Examining outpatients’ hand hygiene behaviour and its relation to COVID-19 infection prevention measures

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SUMMARY

Background: The increasing demand for outpatient care is associated with a higher risk of infection transmission in these settings. However, there is limited research on infection prevention and control practices in ambulatory clinics, and none focuses on patients.

Aim: To examine outpatients’ hand hygiene behaviours, their determinants, and their associations with other infection prevention measures during the COVID-19 pandemic.

Methods: We observed the hand hygiene behaviour of one cohort of patients in one outpatient clinic and surveyed a separate sample in five clinics about their hand hygiene practice in outpatient facilities. A questionnaire based on the Theoretical Domains Framework (TDF) was used to examine predictors of the behaviour. Moreover, patients indicated their compliance with COVID-19 infection prevention measures, vaccination status, disease risk perception, and vaccine hesitancy.

Findings: Observed hand hygiene rates among 618 patients were low (12.8%), while 67.3% of the 300 surveyed patients indicated sanitizing their hands upon entering the clinic. The TDF domains ‘memory, attention, and decision processes’ and ‘emotions’ significantly predicted both current (today’s) and general hand hygiene behaviour in outpatient clinics. Hand hygiene behaviour and compliance with COVID-19 infection prevention showed a positive association; however, no significant connection was found with patients’ vaccination status, suggesting different behavioural motivators.

Conclusion: Hand hygiene among outpatients should be improved through interventions focusing on helping patients remember to clean their hands. More research on infection prevention in outpatient facilities is needed to ensure patient safety.

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Introduction

In Germany, the vast majority of all individuals receiving medical care are treated on an outpatient basis [1, 2]. Outpatient care settings include physician offices, surgical centres, specialized service centres, and other facilities [3]. The increasing demand for care, severity of treated conditions, and complexity of procedures performed in outpatient settings are associated with a growing risk of transmission of infections [4, 5]. However, outpatient facilities often do not have the same infection prevention infrastructure and resources as acute care hospitals, further increasing infection risks [4]. Some studies have shown high pathogenic contamination of hands and surfaces in outpatient facilities [4–10]. Therefore, it is not surprising that healthcare-associated infections, including with COVID-19, have been linked to outpatient treatments [6, 11, 12]. Inadequate compliance with infection prevention and control measures (e.g. hand hygiene behaviour, wearing masks, and cleaning surfaces) puts patients and healthcare workers (HCWs) at risk [8]. However, little research has been conducted on compliance with infection prevention measures in outpatient settings, with most studies focusing on HCWs’ hand hygiene behaviour, whereas almost no studies have examined the behaviours of outpatients [6, 13–17]. Consequently, the primary objective of this study was to shed light on patients’ infection prevention practices in outpatient care settings.

Good hand hygiene is the most effective method to prevent the spread of pathogens and reduce the risk of healthcare-associated infections [18–21]. Some studies have already investigated the hand hygiene of patients and visitors in hospital settings [22–29]. Most of these studies have shown that hand hygiene among patients and visitors is insufficient and needs improvement (see [30] for an overview). We expect the hand hygiene behaviour of patients in outpatient facilities to be equally poor. To improve a behaviour, it is essential to understand the factors that promote or hinder it. Previous work has shown that the Theoretical Domains Framework (TDF) is a useful model for examining the facilitators and barriers of hand hygiene behaviour among HCWs as well as hospital patients and visitors [22, 23, 31–34]. According to the TDF, health behaviours are determined through 12 theoretical domains: (1) knowledge; (2) skills; (3) social/professional role and identity; (4) beliefs about capabilities; (5) beliefs about consequences; (6) motivation and goals; (7) memory, attention, and decision processes; (8) environmental context and resources; (9) social influences; (10) emotions; (11) behavioural regulation; and (12) nature of behaviour. The domains’ definitions are provided in Supplementary Table SI. Depending on the target population (HCWs vs patients vs visitors), study type (quantitative vs qualitative), and type of behaviour assessed (self-reported behaviour across multiple moments vs observed behaviour at one moment), slightly different TDF domains have emerged as the most relevant predictors for people’s hand hygiene behaviour [22]. For example, a study among hospital inpatients identified the domains (1) ‘memory, attention, and decision processes’, (2) ‘social/professional role and identity’, and (3) ‘emotions’ as the most impactful predictors of self-reported hand hygiene behaviour [22]. In line with the literature, we hypothesized that (H1) the TDF is a suitable model to predict patients’ hand hygiene behaviour at the outpatient facility [22, 23]; and (H2) the TDF domains (1) ‘memory, attention, and decision processes’, (2) ‘social/professional role and identity’, and (3) ‘emotions’ will emerge as the most important determinants for outpatients’ hand hygiene behaviour [22].

