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Serial home-based self-collection of anterior nasal swabs to detect \textit{Staphylococcus aureus} carriage in a randomized population-based study in Germany

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**ARTICLE INFO**

**Objective:** Participant-collected serial nasal swabs would be a cost-efficient feature of prospective population-based microbiological studies. We examined the feasibility of serial anterior nasal self-swabbing for \textit{Staphylococcus aureus} detection in a prospective population-based study in Braunschweig, Germany, and assessed the impact of three interventions on participation and compliance.

**Methods:** Two thousand twenty-six inhabitants were selected randomly from the resident registries and asked to self-collect a nasal swab monthly from July 2012 to January 2013 and return it by mail. The swabs were tested for the presence of \textit{S. aureus}. Participation and compliance were assessed in four study groups (incremental cash incentive, participation in a lottery, reminder by mail, and control group without incentive or reminder).

**Results:** Baseline participation was highest in the cash incentive group (24%; 123/504) and lowest in the reminder group (16%; 83/509). Approximately 90% of the participants in all groups returned the swabs each month, demonstrating high compliance irrespective of the intervention. Laboratory analyses showed that most swabs were usable for bacteriological studies. \textit{S. aureus} was detected at the expected frequency of 20–27%.

**Conclusions:** Home-based serial nasal self-swabbing proved to be feasible and highly acceptable and promises to be a cost-efficient tool for large-scale prospective population-based studies on bacterial infection or colonization.

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1. **Introduction**

Collecting biological specimens is becoming an increasingly frequent feature of epidemiological studies, likely due to the rapid development of assays for the quantification of biomarkers and other molecular-defined variables.\textsuperscript{1} However, the high cost of collection methods requiring face-to-face contact of study personnel with participants may limit the feasibility of collecting certain types of biospecimens. This is especially problematic in prospective studies requiring serial sample collection. An alternative would be to ask the participants to self-collect certain biosamples, such as nasal swabs, vaginal swabs, saliva, or capillary blood samples, at home and return them by mail. Self-collection may thus greatly reduce costs and also be more acceptable to the participants. The lower cost of this method may also facilitate studies involving large populations.\textsuperscript{2}

Several, mainly cross-sectional, studies have applied self-collection in various settings. Studies have shown adequate quality and quantity of DNA in self-collected saliva\textsuperscript{3,4} and vaginal samples\textsuperscript{5} that were returned by mail. Self-collection of nasal swabs to measure the prevalence of methicillin-sensitive and methicillin-resistant \textit{S. aureus} (MSSA and MRSA) carriage has been applied in several cross-sectional studies.\textsuperscript{6–8} It has also been used to detect respiratory pathogens in prospective cohort studies spanning one acute respiratory infection (ARI) season. For instance, nurses have collected their own nasal swabs,\textsuperscript{9} and parents have collected nasal swabs from their children.\textsuperscript{10} We have asked adult participants to self-collect nasal swabs in two prospective studies on viral...
ARIs.\textsuperscript{11,12} The participants self-collected a nasal swab if they developed ARI symptoms, amounting to up to three swabs per ARI season. However, serial nasal self-swabbing has not been applied in longitudinal population-based studies. In particular, there are no such studies in 'unsupervised settings', i.e. scenarios not involving at least some face-to-face contact between the participants and study personnel. Thus, it is unknown (1) whether participants will comply with such demanding study designs, and (2) how participation and/or compliance can be optimized in such studies. We therefore examined the feasibility of collecting serial nasal self-swabs by mail in an unsupervised setting and also assessed the impact of any of three interventions (an incremental cash incentive, participation in a lottery, and reminder by mail), compared to a control group, on participation and compliance.

2. Methods

2.1. Sampling and study participants

We conducted a prospective population-based study over a period of 6 months (July 2012 to January 2013). A local public relations campaign was conducted 1 week before sending out the invitation to participate in the study. The campaign featured a press release (leading to coverage in local newspapers), an interview for a local radio newscast, and posting of a podcast on the institution's internet page. Potential participants, males and females between 20 and 69 years of age (n = 2026), were selected randomly through the resident registration office and invited with a personalized letter to participate in the study.

