

# Surgical hand scrubbing in cardiac surgery teams: a microbiological analysis

*Degermação cirúrgica das mãos da equipe de cirurgia cardíaca: uma análise microbiológica*

*Desinfección quirúrgica de las manos en los equipos de cirugía cardíaca: un análisis microbiológico*

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**ABSTRACT: Objective:** To describe the microbiota of the hands of the cardiac surgery team after surgical hand scrubbing and glove removal at the end of the surgical procedure, and to compare this with adherence to the recommended surgical scrubbing time. **Method:** An observational study was carried out at two points: after the surgical scrubbing of the cardiac surgery team's hands and after glove removal at the end of the surgical procedure. The variables analyzed included professional identification and aspects of surgical hand scrubbing. Data were collected using an observation script based on the literature. **Results:** Twenty professionals were observed, resulting in 40 samples. At both collection times, microorganisms from the skin's resident microbiota were identified, including coagulase-negative *Staphylococcus*, methicillin-sensitive *Staphylococcus aureus*, and *Bacillus* sp. in 35% (7) of the surgical team. Microorganisms potentially related to surgical site infections, such as *Escherichia coli*, *Klebsiella pneumoniae*, and *Proteus mirabilis* were isolated in 25% (5) of the population studied. The risk of pathogenic microorganisms being present when surgical hand scrubbing was not carried out in the recommended time was 14.2%. **Conclusion:** Strategies for ensuring adherence to proper hand scrubbing technique and periodic training should be implemented to mitigate the occurrence of surgical site infections and enhance patient safety.

**Keywords:** Hand disinfection. Surgical wound infection. Infection control. Patient safety.

**RESUMO: Objetivo:** Descrever a microbiota das mãos da equipe de cirurgia cardíaca após a degermação cirúrgica das mãos e a retirada das luvas ao término do procedimento cirúrgico, e comparar com a adesão ao tempo correto de degermação cirúrgica. **Método:** Estudo observacional realizado em dois momentos: após degermação cirúrgica das mãos da equipe de cirurgia cardíaca e após a retirada das luvas ao término do procedimento cirúrgico. As variáveis analisadas foram de identificação dos profissionais e aspectos da degermação cirúrgica das mãos. O instrumento de coleta de dados contou com um roteiro de observação, com base na literatura. **Resultados:** Vinte profissionais foram observados, resultando em 40 amostras. Nos dois momentos de coleta, foram identificados microrganismos da microbiota residente da pele, como *Staphylococcus* coagulase negativa, *Staphylococcus aureus* sensível à meticilina, *Bacillus* sp em 35% (7) da equipe cirúrgica. Houve isolamento de microrganismos potencialmente relacionados à infecção de sítio cirúrgico, *Escherichia coli*, *Klebsiella pneumoniae* e *Proteus mirabilis* em 25% (5) da população estudada. O risco da presença de microrganismo patogênico quando a degermação cirúrgica das mãos não é realizada no tempo recomendado foi de 14,2%. **Conclusão:** estratégias para adesão à técnica correta e ao treinamento periódico de degermação das mãos devem ser implementadas para mitigar a ocorrência de infecção de sítio cirúrgico e segurança do paciente. **Palavras-chave:** Desinfecção das mãos. Infecção da ferida cirúrgica. Controle de infecções. Segurança do paciente.

**RESUMEN: Objetivo:** Describir la microbiota de las manos del equipo de cirugía cardíaca tras el desgerminado quirúrgico de las manos y la retirada de los guantes al final del procedimiento quirúrgico, y compararla con el cumplimiento del tiempo recomendado de desgerminado quirúrgico. **Método:** Estudio