The COVID-19 pandemic has highlighted that hand hygiene is not the only, and depending on the transmission route, not even the most effective measure [35, 36]. Protective health behaviours are often studied in isolation; however, effective infection prevention depends on people’s adherence to multiple recommended measures simultaneously [11, 17, 37]. Therefore, studying infection prevention behaviours in combination is vital, as only their co-occurrence might ensure adequate protection. In addition, knowing how infection prevention behaviours co-occur can support the development of multi-behaviour intervention strategies. People often show consistent patterns across various health behaviours [39–43]. On the one hand, risky health behaviours frequently co-occur, for instance, smoking is often associated with higher alcohol consumption. On the other hand, people who engage in one protective behaviour, e.g. physical activity, also frequently engage in other positive behaviours such as healthy eating. Research has also shown an association between COVID-19 infection prevention behaviours [44, 45]. During the COVID-19 pandemic, German health officials issued guidelines for the public, indicating the most crucial protective behaviours, including (a) social distancing, (b) regular hand hygiene, (c) covering mouth and nose when coughing or sneezing, (d) avoiding to touch the face, (e) good household hygiene, and (f) wearing a face mask [46]. As the COVID-19 vaccine became available, it was included in the catalogue of recommended behaviours [47]. The present study examined the co-occurrence between different protective behaviours among outpatients. In accordance with the literature, we hypothesized that there is a positive association between patients’ hand hygiene behaviour at the outpatient facility and (H3) their compliance with COVID-19 protective measures as well as (H4) their COVID-19 vaccination status [39–45]. We also expected that (H5) there is a positive association between patients’ compliance with COVID-19 protective measures and their COVID-19 vaccination status.

Moreover, it is important to examine how individual differences among patients affect their actions. Two relevant factors for infection prevention behaviours during the COVID-19 pandemic are vaccine hesitancy and disease risk perception. Since vaccines against COVID-19 were available, some people have been reluctant to get vaccinated, and much research has focused on understanding this phenomenon [48, 49]. The term vaccine hesitancy ‘refers to delay in acceptance or refusal of vaccination despite availability of vaccination services. Vaccine hesitancy is complex and context specific, varying across time, place, and vaccines. It is influenced by factors such as complacency, convenience, and confidence.’ ([50], p. 4163). We expected a large proportion of outpatients’ vaccination status to be explained by vaccine hesitancy and hypothesized that (H6) there is a negative association between patients’ COVID-19 vaccine hesitancy and their COVID-19 vaccination status.

The COVID-19 pandemic also illustrated how disease risk perceptions impacted individuals’ willingness to vaccinate and engage in infection prevention. The notion that risk perception
influences behaviour is stated in many health behaviour theories [51]. Commonly, risk perception is measured by asking people to rate their likelihood and severity of harm due to a disease, but it can also be defined more broadly [51–53]. Research has shown that risk perception is associated with vaccination behaviour, including vaccination against COVID-19 [52,54]. Moreover, risk perception has also been linked to many other infection prevention behaviours, such as hand hygiene and social distancing [22,23,55]. Consequently, we hypothesized that (H7) there is a significant association between outpatients’ risk perception regarding COVID-19 and their (a) hand hygiene behaviour, (b) compliance with COVID-19 protective measures, (c) COVID-19 vaccine hesitancy, and (d) COVID-19 vaccination status.