In accordance with the envisaged age and sex distribution of the German National Cohort\textsuperscript{13} (for which studies on \textit{S. aureus} dynamics in the community are planned), the proportion of older participants (age groups 40–49, 50–59, and 60–69 years) was oversampled (26.7% in each age group vs. 10% in the age groups 20–29 and 30–39 years). Individuals were asked to self-collect a nasal swab every month and mail it to the laboratory within 48 h of self-swabbing. Since a major aim of the study was to detect \textit{S. aureus} carriage patterns, it was planned to collect seven swabs over a period of 6 months.\textsuperscript{14} Individuals were assigned by block randomization to one of the following four groups: (1) incremental cash incentive, also referred to as the 'cash incentive' group; (2) participation in a lottery, aka 'lottery' group; (3) reminder by mail, aka 'reminder' group; and (4) a control group. Approximately 500 invitees were included in each group. The participants in the cash incentive group were successively awarded 1€, 3€, 5€, 7€, 9€, and 11€ for each returned swab (starting from the second swab), resulting in a total of 36€ to be paid upon completion of the study. Participants in the lottery group had a chance to win 20€, 30€, or 50€ each month in which they returned the swab. The reminder group received a short reminder letter by mail approximately 2 weeks after the monthly self-swabbing kit if the requested swab was not received by the laboratory. The control group received neither the promise of an incentive nor a reminder letter. Separate invitation letters and information brochures were designed for each of the four study groups, ensuring that the participants in each group were blinded to the existence of the other three study arms. These strategies could have affected the participants' initial willingness to join the study (participation) as well as their subsequent compliance with the study protocol, because each

![Figure 1](image-url) Schematic presentation of the study design. (1) Total sample selected randomly from the resident registration office. (2) Invitation sent. (3) Response (agreement to participate). (4) Monthly self-swabbing (‘returned at least one swab) and non-responder survey. **Information about the assignment of non-responders to the study arms was not collected.
intervention strategy was described fully in the initial material describing the study that was sent out to the individuals to be recruited into the respective groups. Those who were willing to participate in the study were asked to return an enclosed stamped postcard and the signed informed consent form.

Basic socio-demographic data (e.g. sex, age, education, self-perceived health status, chronic diseases, and other common risk factors for *S. aureus* colonization), as well as information on comprehension of the instructions and acceptance of the self-collection of nasal swabs, were collected at baseline through a self-administered questionnaire that was sent out with the first self-swabbing kit.

Participants were provided with written and visual instructions on how to self-collect an anterior nasal swab. Each month an envelope was sent to the participant that contained the following items: a swabbing kit containing an Amies gel swab (Copan, Italy; catalog No. 108C), a short questionnaire, instructions for self-swabbing of the anterior nares, and a return envelope. In brief, the swab was to be inserted into one nostril to a depth of 1 cm, rotated three times on the nasal lining, and then placed into the transport medium. A schematic of the study design is shown in Figure 1.

### 2.2. Ethical and data safety approval

The study was approved by the Ethics Committee of the State Board of Physicians of the German Federal State of Lower Saxony and the Federal Commissioner for Data Protection and Freedom of Information of the Federal Republic of Germany.

### 2.3. Feasibility, compliance, and acceptance

The feasibility of serial self-collection of nasal swabs by mail was assessed by the following parameters: (1) the proportion of participants who had difficulties understanding the self-swabbing instructions (asked only at baseline), (2) the proportion of participants who reported deviations from the suggested self-swabbing procedure, (3) time from dispatch to arrival of the swab in the laboratory, and (d) time from self-collection to arrival of the swab in the laboratory. Each month the participants’ compliance with serial self-collection was assessed by the proportion of returned swabs. Acceptance of self-collection of nasal swabs was assessed with the following questions on a Likert scale with five answer categories: “Collecting the nasal swab myself was acceptable”, “I felt uncomfortable when taking the swab myself”, and “Nasal self-swabbing was easy to perform”. These questions were asked twice, i.e. at baseline and in study month 3.