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observacional realizado en dos momentos: tras el desgerminado quirúrgico de las manos del equipo de cirugía cardíaca y tras la retirada de los guantes al final del procedimiento quirúrgico. Las variables analizadas fueron la identificación profesional y los aspectos del desgerminado quirúrgico de las manos. El instrumento de recolección de datos incluyó un guion de observación basado en la literatura. **Resultados:** Se observó a 20 profesionales, resultando en 40 muestras. En ambos momentos de recolección, se identificaron microorganismos de la microbiota residente de la piel, como *Staphylococcus coagulasa-negativo*, *Staphylococcus aureus* sensible a meticilina y *Bacillus sp* en el 35% (7) del equipo quirúrgico. Los microorganismos potencialmente relacionados con la infección del sitio quirúrgico, como *Escherichia coli*, *Klebsiella pneumoniae* y *Proteus mirabilis* se aislaron en el 25% (5) de la población estudiada. El riesgo de presencia de microorganismos patógenos cuando la desgerminación quirúrgica de las manos no se realiza en el tiempo recomendado fue del 14,2%. **Conclusión:** Se deben implementar estrategias de adherencia a la técnica correcta y entrenamientos periódicos en el desgerminado de manos para mitigar la ocurrencia de infección del sitio quirúrgico y promover la seguridad del paciente.

**Palabras clave:** Desinfección de las manos. Infección de la herida quirúrgica. Control de infecciones. Seguridad del paciente.

## INTRODUCTION

Healthcare-associated infections (HAIs) represent a serious global public health problem, with increased morbidity, mortality, length of stay and hospital costs, without highlighting the direct impact on the quality of healthcare services and patient safety<sup>1</sup>.

Surgical site infections (SSI) occur between the first 30 days after the anesthetic-surgical procedure and up to 90 days, if implants are placed or deep soft tissues are involved<sup>1</sup>. These are complications that occur in approximately 3 to 20% of procedures performed and are associated with a mortality rate of 38%. It represents around 20% of all HAIs; Furthermore, several surgeries have been associated with the development of antimicrobial resistance<sup>1-3</sup>.

SSI has a significant impact in the United States and Europe, ranking second among the most prevalent HAIs. It represents a cost of around US\$ 10 billion annually, in addition to the increase in hospitalization time (on average, 9.7 days), the increase in the risk of mortality (11 times), the increase in cost (US\$ 20 thousand per admission) and the possible need for admission to the intensive care unit. In Brazil, it ranks third among all HAIs, being prevalent in around 14 to 16% of hospitalized surgical patients<sup>4,5</sup>.

It is estimated that around 50% of SSIs are preventable by adopting preventive measures. Among these measures, this study highlights surgical hand scrubbing, a procedure performed by the surgical team before the anesthetic-surgical procedure, with the aim of eliminating the transient microbiota and reducing the resident microbiota, producing a residual effect on the professional's skin<sup>5</sup>. The technique lasts at least 3 to 5 min in the first surgery and 2 to 3 min in subsequent surgeries<sup>6-8</sup>.

Surgical hand scrubbing is essential before the surgical team puts on sterile surgical gloves, as these can promote a

humid environment on the hands of professionals, which if antiseptics does not occur or occurs in a non-compliant manner, it will result in exacerbated proliferation of microorganisms present in the microbiota on the hands of the multidisciplinary team<sup>7</sup>.

The use of sterile surgical gloves is standardized, but there is evidence that microscopic perforations are found after removing them at the end of surgeries. The longer the duration of the surgical procedure, the greater the risk of increased rates of microperforations in gloves. The reduction in microbial contamination is associated with an increase in the frequency of changing surgical gloves<sup>7</sup>. Therefore, it is recommended to replace gloves during prolonged surgeries, such as cardiothoracic and orthopedic surgeries, preferably every 90 min<sup>7,8</sup>.

The use of double surgical gloves or double gloving during surgery is advocated by professionals as a means to reduce the risk of contamination for professionals and patients — the result of possible perforation of gloves during surgery<sup>7,8</sup>. A systematic review that investigated the effectiveness of using double gloves in preventing perforation of surgical gloves and blood contamination compared to the use of single gloves, identified that the perforation rate in the double glove group was statistically lower than that in the use of single gloves (odds ratio — OR=0.75, 95% confidence interval — 95%CI 0.64–0.89, p<0.05). Thus, it was concluded that the use of double gloves can reduce the perforation rate of surgical gloves and, consequently, the risk of contamination by a blood-borne pathogen during surgery<sup>9</sup>.

In the context of cardiac surgery, studies have linked SSIs to the patient's microbiota. The sternum region has been a reported complication, with an incidence reported between 3.5 and 9.7%, and aortic stent graft infection is one of the infectious complications with the highest mortality (16.9 to 39.2%)<sup>10,11</sup>.