The present study aims to expand the literature on patients’ infection prevention behaviours in outpatient settings during the COVID-19 pandemic. This is the first study to examine outpatients’ hand hygiene behaviour and its association with other infection prevention measures.

**Methods**

**Participants and procedure**

Patients in five German outpatient clinics were invited to participate in the pre-registered (https://osf.io/wcmf5) study. The clinics, located in Bavaria, were selected to ensure a diverse mix of medical specialties (see Table I). Data were collected between March and December 2022. All participants were informed about the study’s purpose and gave informed consent. The university’s research ethics committee waived the requirement for a full ethical review because of the low-risk nature of the research activities.

**Materials**

**Demographics**

The questionnaire started with information about the study’s purpose and instructions, followed by questions regarding patients’ age, gender, and experience with multidrug-resistant organisms (yes/no), whether they currently suffered from an infectious disease (yes/no), and if they previously had had a confirmed COVID-19 infection (yes/no).

**Hand hygiene behaviour**

The questionnaire included one question about patients’ current hand hygiene behaviour (‘Did you sanitize your hands … (a) when entering the outpatient clinic; (b) before leaving the outpatient clinic; (c) after using the toilet at the outpatient clinic.’) on a six-point response format from 1 (never) to 6 (always). The third question from the scale was removed because it did not show good internal consistency.

The internal consistency of the two-item general hand hygiene scale was acceptable (α = 0.70). Additionally, we directly observed the hand hygiene behaviour of every outpatient entering the facility during the infection consultation hours in Clinic 3 between June and December 2022.

**Theoretical Domains Framework (TDF)**

The 38 items to measure the TDF domains were adopted from a German study investigating barriers and levers to hospital patients’ and visitors’ hand hygiene behaviour [22]. This questionnaire combined knowledge and skills and excluded the ‘nature of behaviour’ domain (see also [32] for the validation of the instrument). The items were adjusted to fit the outpatient sample. All TDF items were rated on a seven-point Likert scale from 1 (strongly disagree) to 7 (strongly agree). Example items and the internal consistencies of the TDF subscales can be seen in Supplementary Table SII.

**Compliance with COVID-19 protective measures**

Patients rated their compliance with the recommended COVID-19 protective measures (i.e. social distancing, safe coughing/sneezing, regular hand hygiene, avoiding touching the face, good household hygiene, and mask-wearing) using six self-developed items on a six-point response scale from 1 (never) to 6 (always). These behaviours were promoted in Germany during the pandemic. The scale showed acceptable internal consistency (α = 0.78).

**COVID-19 vaccination status**

Patients’ COVID-19 vaccination status was measured with one item with the following response options: three times/fully vaccinated, twice vaccinated, once vaccinated, and unvaccinated.

**COVID-19-related vaccine hesitancy**

Patients’ attitudes towards the COVID-19 vaccination were measured using the COVID-19 adapted version of the vaccine hesitancy scale [56,57]. The response format of the ten items was a seven-point Likert scale from 1 (strongly disagree) to 7 (strongly agree). The internal consistency of the scale was excellent (α = 0.93).

