the prime minister not using masks in public spaces, which was transparently reported by the media [35-37], could influence mask usage by the public, by simply signaling that fears related to the virus are overblown. Public officials should be acutely aware they are in position to lead by example, with the choices they make and how they carry themselves can send a powerful message; this also refers to the SARS-Cov-2 pandemic. Sadly, face masks have become one of the potent symbols in how poorly Polish leaders have responded to this public health crisis.

Of note, during the observation period of this study, the number of daily reported SARS-Cov-2 cases in Poland was rather stable (between 300-400), with the ongoing outbreak in the Silesian region among miners and their family members and smaller outbreaks in Lodz and Wielkopolska provinces. Basic reproductive number for those regions exceeded 1 [23]. As such, the perceived risk of infection among the general public in those regions should be higher than the rest of Poland. However, the results of the study did not show significant differences in masks usage among the regions divided by pandemic risk. Thus, existing communication channels should be improved to increase general public awareness regarding infection risk.

### 4.3 Determinants of mask use

Various factors, including socio-demographic characteristics, social context, and individual values can affect the subjects' perception of their actual risk of disease, as well as influence their worries about a pandemic [3,38,39]. Based on recent studies, being older, female, more educated, are associated with a higher chance of adopting protective behaviors [3,32,40]. The results of this study show that males, traditionally risk takers, were significantly less likely to have appropriate practices regarding mask usage, and protecting themselves and others against SARS-Cov-2. These findings are consistent with other studies on SARS and MERS, showing that females are more health conscious and risk averse [32,33,41]. This was also reported during the current SARS-Cov-2 pandemic [42]. It is suggested that health promotion messages sent through female mediators who are significant for young males, e.g. mothers, sisters or partners, could increase mask use for this vulnerable subgroup [33]. In addition, there was a positive dose-response gradient with increasing age and mask usage. Older age was also found by other authors as a determinant of precautionary measures taken against respiratory infections [33,40]; elderly people might feel more susceptible to being affected by a pandemic [40].

Wearing masks to the cover mouth and nose when out in public was significantly lower in open spaces during the three-week observation, and decreased to a greater extent (10%) over time, when compared to enclosed spaces. During the study period government officials announced that in the upcoming weeks it would not be necessary to wear masks while walking on the street, in parks or during sport activities outdoors, e.g. riding a bike [43]; this could have influenced the behavioral change regarding the mask usage by the general public. The message that it would still be mandatory to wear masks in shops might have made the population consider its importance, which in turn influenced high compliance.

### 4.4 Type of mask used

To control the infection source, as well as to self-protect, cloth masks, as recommended by the WHO, CDC, and ECED [13-16] are likely to be adequate to minimize SARS-Cov-2 transmission in the community, especially if everyone wears a mask correctly. Cloth masks were predominantly used in the public space in this study, possibly due to the low price and the fact that they can be easily manufactured or made at home and reused after washing. The shortage of mask supply in the community and the integrated governmental and media message that medical masks and N95 respirators must be reserved for health-care workers might have influenced their poor usage by the public.

Notably, compliance of correct mask use was poor – only two thirds of those wearing facial masks (cloth and medical) wore them correctly at the first time point, this decreased over time, with 55% wearing cloth masks and 60% - medical ones. Although N95 respiratory masks were rarely used by the public, compliance with correct use was the best and increased over time. One of the possible interpretations of this observation could be that the potential N95 respiratory masks wearers were more health oriented and health educated. People with high health literacy skills are more competent in related to public health outbreak controls [3,40,44]. Due to the small number of observations regarding this type of mask usage, further qualitative and quantitative studies are

needed to better assess this issue. Correct mask usage was gender dependent with more females using a mask in the proper manner. Interestingly, no differences were observed regarding the correct mask usage and age, residence, as well as location and type of activity.

At all 3 time points breaches in nose covering and hanging masks around the neck were the most common incorrect practices while wearing a mask. Such practices elevate infection risk regarding SARS-Cov-2 and other airborne respiratory pathogens. Notably, the pathogens may settle on the surface of used masks layers, resulting in mask contamination [45] which in turn highlights the risk of self-contamination to the wearer, particularly when fixing, elevating or doffing a mask.

### 4.5 Strengths and Limitations

To our knowledge, this is the first study to investigate facial masks use in the general population in Poland, as well as in the EU. One particular strength of the study is that participants were observed during an actual continuing outbreak - data collection started three weeks after an introduction of the regulation about obligatory mask use in the public space. Furthermore, by covert observation, the Hawthorne effect has been limited as the behavior of participants was not altered [46].