Therefore, the present study highlights the importance of the microbiota of the surgical team when considering that the effectiveness of surgical hand scrubbing may be influenced by low adherence to international guidelines. An observational study in operating rooms at a German university clinic investigated 1,145 opportunities for hand scrubbing during 16 surgeries. Overall adherence was 40.8% (95%CI 37.9–43.6%), with a greater difference between the surgical team versus the anesthesia team (28.4% versus 46.1%,  $p < 0.001$ ) than between doctors versus nurses (38.5 versus 42.9%,  $p = 0.13$ )<sup>12</sup>.

Knowledge of the surgical team's skin microbiota and monitoring adherence to recommended good practices for surgical hand scrubbing can guide strategic health education actions and prevention of SSIs and antimicrobial resistance.

## OBJECTIVE

The present study aimed to describe the hand microbiota of the cardiac surgery team after surgical hand scrubbing and removal of gloves at the end of the surgical procedure, and to compare with adherence to the correct surgical scrubbing time.

## METHOD

A descriptive observational study was conducted; it was anchored in the 22 items of the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) recommendation<sup>13</sup>. In the study, the microbiota of the hands of the cardiac surgery team was described, considering two moments: immediately after surgical hand scrubbing (1st moment) and after removing the sterile gloves, at the end of the surgical procedure (2nd moment).

The study setting was the surgical center of a university hospital, located in the city of Rio de Janeiro, Brazil. Data collection took place between the months of June and August 2023.

The study participants were selected by convenience sampling, and the recruitment process was non-probabilistic. Professionals from the multidisciplinary cardiac surgery team were included, consisting of a staff surgeon, cardiac surgery medical resident, anesthesiologist, anesthesia resident, nurse, nursing resident and instrumentation technicians and perfusionists, who agreed to participate in the study, filled

out and signed an informed consent form, and performed surgical hand scrubbing. Cardiac surgery was chosen because it is a prolonged surgery with a recommendation to change gloves after 90 min of the surgical procedure, and given the prevalence of SSIs, that must be notified in myocardial revascularization surgeries, as described in the literature<sup>7,8</sup>. Professionals with less than 6 months of experience in the service were excluded, considering experience and knowledge of the routine and technique of surgical hand scrubbing<sup>7,8</sup>.

An instrument was created for data collection; it was composed of sociodemographic variables and those related to surgical hand scrubbing, which included: time to perform the technique (in minutes), technique for removing nail debris, presence or absence of adornments and false nails, adequacy of steps to degerm the hands, and whether gloves were changed during the surgical procedure<sup>14</sup>. It is noteworthy that all study participants used the same brand of sponge brush, with 2% chlorhexidine digluconate, and the same brand of sterile gloves.

Hand data collection was directed by another instrument, which presented the step-by-step process after surgical hand scrubbing and after removing gloves at the end of the anesthetic-surgical procedure. Sterile swabs were identified and recorded to guarantee the anonymity of health professionals, with each swab being assigned a code for observing the hand scrubbing technique that corresponds to the professional's training, the time of collection, the sample number and the date the sample was collected.

A microbiological standard for hand swabs was not identified; therefore, studies have used collection patterns used by food handlers<sup>15,16</sup>. This study followed the collection recommendations of the American Public Health Association (APHA), Compendium of Methods for the Microbiological Examination of Foods<sup>17</sup>. A single trained researcher collected the samples from the first surgery from the surgical team that worked only in elective myocardial revascularization surgeries, usually performed in the morning.

During the collection procedure, the researcher used the end containing the cotton moistened in sterile saline, passing the swab over the palms of the professionals' hands, rotating it so that the entire surface of the cotton swab came into contact with the determined areas. At the two moments defined by the study, the swabs were collected from the right and left hands, in five different locations on the hands, in the following order: back of the hand, palm of the hand, interdigital spaces, nail bed and wrists. The swabs were preserved in Stuart semi-solid medium; after collection, they were transported

in an airtight box and sent directly to the clinical bacteriology laboratory at the study institution.

The swabs were analyzed by sowing them on 5% Base Columbia sheep blood agar (Plastlabor, Rio de Janeiro, Brazil), used because it is a culture medium rich in nutrients intended for the isolation of aerobic, anaerobic or facultative bacteria, originating from different types of clinical samples.