**COVID-19-related risk perception**

Patients assessed their COVID-19 risk perception in two ways. First, with two items to measure risk likelihood from 1

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**Table I**

Self-reported current hand hygiene behaviour per outpatient clinic

<table>
<thead>
<tr>
<th>Hands sanitized</th>
<th>Clinic 1: Surgery and hand surgery (N = 27)</th>
<th>Clinic 2: Neurology and psychiatry (N = 28)</th>
<th>Clinic 3: General medicine (N = 101)</th>
<th>Clinic 4: Ear, nose, and throat specialists (N = 48)</th>
<th>Clinic 5: Oral and maxillofacial surgery (N = 96)</th>
<th>Overall (N = 300)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>24 (88.9%)</td>
<td>23 (82.1%)</td>
<td>79 (78.2%)</td>
<td>32 (66.7%)</td>
<td>44 (45.8%)</td>
<td>202 (67.3%)</td>
</tr>
<tr>
<td>No</td>
<td>3 (11.1%)</td>
<td>5 (17.9%)</td>
<td>22 (21.8%)</td>
<td>16 (33.3%)</td>
<td>52 (54.2%)</td>
<td>98 (32.7%)</td>
</tr>
</tbody>
</table>
(far below average) to 5 (far above average) and severity from 1 (neglectable) to 6 (life-threatening). Second, with four self-developed items to measure a broader concept of risk perception, rated on a seven-point Likert scale from 1 (strongly disagree) to 7 (strongly agree), that showed good internal consistency ($\alpha = 0.82$). We included only the four-item risk measure in the analysis since it cannot be combined with risk likelihood and severity items. Neither can the latter two because of their different rating scales.

Data analysis

The data were analysed using R version 4.2.2 [58]. The confirmatory factor analyses (CFAs) and structural equation modelling (SEM) were performed using the lavaan package [59]. The most widely reported indexes were used and we assumed at least a reasonable model fit with Comparative Fit Index (CFI) and Tucker–Lewis Index (TLI) values close to or exceeding 0.90 [60]. Root-Mean-Square Error of Approximation (RMSEA) values $<0.08$ are considered acceptable, and Standardized Root-Mean-Square Residual (SRMR) values up to 0.08 are regarded as satisfactory [60,61].

To test Hypotheses 1 and 2, the TDF domains on general and current hand hygiene behaviour were regressed using a linear and a logistic regression model, respectively. Additionally, SEM was conducted to examine the proposed relationships between hand hygiene practice in the outpatient context and COVID-19-related measures as proposed in Hypotheses 3–7 (see Supplementary Appendix for pre-registration and data).

Results

Overall, 331 patients returned the questionnaire and 305 answered the behavioural measures. Five patients indicated that they did not enter the clinic on the day they completed the survey, leaving us with a sample of $N = 300$ (M$_{age} = 52.73$, SD$_{age} = 17.30$; 60.33% female). In all, 77.33% were fully (three or more times), 14.67% twice, 1.67% once, and 6.33% were not vaccinated. Table I shows the distribution of self-reported current hand hygiene behaviour on entering the five outpatient clinics. In Clinic 3, we also observed the hand hygiene behaviour upon entering the facility of 618 patients, which approximates to about 5% of the total number of patients visiting the clinic. The observation showed that only 79 (12.8%) sanitized their hands. In addition to current hand hygiene, patients reported sanitizing their hands in outpatient clinics frequently to usually when averaging the two statements for general hand hygiene: $M = 4.66$ (SD = 1.24).

A CFA was performed to ensure that all items included in the TDF subscales had at least a standardized factor loading of 0.50. Items with lower standardized factor loadings were excluded, leaving 34 TDF items. The data fitted adequately with the TDF structure $\chi^2$(df) = 923.14(482), $P < 0.001$, CFI = 0.90, TLI = 0.89, RMSEA = 0.06, SRMR = 0.06. A second CFA was performed to ensure that the items included in the three COVID-19 scales (vaccine hesitancy, risk perception, and compliance) had at least a standardized factor loading of 0.50. Only one item from the compliance scale had to be excluded. The data fitted adequately with the suggested model: $\chi^2$(df) = 482.08(149), $P < 0.001$, CFI = 0.89, TLI = 0.88, RMSEA = 0.09, SRMR = 0.08.