### 2.4. Laboratory analysis

Nasal swabs were inoculated on blood agar (Mueller–Hinton II agar with 5% sheep blood; BD Diagnostics 254 080) and MRSA agar (Chrome agar II MRSA; BD Diagnostics 257 434). The plates were incubated overnight (approximately 18 h) at 37 °C. The appearance of the colonies on the blood agar plates was recorded (0 = no growth; 1 = rare; 2 = light; 3 = moderate; 4 = heavy). Colonies with the appearance of *S. aureus* were then subcultured on blood agar and tested with a slide coagulase test. Human blood plasma received from a local hospital and fibrinogen from human blood plasma (Sigma-Aldrich, USA) were used for coagulase testing. DNA was extracted with the DNeasy Blood and Tissue Kit (Qiagen). PCR for the *spa* gene was used to confirm the diagnosis of *S. aureus*.15

### 2.5. Non-responder survey

A short anonymous questionnaire was sent to 1480 non-responders. This questionnaire could not be sent to the other non-responders, because the initial invitation was undeliverable due to incorrect address information. The questionnaire contained questions on basic socio-demographics, common risk factors for *S. aureus* carriage, and reasons for not participating in the study.

### 2.6. Statistical analysis

Associations between categorical variables were tested with the Chi-squared test. Differences in continuous variables across various groups were tested with the Wilcoxon signed rank test. The effect of the interventions on compliance was examined with repeated measures logistic regression using the generalized estimating equations procedure. The model was adjusted for participant age, sex, and level of school-leaving qualification. Semiparametric group-based modeling was used to classify participants into compliance trajectories (the SAS procedure PROC TRAJ).16 We started with a single trajectory and subsequently increased the number of trajectories by one until we reached the

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**Table 1**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Cash incentive group</th>
<th>Lottery group</th>
<th>Reminder group</th>
<th>Control group</th>
<th>p-Value*</th>
<th>All responders</th>
<th>Non-responders</th>
<th>p-Value†</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n = 123</td>
<td>n = 109</td>
<td>n = 83</td>
<td>n = 90</td>
<td>0.08</td>
<td>61</td>
<td>53</td>
<td>0.05</td>
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<tr>
<td><strong>Sex</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>68</td>
<td>51</td>
<td>64</td>
<td>61</td>
<td></td>
<td>0.08</td>
<td>61</td>
<td>53</td>
</tr>
<tr>
<td>Male</td>
<td>32</td>
<td>49</td>
<td>36</td>
<td>39</td>
<td></td>
<td>39</td>
<td>47</td>
<td></td>
</tr>
<tr>
<td><strong>Age, years, median (IQR)</strong></td>
<td>47 (38–59)</td>
<td>51 (40–62)</td>
<td>50 (39–63)</td>
<td>50 (38–60)</td>
<td>0.63†</td>
<td>49 (39–61)</td>
<td>50 (38–62)</td>
<td>0.59†</td>
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<tr>
<td><strong>Level of school leaving qualification</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lower</td>
<td>20</td>
<td>22</td>
<td>25</td>
<td>23</td>
<td>0.97</td>
<td>22</td>
<td>26</td>
<td>0.31</td>
</tr>
<tr>
<td>Middle</td>
<td>36</td>
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<td>34</td>
<td>31</td>
<td></td>
<td>34</td>
<td>36</td>
<td></td>
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<tr>
<td>Higher</td>
<td>44</td>
<td>43</td>
<td>41</td>
<td>46</td>
<td></td>
<td>44</td>
<td>38</td>
<td></td>
</tr>
<tr>
<td><strong>Self-perceived health status</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poor/fair</td>
<td>10</td>
<td>9.0</td>
<td>10</td>
<td>7.0</td>
<td>0.92</td>
<td>9.2</td>
<td>14</td>
<td>0.03</td>
</tr>
<tr>
<td>Good</td>
<td>61</td>
<td>65</td>
<td>62</td>
<td>70</td>
<td></td>
<td>64</td>
<td>55</td>
<td></td>
</tr>
<tr>
<td>Very good/excellent</td>
<td>29</td>
<td>26</td>
<td>28</td>
<td>23</td>
<td>0.68†</td>
<td>27</td>
<td>31</td>
<td></td>
</tr>
<tr>
<td><strong>BMI, kg/m², median (IQR)</strong></td>
<td>25.3 (22.6–28.4)</td>
<td>25.2 (22.4–28.1)</td>
<td>24.9 (22.0–26.9)</td>
<td>25.2 (22.6–27.1)</td>
<td>0.94‡</td>
<td>25.1 (22.5–27.8)</td>
<td>24.8 (22.5–28.0)</td>
<td></td>
</tr>
<tr>
<td><strong>Country of birth</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Germany</td>
<td>87</td>
<td>94</td>
<td>96</td>
<td>92</td>
<td>0.09</td>
<td>92</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Other</td>
<td>13</td>
<td>5.8</td>
<td>3.7</td>
<td>8.0</td>
<td></td>
<td>8.0</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

IQR, interquartile range; BMI, body mass index.