Depletion sowing was carried out, considering that it is a technique that allows a uniform distribution of the microorganisms present in the sample over the surface of the culture medium, providing ideal conditions for the growth of a wide variety of bacterial species.

After seeding, the plates were placed in an oven at a temperature of 37°C for 24 hours. In the case of no growth, they were maintained for another 24 hours. After the characteristic analysis of the colonies, the microorganisms were identified. To identify *Staphylococcus* sp., the colonies were subjected to Gram staining and subsequent catalase and coagulase tests.

Gram-positive bacteria were identified, and the antibiogram was performed using the VITEK-2 automated system (Biomérieux, Nürtingen, Germany).

Sociodemographic data, compliance with surgical hand scrubbing and swab results were organized and analyzed in an Excel® spreadsheet. Initially, descriptive statistics were performed, and subsequently, quantitative variables (time of surgical hand scrubbing and presence of microorganisms) were analyzed using Fisher's exact test. In all tests,  $p < 0.05$  was considered significant.

The study was conducted in accordance with national and international ethics guidelines and was approved by the Research Ethics Committee (CEP), in accordance with Resolution No. 466/12, opinion No. 5.903.837. A signed informed consent form was obtained from all participants involved in the study.

## RESULTS

Twenty professionals from the cardiac surgery team participated in the study, of which 12 (60%) showed growth of microorganisms on their hands. Surgical hand scrubbing was performed by the surgery team at two moments: immediately after scrubbing and after removing sterile gloves at the end of the anesthetic-surgical procedure, totaling 40 swabs.

Regarding sociodemographic data, half of the professionals were male, with a predominance of the age group between 20 and 40 years old (17; 85%). Of the professional

categories that participated in the study, surgical scrub nurses had the greatest participation (11; 55%), followed by surgery residents (6; 30%). Professionals with 1 to 5 years of training (7) represented 35% of the sample, followed by those with 5 to 10 years (4; 20%) and those with over 20 years of training (4; 20%).

Table 1 shows the distribution of microorganisms according to the time of swab collection, the performance of surgical hand scrubbing and the time elapsed to carry out the procedure.

The average time for hand scrubbing was 3 min and 15 s (minimum time: 2 min; maximum time: 4 min).

Regarding the observation of the surgical hand scrubbing technique, for items related to the removal of debris from the nail bed, absence of decorations and false nails, all professionals followed the recommendations established in the literature. It is noteworthy that no change of gloves was recorded during the surgical procedure.

It was observed that the technique used to cultivate the swabs did not recover microorganisms in samples from nine (45%) professionals on the surgical team. The exclusive presence of microorganisms from the normal skin microbiota, such as coagulase-negative *Staphylococcus* sp. (CNS), methicillin-sensitive *Staphylococcus aureus* (MSSA), methicillin-resistant *Staphylococcus aureus* (MRSA), *Bacillus* sp. and gram-negative *Corynebacterium bacillus* (GNB), was evidenced in seven (35%) professionals. In five (25%) the isolation of microorganisms potentially related to SSI was identified, such as the enterobacteria *Escherichia coli*, *Klebsiella pneumoniae* and *Proteus mirabilis*. The growth of MRSA in two professionals stands out, as well as the presence of *Candida* sp.

When it comes to recovering and identifying microorganisms present on the skin, it is important to recognize the challenges inherent in the cultivation process. Swab collection, although widely used, may have limitations, which may result in a partial representation of the skin microbiome, since microorganisms may not be recovered under conventional laboratory conditions — which justifies the results of samples 2 and 10.

Table 2 shows the association between the time taken to perform the surgical hand scrubbing procedure, in accordance with scientific recommendations, and the presence of potentially pathogenic microorganisms.

Correct surgical hand scrubbing was carried out by 14 professionals from the cardiac surgery team, and in only 1 of them did the growth of potentially pathogenic microorganisms occur, which were possibly already part of the

**Table 1.** Distribution of microorganisms isolated from hands of professionals from the cardiac surgery team. Rio de Janeiro, RJ, Brazil. 2024.