However, the study has some limitations which should be pointed out. Community-based national surveys were not feasible regarding the phase of SARS-Cov-2 pandemic in Poland in which the study had been conducted. As such, data were collected through students observations, depending on their place of residence. Therefore, the majority of the participants were observed in the western and central regions of Poland, where most of the students came from. Further research should cover all Polish provinces to better assess mask usage at a national level. Due to student sick leave, the numbers of observations were smaller at the first and third time point than at the second time point. Nevertheless, the response rate was still high which led to a relatively large sample size. Another limitation is that the study was administered over a short time period. Thus, the stability of the responses is unknown [33]. Further observations are needed to track possible changes as the pandemic evolves. Age assessment was based on the subjective observations of students. However, the age range was categorized to “every 10 years”, which should have minimized any possible assessment mistakes. The implication is for future research to assess whether there is a relationship between mask usage and other variables, not covered by this study, such as education, knowledge on infection control, anxiety level, trust in the health authorities, etc. Finally, this study did not address causation. Therefore, the regression results should be interpreted with caution.

## Conclusions

The results show an essential difference in how the general public responds to the SARS-Cov-2 pandemic in the context of facial mask usage. Practices were found to be inadequate, especially among young males, and tended to decrease over time, more significantly among young individuals, and those wearing cloth masks than when compared to the older subjects and wearing N95 respirators. This message can be used to target specific vulnerable groups when developing public health campaigns which should be then rigorously evaluated for their effectiveness. Among those using face masks, every third individual wore them incorrectly. Therefore, awareness campaigns regarding the need for the proper usage of face masks - by utilizing all communication channels available - would be helpful during this pandemic. The results may also help policy makers to adequately tailor mask usage strategies to better prevent SARS-Cov-2 transmission. Finally, political leaders should act as role models and set a good example wearing masks in the public arena to create a sense of solidarity and make a gesture with regards to evidence based practices.

In conclusion, this study identified topics that may need attitudinal modification to improve self-protection against SARS-Cov-2 infection and community spread of the virus. There is now an ideal moment to implement these adjustments before a possible next pandemic wave hits in the fall.

## Abbreviations

| | |
|---|---|
| 95%-CI | 95%-confidence interval |
| CDC | Centers for Disease Control and Prevention (CDC) |
| ECDC | European Centre for Disease Control |
| EU | European Union |
| IRB | Institutional Review Board |
| MERS | Middle East Respiratory Syndrome |
| OR | Odds ratio |
| R | basic reproductive number |
| SARS | Severe Acute Respiratory Syndrome |
| SARS-Cov-2 | Severe Acute Respiratory Syndrome Coronavirus 2 |
| WHO | World Health Organization |

## Declarations

### Ethics approval and consent to participate

In Poland there is no requirement for ethics committee (Institutional Review Board; IRB) approval for observational studies similar to ours [47]. The study was designed and conducted in accordance with these regulations and regulations established by the IRB of the University of Zielona Gora (Komisja Bioetyczna CM UZ) [48] and the 1964 Helsinki declaration [49].

The need for participant informed consent regarding observational covert studies is deemed unnecessary according to Polish national regulations [47]; covert research does not allow for the participants to give informed consent [47, 50].

### Consent for publication

Not applicable.

### Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

### Competing interests

The authors declare that they have no competing interests.


### Funding

Not applicable.


### Authors' contributions

MG was involved in conception and design of the study. OP made contributions to acquisition and together with MG – to review of data completeness. MK together with MG, OP, DŚ andŁD-D analyzed the data. MG was involved in literature search and in drafting the manuscript, as well as – together with OP, DŚ, ŁD-D and MK - in finalizing the version to be published. All authors read and approved the final version of the manuscript.