* Percentages are rounded so that uniform numbers of significant figures are shown.
† Chi-square test for differences across groups.
‡ There were six missing values spread across variables.
§ Chi-square test for differences between responders and non-responders.
∥ Wilcoxon signed rank test.
3. Results

3.1. Participation rate and sample characteristics

The initial overall participation rate was 20% (405/2026). The highest participation was observed in the cash incentive group (24%; 123/504), followed by the lottery (22%; 109/508), control (18%; 90/505), and reminder (16%; 83/509) groups (Chi-square = 12.627, df = 3, p = 0.006). We observed only minor differences across groups in selected socio-demographic variables (Table 1).

Of the 1480 individuals to whom a non-responder questionnaire was sent, 274 (19%) returned the completed questionnaire. The proportions of male participants and of individuals who reported poor/fair health status were significantly lower in the study sample than in the non-responder sample (Table 1). None of the other variables (e.g. age, education, and body mass index) differed significantly between responders and non-responders. The most commonly reported reasons for not participating in the study were ‘lack of time’ (41%), ‘no interest’ (13%), ‘I was not convinced by the aims of the study’ (5.9%), ‘language difficulties’ (4.1%), and other reasons (24%). No specific reason was provided in 12%.

3.2. Feasibility

About 98% (381/388) of the participants reported no difficulties understanding the self-swabbing instructions (asked at baseline). The proportion of participants who reported a deviation in the self-swabbing procedure was highest at baseline (2.1%, 8/386) and lowest in study month 6 (0.53%, 2/375). The reported difficulties were (1) the top of the swab touched something else (e.g. edge of the table), and (2) the swab fell on the floor. Across all months, the median time between dispatch of the monthly swab kits and receipt of the swabs in the laboratory was 6 days (range 1–65, interquartile range (IQR) 5–8 days). The median time between self-swabbing and arrival of the swabs in the study center was 1 day (range 0–36, IQR 1–2 days). Ninety-nine percent of the nasal swabs (2634/2656) were returned within 1 week of self-swabbing.

3.3. Compliance

Compliance with serial self-swabbing (as measured by the proportion of returned swabs) was high in all months (Figure 2). Of the 405 participants, 396 (98%) returned at least one nasal swab.
during the study period and nine (2.2%) did not return any swab. There were no statistically significant differences in compliance across the four study groups (Figure 2). Older participants were somewhat more likely to return a nasal swab than younger participants (increase of odds per year of age: odds ratio 1.04, 95% confidence interval 1.01–1.07). Three compliance trajectories were estimated using semiparametric group-based modeling (Figure 3): persistently perfect compliance (87%), initial high but decreasing compliance (8.0%), and initial low and decreasing compliance (4.7%).

3.4. Acceptance

Ninety-nine percent (335/338) of the participants reported that nasal self-swabbing was acceptable or highly acceptable and 0.89% reported ‘not sure’; no one reported disagreement with this statement. Ninety percent (305/338) reported no difficulties when self-collecting the swab, 11 (3.3%) were not sure, and 22 (6.5%) reported that they felt uncomfortable. Of the 340 participants, 335 (99%) stated that nasal self-swabbing was easy to perform, one (0.29%) was not sure, and four (1.2%) disagreed with this statement. No significant differences were observed in the second questionnaire administered 3 months later.

3.5. Laboratory findings

The mean colony density varied between 2.5 and 3.3 across the study months (Table 2). The proportion of nasal swabs with no bacterial growth varied between 0.77% (3/389, baseline) and 5.6% (21/377, month 4) (Table 3). The proportion of swabs positive for S. aureus varied between 20% and 27% (Table 3).