Next, two regression models tested the TDF’s suitability for predicting hand hygiene behaviour at outpatient clinics (see Table II). The TDF domains in both models predicted a significant proportion of the variance of patients’ general (rating scale; $N = 282$, $R^2 = 0.53$, $R^2_{adj} = 0.52$, $F(10/271) = 30.91, P < 0.001$) and current (yes/no scale; $N = 282$, $R^2 = 0.43$, $\chi^2(10) = 102.82, P < 0.001$) hand hygiene behaviour, supporting Hypothesis 1. The TDF domains (1) ‘memory, attention, and decision processes’, (2) ‘social/professional role and identity’, and (3) ‘emotions’ emerged as statistically significant predictors for general hand hygiene behaviour, supporting Hypothesis 2. However, current hand hygiene behaviour was only significantly associated with the domains ‘memory, attention, and decision processes’ and ‘emotions’.

Furthermore, an SEM was specified to test Hypotheses 3–7. A mediated pathway of the relationship between COVID-related risk perception and vaccination status through vaccine hesitancy was added. All results are shown in Figure 1 and Supplementary Table SIII. The model fitted the data adequately: $\chi^2$(df) = 1031.25(479), $P < 0.001$, CFI = 0.89, TLI = 0.89, RMSEA = 0.06, SRMR = 0.07. As expected, the three TDF domains had a significant association with general hand hygiene behaviour in outpatient clinics. In addition, hand hygiene behaviour was positively related to compliance with

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Linear (general hand hygiene)</th>
<th>Logistic (current hand hygiene)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>2.95 (0.76) 3.87 ($&lt;0.001$)</td>
<td>−0.57 (2.06) −0.28 (NS)</td>
</tr>
<tr>
<td>Knowledge and skills</td>
<td>−0.05 (0.10) −0.57 (NS)</td>
<td>−0.16 (0.27) −0.62 (NS)</td>
</tr>
<tr>
<td>Social/professional role and identity</td>
<td>0.31 (0.07) 4.57 ($&lt;0.001$)</td>
<td>−0.22 (0.20) −1.13 (NS)</td>
</tr>
<tr>
<td>Beliefs about capabilities</td>
<td>−0.03 (0.03) −0.83 (NS)</td>
<td>0.00 (0.09) −0.04 (NS)</td>
</tr>
<tr>
<td>Beliefs about consequences</td>
<td>0.02 (0.05) 0.43 (NS)</td>
<td>−0.17 (0.14) −1.19 (NS)</td>
</tr>
<tr>
<td>Motivation and goals</td>
<td>0.05 (0.08) 0.65 (NS)</td>
<td>0.42 (0.23) 1.81 (NS)</td>
</tr>
<tr>
<td>Memory, attention, and decision processes</td>
<td>−0.29 (0.04) −7.47 ($&lt;0.001$)</td>
<td>0.66 (0.12) 5.40 ($&lt;0.001$)</td>
</tr>
<tr>
<td>Environmental context and resources</td>
<td>0.01 (0.05) 0.11 (NS)</td>
<td>0.09 (0.14) 0.66 (NS)</td>
</tr>
<tr>
<td>Social influences</td>
<td>0.02 (0.04) 0.37 (NS)</td>
<td>0.03 (0.15) 0.23 (NS)</td>
</tr>
<tr>
<td>Emotions</td>
<td>0.07 (0.04) 2.09 (0.037)</td>
<td>−0.22 (0.11) −2.04 (0.041)</td>
</tr>
<tr>
<td>Behavioural regulation</td>
<td>0.05 (0.03) 1.32 (NS)</td>
<td>−0.19 (0.10) −1.83 (NS)</td>
</tr>
</tbody>
</table>

Est., standardized coefficient; SE, standard error; $t$, Est./SE; $z$, Est./SE; NS, not significant.
COVID-19 protective measures, supporting Hypothesis 3. However, neither hand hygiene behaviour nor compliance with COVID-19 protective measures was significantly associated with the COVID-19 vaccination status. Consequently, we found no support for Hypotheses 4 and 5. Supporting Hypothesis 6, there was a negative association between COVID-19 vaccine hesitancy and COVID-19 vaccination status. Risk perception related to COVID-19 had a significant positive association with compliance with COVID-19 protective measures and a negative association with COVID-19 vaccine hesitancy. However, risk perception was unrelated to hand hygiene behaviour in the outpatient facility, providing only partial support for Hypothesis 7. The mediation analysis suggests that the negative relationship between COVID-19 risk perception and COVID-19 vaccination status is fully mediated through vaccine hesitancy.