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## Figures

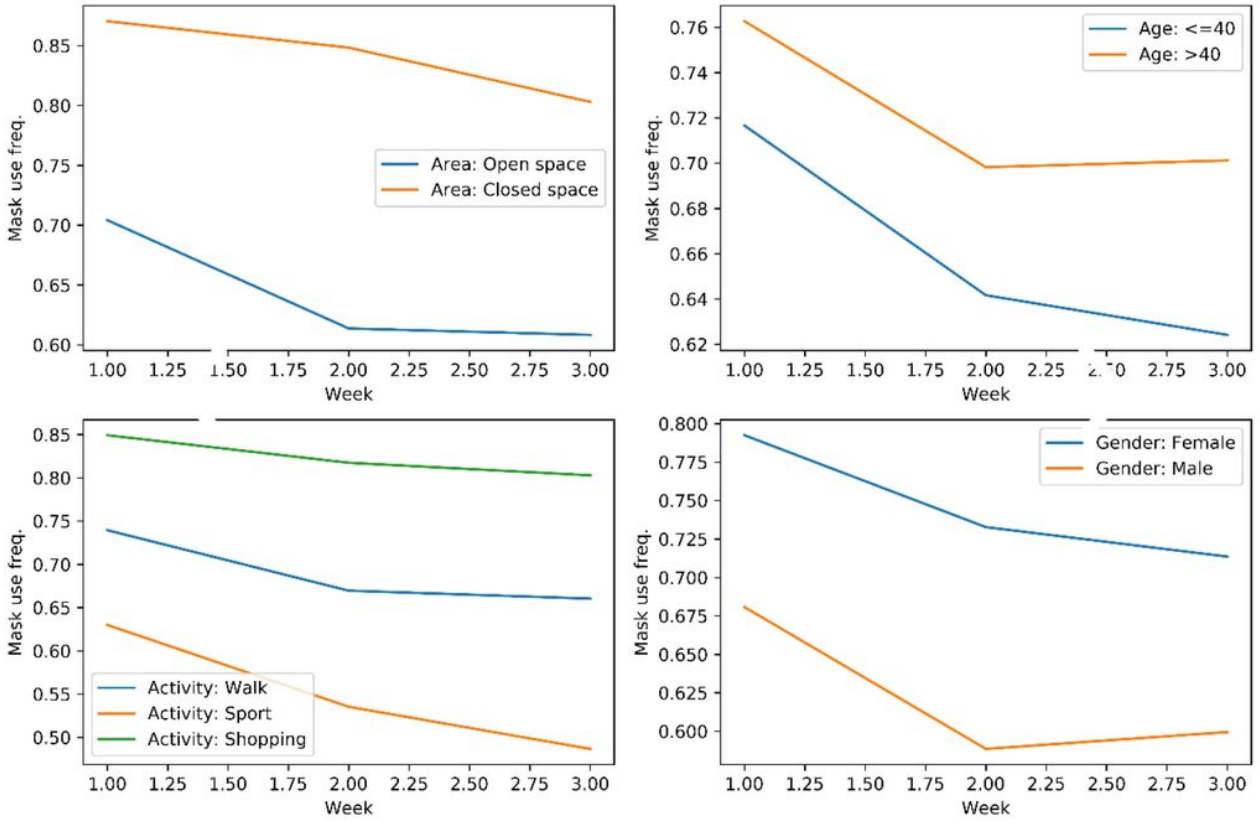


**Figure 1**

Masks usage trend by age, gender, area and activity. Poland, 2020; n = 750-818.

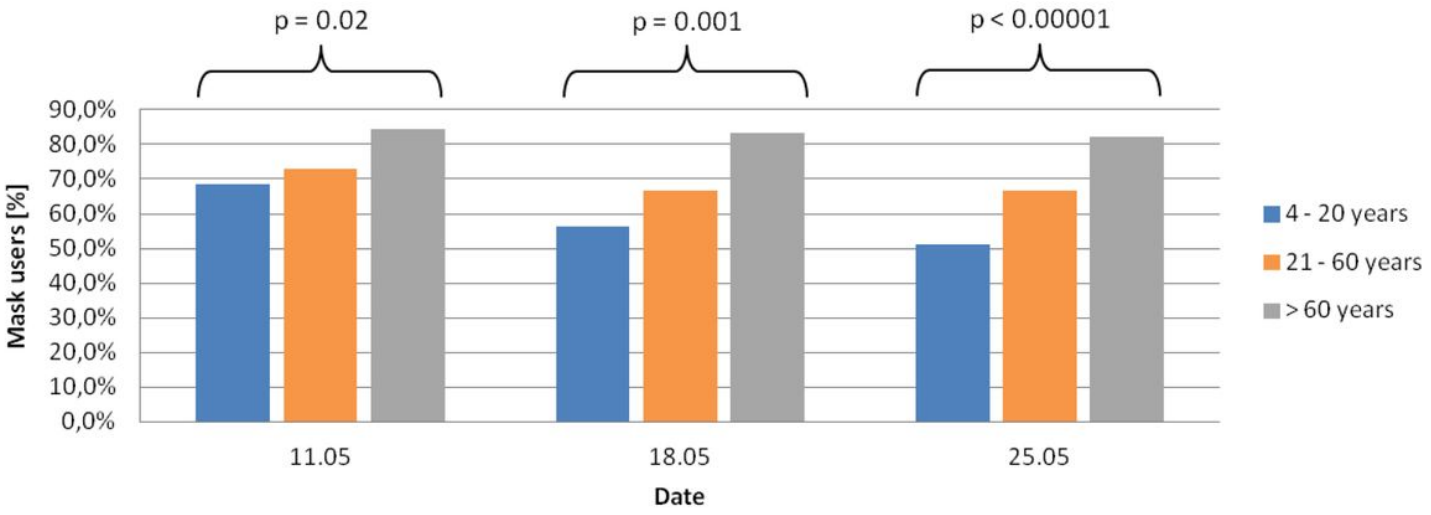


Figure 2

Masks usage at 3 time points by age group (chi square for trend by time point).