### Table 2

<table>
<thead>
<tr>
<th>Bacterial growth score</th>
<th>Mean growth score (range, IQR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline swab (n = 367)</td>
<td>3.1 (0–4, 3–4)</td>
</tr>
<tr>
<td>Swab at month 1 (n = 361)</td>
<td>3.3 (0–4, 3–4)</td>
</tr>
<tr>
<td>Swab at month 2 (n = 382)</td>
<td>3.2 (0–4, 3–4)</td>
</tr>
<tr>
<td>Swab at month 3 (n = 362)</td>
<td>2.7 (0–4, 2–4)</td>
</tr>
<tr>
<td>Swab at month 4 (n = 359)</td>
<td>2.6 (0–4, 2–4)</td>
</tr>
<tr>
<td>Swab at month 5 (n = 365)</td>
<td>2.5 (0–4, 2–3)</td>
</tr>
<tr>
<td>Swab at month 6 (n = 352)</td>
<td>2.5 (0–4, 2–3)</td>
</tr>
</tbody>
</table>

IQR, interquartile range.

a A score was not recorded for plates with Proteus spp overgrowth.

b The appearance of the colonies on blood agar plates was scored as follows: 0 = no growth; 1 = rare; 2 = light; 3 = moderate; 4 = heavy.

| Table 3

Bacterial growth observed on blood agar plates (%) |

<table>
<thead>
<tr>
<th></th>
<th>Baseline swab n = 390</th>
<th>Swab at month 1 n = 384</th>
<th>Swab at month 2 n = 386</th>
<th>Swab at month 3 n = 384</th>
<th>Swab at month 4 n = 378</th>
<th>Swab at month 5 n = 378</th>
<th>Swab at month 6 n = 375</th>
</tr>
</thead>
<tbody>
<tr>
<td>No growth</td>
<td>0.77</td>
<td>1.6</td>
<td>2.6</td>
<td>3.6</td>
<td>5.6</td>
<td>3.4</td>
<td>4.5</td>
</tr>
<tr>
<td>Staphylococcus aureusc</td>
<td>22</td>
<td>22</td>
<td>19</td>
<td>23</td>
<td>23</td>
<td>27</td>
<td>24</td>
</tr>
<tr>
<td>Other bacteria</td>
<td>77</td>
<td>74</td>
<td>78</td>
<td>73</td>
<td>72</td>
<td>70</td>
<td>72</td>
</tr>
</tbody>
</table>

a Percentages are rounded so that uniform numbers of significant figures are shown.

b Values represent percentages of all swabs received in the time period specified, based on inspection of bacterial growth.

c Confirmed by PCR.

4. Discussion

Serial nasal self-swabbing, an equally desirable and demanding component of community-based studies on bacterial colonization and infection, turned out to be a feasible and highly acceptable method in this short-term, prospective, population-based study.

4.1. Comparison of the three schemes to enhance participation and compliance

The monetary and lottery incentives were associated with higher participation rates. This is consistent with previous observations that showed positive effects of monetary and non-monetary incentives on participation rates. The reluctance of some participants to receive monthly reminder postcards might be responsible for the slightly lower participation rate in the reminder group. Interestingly, the three intervention strategies were not associated with differences in compliance with the self-swabbing protocol, suggesting that less obvious rewards not measured here, or an intrinsically high motivation, governed the participants’ study behavior once they had decided to join the study. We favor the latter possibility, as compliance was high throughout the duration of the study. Age was the only variable significantly associated with better compliance.

These findings are of particular importance since substantial savings would result if costly incentives and/or reminders are not needed in a large population-based study. These savings would be particularly noticeable in large population-based studies involving thousands of participants, such as genome-wide association studies of nasal S. aureus carriage. Interestingly, previous research on retention methods in prospective population-based studies lasting up to several years showed that both monetary incentives and reminders increased retention rates. However, by receiving self-swabbing kits on a monthly basis, the participants in all four study groups were exposed to a continual alerting system. Moreover, our study was of relatively short duration, and the
effects of the interventions might have become apparent after a longer study period.

4.2. Feasibility, acceptance, and compliance

Most participants (99%) returned the nasal swabs within 1 week of self-swabbing. This is important since a longer time from self-collection to the arrival of the swab in the laboratory may have a negative impact on pathogen detection. Baay et al. examined the effect of shipping time on the quality of genomic DNA in self-collected vaginal swabs and found that a longer shipping time resulted in a marginal decrease in DNA yield. However, the trend was not significant and the amount of DNA was sufficient for analysis. In a previous study of nasal self-swabbing to detect acute viral respiratory pathogens with PCR, we found no association between shipping time and positivity rate. Delacour et al. examined the survival of S. aureus strains in the Amies swab transport system (which we used in the present study) and found that S. aureus can survive for up to 3 weeks during transport at room temperature. However, the authors recommend a time frame of 18 days between swab collection and laboratory analysis for optimal isolation of S. aureus strains. As mentioned above, nearly all swabs in the current study were returned within 1 week.