**Discussion**

The present study is the first to examine outpatients’ hand hygiene behaviour and its relationship to other infection prevention measures in the context of the COVID-19 pandemic. In all, 67.3% of patients stated that they had sanitized their hands upon entry. Additionally, the majority reported that they usually or always sanitize or wash their hands when entering and leaving an outpatient clinic. However, the observed hand hygiene rate upon entering one of the facilities was much lower (12.8%) than the self-reported rate. Though the two rates did not come from the same sample, the difference suggests that the self-reported rate may be inflated, as shown in previous studies among HCWs and hospital visitors [23,62,63]. Nevertheless, even the self-reported rates indicate that there is still room to improve hand hygiene among outpatients to reduce the risk of environmental contamination and the transmission of pathogens in healthcare settings.

In line with previous research, this study has demonstrated that the TDF is an appropriate model for investigating hand hygiene behaviour among patients in healthcare facilities [22,23]. As expected, the three TDF domains (1) ‘memory, attention, and decision processes’, (2) ‘social/professional role and identity’, and (3) ‘emotions’ were significantly associated with patients’ self-reported general hand hygiene behaviour. The results correspond with previous research showing that slightly different domains may surface as relevant predictors when assessing slightly different behaviours since we found only ‘memory, attention, and decision processes’ and ‘emotions’ to be significantly associated with current behaviour (upon entering the clinic) [22,23]. Across multiple studies, ‘memory, attention, and decision processes’ are consistently among the most relevant TDF domains for hand hygiene behaviour [22,23,32–34]. This finding underlines previous research that many people simply forget to clean their hands [23,33]. Therefore, hand-rub dispensers should be placed in highly visible and easily accessible locations to facilitate the behaviour. Posters and other reminders may help to prevent forgetting and can be designed to target people’s social/professional role and identity and to convey emotions [64–69].

The present study also examined the co-occurrence between infection prevention behaviours during the COVID-19 pandemic. Outpatients’ hand hygiene behaviour was found to be positively associated with compliance with COVID-19 protective measures; however, not with their COVID-19 vaccine status. The first result corresponds with previous research indicating that people often show consistent patterns across multiple health behaviours [39–43]. Moreover, it is unsurprising that hand hygiene behaviour in outpatient facilities correlates with people’s compliance with COVID-19 protective measures since everyday hand hygiene is part of the latter set of actions. The fact that both hand hygiene behaviour and compliance with COVID-19 protective measures showed almost a null correlation with patients’ COVID-19 vaccination status was unexpected. One potential explanation might be risk compensation. According to the Peltzman effect, implementing safety measures reduces people’s perceived risk and causes them to engage in more risk-taking or less risk-avoiding behaviours [70]. This effect has been demonstrated in many domains, including healthcare [71,72]. However, previous research on the Peltzman effect during the COVID-19 pandemic has been inconsistent. One longitudinal study

![Figure 1. Path models with standardized parameter estimates. *P < 0.05, **P < 0.001.](image-url)
found that people engaged less in COVID-19-related safety behaviours after the government implemented stricter regulations [73]. Another study found that frequent mandatory COVID-19 testing was associated with greater participation in events related to COVID-19 dissemination [74]. However, two studies investigating the risk compensation effects of the COVID-19 vaccination did not find that people engaged less in protective measures after getting vaccinated [75,76]. Another possibility is that, for some people, the primary reason for getting vaccinated was never infection prevention but rather to use the vaccine as a tool to engage in leisure and social activities again [77]. When this is the case, the COVID-19 vaccine status might be unrelated to other infection prevention behaviours, which would also explain our findings. Given the available data, it can only be speculated as to why the proposed association was not observed.