Professionals from cardiac surgery team	Time of first surgical hand scrubbing	Moment 1: after surgical hand scrubbing	Moment 2: after surgical procedure
1	2 min 40 s	CNS MSSA MRSA <i>E. coli</i>	CNS MSSA MRSA <i>E. coli</i> <i>Candida sp.</i>
2	2 min	CNS MSSA MRSA GNB	CNS
3	3 min	CNS MSSA	CNS MSSA GNB
4	4 min	0	0
5	3 min 54 s	CNS <i>Bacillus subtilis</i>	CNS
6	2 min	CNS <i>Klebsiella pneumoniae</i>	CNS <i>Klebsiella pneumoniae</i>
7	4 min 7 s	0	0
8	3 min 9 s	0	CNS
9	5 min	0	0
10	2 min 32 s	CNS	0
11	2 min 24 s	CNS	CNS
12	3 min	0	0
13	3 min 7 s	0	0
14	3 min	0	0
15	3 min 17 s	0	0
16	2 min 39 s	0	CNS
17	4 min	0	0
18	3 min 18 s	0	0
19	2 min 10 s	CNS GNB	CNS GNB
20	4 min	<i>Proteus mirabilis</i>	<i>Proteus mirabilis</i>

CNS: coagulase-negative *Staphylococcus*; MSSA: methicilin-sensitive *Staphylococcus aureus*; MRSA: methicilin-resistant *Staphylococcus aureus*; GNB: gram-negative bacillus.

**Table 2.** Association of the time of the first surgical hand scrubbing by professionals from the cardiac surgery team with the presence of pathogenic microorganisms isolated in swabs. Rio de Janeiro, RJ, Brazil. 2024.

		Potentially pathogenic microorganisms		RR	95%CI	p-value
		Yes	No			
Scrubbing time	3 to 5 min	1	13	0.142	(0.018–1.111)	0.060*
	<3 min	3	3			
Total		4	16			

RR: relative risk; 95%CI: 95% confidence interval; \*Fisher's exact test;



individual's microbiota. Although no statistical significance was found, it was identified that the risk of acquiring pathogenic microorganisms when scrubbing was not carried out within the recommended time was 14.2%.

## DISCUSSION

This study described a young surgical team, aged between 20 and 40 years (17; 85%); surgery residents totaled six professionals (30%) in the sample. As this study was carried out in a university hospital, this finding corroborates a quasi-experimental study that evaluated the compliance with the practice of surgical hand scrubbing among young surgeons at a university hospital in Pakistan. The technique of 30 surgical residents was analyzed. After implementing educational strategies aimed at improving the quality of surgical hand scrubbing, compliance increased from 63 to 90%, showing that educational strategies can be effective for the population of surgery residents<sup>18</sup>.

It is noteworthy that adherence to surgical hand scrubbing protocols, respecting the recommended technique and time, anchored in robust scientific evidence, can be a barrier to SSI and, consequently, contribute to reducing hospitalization time and rates of morbidity and mortality<sup>7,8,19</sup>.

In this study, 14 (70%) professionals complied with the recommended time and 20 (100%) respected the recommendations regarding the removal of debris from the nail bed, the absence of decorations and false nails. Another study, carried out in a university hospital in Turkey, aimed to evaluate the surgical hand scrubbing of a team of 66 professionals from a surgical center and showed that 51% of the professionals performed the procedure inappropriately<sup>20</sup>.

A Norwegian study that investigated surgical hand scrubbing identified, based on 132 systematic observations by 52 surgeons and 32 scrub nurses, that the correct technique was performed by 34% of professionals and only 20% used both the correct time and technique for surgical hand washing<sup>21</sup>.

In Brazil, a study carried out in São Luís, Maranhão, analyzed the prevalence of microorganisms on the hands of 131 surgeons from a university hospital before the surgical procedure. The results showed a high frequency (100%) of microorganisms before surgical hand scrubbing, a rate that dropped significantly after surgical scrubbing (27.5%;  $p < 0.05$ )<sup>22</sup>.

A randomized clinical trial that aimed to determine the effective methods and ideal duration of surgical hand scrubbing, performed bacterial counts on the hands of 180 surgical

nurses and surgeons before and after scrubbing and after surgery. It was evident that there was no statistically significant difference between the groups studied in terms of bacterial count on the hands immediately after surgical hand scrubbing and after the end of the surgery, corroborating data from this study<sup>23</sup>.

In this study, after surgical hand scrubbing and after the surgical procedure, the exclusive presence of microorganisms from the normal skin microbiota, such as CNS, MSSA, MRSA, *Bacillus* sp. and GNB, was identified in seven (35%) professionals.