We observed an interesting pattern regarding compliance changes over the study period. The overwhelming majority of participants showed consistently perfect compliance by sending in all scheduled nasal swabs during the study period, and compliance decreased in only a small proportion of participants. Such very high compliance with serial self-collection of nasal swabs in population-based longitudinal studies would certainly facilitate conducting studies on bacterial carriage/infection patterns and their risk factors; first, by substantially lowering study expenses because costly home visits or visits to the study center are avoided, and second, by providing an uninterrupted chain of sequential swabs. For example, individuals may be permanently, transiently, or not at all colonized with S. aureus, and persistent carriers are at higher risk of developing invasive infections. However, the underlying risk factors for these different colonization patterns are not well understood, and serial self-collection of nasal swabs would allow capturing of the relevant phenotypes in the general population.

4.3. Strengths and limitations

This is the first prospective population-based study to use serial nasal self-swabbing and swab remittance by mail without any direct contact between staff and participants. Previous studies have used self-collection of nasal swabs mainly in cross-sectional approaches and the small number of prospective studies used it to detect viral acute respiratory pathogens. The latter studies applied self-collection of nasal swabs if participants developed an acute respiratory episode during an ARI season. Peltola et al. used serial self- or parent-collected nasal swabs in a short-term prospective study of hospitalized individuals to examine the shedding patterns of rhinoviruses; the participants were asked to self-collect a nasal swab twice a week over a period of 3 weeks. In that study, the study personnel instructed the participants in the self-swabbing technique during the initial recruitment visit. In contrast, in the present study all communication with the participants, including recruitment, data collection, and feedback of personal results, took place by mail, and the participants learned the self-swabbing procedure through the instruction brochure. This is especially important since many individuals may not want to participate in epidemiological studies due to a lack of time or because they are reluctant to engage in personal contact with study personnel. Self-collection in a home-based setting would be an alternate option for such individuals. In addition, avoiding travel to the study center or expensive communication tools such as email would be favorable for implementing nasal self-swabbing in studies in resource-poor countries.

Our study is limited by the possibility that the study sample may not be representative of the source population, since the participation rate was only 20%. Indeed, the proportions of men and of individuals with a poor health status were lower in the responder than the non-responder samples. Another possible limitation is that we did not examine the validity of the self-collected swabs to detect S. aureus carriage by comparing it with the gold standard, e.g. a staff-collected swab. However, self-collection of nasal swabs has been shown to be a valid method to detect viral and bacterial infections in various settings. van Cleef et al. compared the detection of S. aureus in self- and staff-collected nasal swabs among nursing and technical staff and observed high agreement (93%, kappa coefficient 0.85). The detection rate of S. aureus was even higher in self- than in staff-collected swabs. Lautenbach et al. observed similar results in a hospital-based study.

Both studies revealed a high sensitivity of nasal self-swabs to detect S. aureus compared to the gold standards, ranging from 91% to 97%. Moreover, in a previous study of nasal self-swabbing, we observed that self-collected swabs are qualitatively as good as those collected by a trained staff member, as measured by the levels of human β-actin gene DNA sequences and pathogen detection rates. The current study showed that the vast majority of nasal swabs were usable for bacteriological culture; there was only a small proportion of swabs that provided no bacterial growth at all. In addition, the S. aureus detection rate of 20–27% was similar to previous reports.

In conclusion, serial self-collection of nasal swabs proved to be a feasible and highly acceptable method in a prospective population-based study. Monetary incentives were associated with higher participation, but compliance was excellent irrespective of incentives or reminders. Serial self-collection of nasal swabs without costly incentives or reminders thus promises to be a cost-efficient tool for large-scale population-based studies examining infections and/or colonization of the upper respiratory tract.

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Conflict of interest: The authors declare that they do not have a conflict of interest relating to the publication of this manuscript.

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