Finally, we examined how individual differences in out-patients’ vaccine hesitancy and disease risk perception affect their behaviours. As expected, patients more hesitant about the COVID-19 vaccine were less likely to be vaccinated or to have received all recommended doses. This finding emphasizes the need to address three key factors contributing to hesitancy when promoting a vaccine: (1) confidence in vaccine effectiveness and safety, (2) complacency towards vaccine-preventable diseases, and (3) convenience of vaccine availability, affordability, and accessibility [50]. Moreover, we found that outpatients with lower COVID-19 risk perception showed more hesitancy against the vaccine. Vaccine hesitancy fully mediated the association between COVID-19 risk perception and vaccination status. In accordance with the literature, outpatients’ with higher COVID-19 risk perception reported more compliance with COVID-19 protective measures [55]. However, we did not find a significant association between COVID-19 risk perception and hand hygiene behaviour in outpatient facilities. This result contradicts previous research showing risk perception as a predictor of hand hygiene behaviour [22,23]. However, previous studies measured the infection risk more broadly, not linked to one pathogen. Considering that by March 2022 people were probably aware that the main transmission route for COVID-19 was through the air, not through contact, it is possible that outpatients did not perceive hand hygiene as the best protective measure against COVID-19. Another explanation could be that respondents perceived their risk of getting infected at the outpatient facility as low, and that therefore their general risk perception did not correspond with their behaviour in the clinic.

The study has limitations. First, most data were self-reported. Given that the observed hand hygiene rate was lower than the self-reported current hand hygiene rate, we assume that patients overreported their behaviour. However, we cannot confirm this assumption since the self-reported and observed data did not necessarily come from the same patients. Whereas relying on self-reports is an economical way to gather data, future research should use observed behaviours as dependent variables. Second, we only have observational data from one clinic, which limits the generalizability of the low hand hygiene rate. Third, we used a cross-sectional design, meaning that no conclusions about causal effects can be drawn. Future studies should use a longitudinal approach to confirm cause and effect. Fourth, the relatively small sample size may restrict the generalizability of the findings to a broader population. Finally, COVID-19 cases peaked in March 2022 in Germany and fell till the end of the same year. Throughout 2022, more and more COVID-19-related restrictions were lifted. Therefore, it is possible that some COVID-19-related infection prevention measures were no longer deemed necessary or strictly followed by the end of the data collection.

In conclusion, this is the first study to investigate patients’ hand hygiene behaviour and its association with other infection prevention measures in an outpatient care setting during the COVID-19 pandemic. It was found that the hand hygiene practice among outpatients should be improved. Our results suggest that using the TDF as a basis for planning behaviour change interventions might be a good strategy. Future interventions should help outpatients remember to clean their hands, potentially using design strategies to target people’s social/professional role and identity and to convey emotions. Moreover, we found that some measured behaviours co-occur while others appear unrelated. This requires further research to understand whether performing one infection prevention practice may affect people’s willingness to engage in others and how the pandemic influenced the results. Given that the majority of people are treated in outpatient facilities and the increasing complexity of procedures performed in these settings, more research on infection prevention and control practices is needed to ensure patient safety.

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**Author contributions**

S.G.: conceptualization, methodology, investigation, data curation, formal analysis, project administration, visualization, writing — original draft; K.W.: conceptualization, investigation (data collection), writing — review and editing; A.K.K.: formal analysis, writing — review and editing; S.D.: data curation, writing — original draft; C.R., S.M., E.B.: investigation (data collection), writing — review and editing; W.S.B.: resources, writing — review and editing, supervision.

**Conflict of interest statement**

None declared.

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**Appendix A. Supplementary data**

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jhin.2023.08.013.

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