The permanence of microorganisms found on the hands of surgical team professionals after surgical hand scrubbing is, in fact, an alarming issue, considering that they may be responsible for high rates of involvement in infections in hospitalized surgical patients<sup>24</sup>.

Considering that SSI is multifactorial and that contamination of the hands of the surgical team is a contributing factor, studies describing the etiology of SSI after cardiac surgery reveal that almost two-thirds of microorganisms isolated from infected patients are gram-positive bacteria (60 to 80%), including *S. aureus* and CNS, which was identified in this study. It is also noteworthy that *S. aureus* is responsible for 40 to 60% of the strains that cause mediastinitis and CNS are involved in 20 to 30% of cases of mediastinitis<sup>25,26</sup>.

Another concern in this study was the isolation of enterobacteria *E. coli*, *K. pneumoniae* and *P. mirabilis*. Enterobacteriaceae have been associated with antimicrobial resistance in 27.2% of cases of infection<sup>27</sup>, corroborating findings from a cohort study that followed 3,609 patients undergoing cardiac surgery, identifying that 184 (5.1%) of them developed SSI. Fifty SSIs (27.1%) were caused by multidrug-resistant organisms, with Enterobacterales producing extended-spectrum beta-lactamases ( $n=16$ ; 8.7%) and Enterobacterales resistant to carbapenems ( $n=26$ ; 14.1%), with predominant resistance being a problem<sup>28</sup>.

The findings of this study highlight that surgical hand scrubbing was performed within the time recommended by scientific evidence by 14 (70%) professionals, and that this good practice contributed to reducing the risk of microorganism growth in 14.2% of the hands of the cardiac surgery team. The average time for surgical hand scrubbing was 3 min and 15 s. A study of cardiac surgery staff conducted 44 observations of 23 individual participants. The recommended time for surgical hand washing was followed by only 34% (CI 17–51) of participants, and the estimated average time was 3 min and 48 s, in line with the results of this study<sup>21</sup>.

Institutional policies are important for better care practices and periodic training, especially in the case of a tertiary institution focused on teaching, research and extension. Studies indicate that quality improvement strategies related to education, motivation and continuous feedback have proven to be effective<sup>7,27,29</sup>.

This study was subject to limitations. The number of sterile swabs collected provided a relatively small sample, which might have influenced the statistical data. Furthermore, it was carried out in a single surgical center, and although the instrument was tested, a validated instrument was not used. Another limitation refers to open and direct observations, in which the Hawthorne effect may have resulted in modification of participants' behavior and different performance under observation<sup>30</sup>. However, it is considered that it can contribute to making an initial diagnosis of the problem, promoting strategies to enhance professionals' adherence to appropriate surgical hand scrubbing, in addition to being able to lead to other more robust studies involving the same object of study.

It is expected that the study can contribute to nursing practice to direct surveillance measures, development and maintenance of care and educational processes aimed at improving good practices in surgical hand scrubbing among members of the surgical team, thus collaborating with the quality of care and patient safety.

## CONCLUSION

It is concluded that the study achieved the proposed objective, evidenced by the description of the microorganisms present in the microbiota of the hands of the cardiac surgery team

after the hand scrubbing and the removal of gloves at the end of the anesthetic-surgical procedure.

The present study identified weaknesses in relation to the surgical team's adherence to the time recommended by the protocols for surgical scrubbing, a practice that can have an impact on the growth of gram-positive and gram-negative microorganisms on the hands of these professionals.

Therefore, new studies are suggested to investigate the factors that contribute to non-compliance with the surgical scrubbing time, which can direct quality improvement actions focused on the education of surgical team professionals.

## FUNDING

None.

## CONFLICT OF INTERESTS

Nothing to declare.

## AUTHORS' CONTRIBUTIONS

**TCP:** Conceptualization, Data curation, Investigation, Writing – original draft. **DMH:** Conceptualization, Data curation, Writing – review and editing, Project administration, Formal analysis, Methodology, Supervision. **CSF:** Conceptualization, Writing – review and editing. **FGC:** Writing – review and editing. **RSL:** Data curation, Writing – review and editing, Methodology. **RFSGS:** Data curation, Writing – review and editing, Methodology. **AAL:** Writing – review and editing.

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