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## Adjusting working conditions and evaluating the risk of infection during the COVID-19 pandemic in different workplace settings – a study protocol for an explorative modular mixed methods approach

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4 2 pandemic in different work-place settings – a study protocol for an explorative modular mixed  
5 3 methods approach  
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35 diseases  
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## 38 **ABSTRACT**

39 **Introduction:** Currently, many countries affected by the COVID-19 pandemic discuss ways  
40 how the “lockdown-restrictions” could be lifted to restart the economy and public life after the  
41 first wave of the COVID-19 disease has subsided. This study protocol describes an approach  
42 designed to provide an in-depth understanding of how companies and their employees deal  
43 with their working conditions during the COVID-19 pandemic. We are also interested in how  
44 and why the risk of infection with SARS-CoV-2 could vary across different professional  
45 activities, company sites and regions with different epidemiological activity or infection control  
46 measures. We expect the results of this study to contribute to the development of working  
47 conditions protecting the health of employees during and beyond the COVID-19 pandemic.

48 **Methods and Analysis:** An explorative multimodal mixed methods approach will be applied.  
49 *Module 1* comprises a document analysis of prevailing federal and regional laws and  
50 regulations at the respective location of the participating company. *Module 2* includes  
51 qualitative interviews with key actors at different company. *Module 3* is a repeated  
52 standardized employee survey designed to capture potential changes in the participants’  
53 experiences and attitudes towards working conditions, occupational safety  
54 regulations/measures, and infection control measures during the COVID-19 pandemic.  
55 *Module 4* comprises SARS-CoV-2 seroprevalence testing. This is carried out by the medical  
56 service of the participating company sites as a voluntary offer for employees. Qualitative data  
57 will be analyzed through document and content analysis. The complexity of the quantitative  
58 analysis depends on the response rates of modules 3 and 4.

59 **Ethics and Dissemination:** The approval of the study design was received in June 2020  
60 from the responsible local ethical committee of the Medical Faculty, University of Tuebingen  
61 and University Hospital Tuebingen (No.: 423/2020BO). The results will be presented at  
62 national and international conferences and published in peer-reviewed journals.

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## 72 **STRENGTH AND LIMITATIONS OF THIS STUDY**

- 73 • One of the first studies to provide a comprehensive understanding of how companies  
74 implement and employees perceive and accept the “new normal” regarding working  
75 conditions during the COVID-19 pandemic.
- 76 • The linkage of complementary methods (document analysis, interviews with company  
77 stakeholders, employee-surveys, testing of antibodies against SARS-CoV-2) will  
78 allow an in-depth exploration of work practices and experiences in relation to  
79 occupational safety regulations/measures, infection control regulations/measures,  
80 and the actual and perceived risk of infection.
- 81 • Depending on the areas of interest and resources of the participating companies, the  
82 modular approach enables the implementation of up to four substudies, also allowing  
83 for a cross-sectional or a longitudinal study design.
- 84 • The implementation of multiple modules requires comprehensive resources in terms  
85 of time, qualified scientific staff and the organization of the cooperation with different  
86 company sites as well as different companies.

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## 89 INTRODUCTION

### 90 Background

91 At the beginning of 2020, the disease COVID-19 (Corona Virus Disease 2019), triggered by  
92 the coronavirus SARS-CoV-2 (severe acute respiratory syndrome coronavirus 2), has  
93 developed into a pandemic.<sup>1</sup> Without specific therapeutics or an effective vaccine available in  
94 the first quarter of 2020, many health care systems and governments responded to the rapid  
95 spread of the virus and the significant lethality of COVID-19 with the traditional means of  
96 containment: identification of cases and if necessary treatment under quarantine conditions,  
97 contact tracing and isolation of suspect cases, closure of schools and other educational  
98 institutions, non-system-relevant public institutions and businesses. In addition, most of the  
99 governments imposed contact restrictions and curfews considerably affecting everyday life of  
100 the population. For such a package of measures the term "lockdown" has become  
101 established. A lockdown lasting several weeks does not only result into a temporary  
102 restriction of civil rights such as freedom of assembly, but also into a considerable  
103 impairment of the economy.<sup>2-5</sup> Currently, debates revolve around which conditions and in  
104 which way the "lockdown-restrictions" could be lifted to restart the economy and public life  
105 after the first wave of the COVID-19 disease has subsided. This poses new challenges for  
106 local and global society: How can restrictions be relaxed without triggering another, even  
107 stronger and possibly uncontrollable wave of infection? Under these conditions, enterprises  
108 cannot simply "go back to business as usual"<sup>2</sup>, and national and international  
109 recommendations regarding occupational health and safety standards tailored to the risks of  
110 SARS-CoV-2 infection have been developed.<sup>6-8</sup>

111 New studies on coronaviruses and COVID-19 have explored a variety of safety-related  
112 dimensions including social public safety, psychological health and domestic safety,  
113 medicine treatment and vaccine safety or the occupational safety of employees.<sup>9</sup> The latter  
114 focuses particularly on working conditions and safety of healthcare professionals in clinical or  
115 ambulant settings.<sup>10-12</sup> Furthermore, research has looked at COVID-19 stressors on migrant  
116 workers<sup>13</sup> and commercial drivers<sup>14 15</sup>, and at measures to control the spreading of the  
117 corona virus in workplaces including engineering and administrative controls (e.g. proper  
118 ventilation, restricting staff gatherings) as well as the provision of personal protective  
119 equipment (e.g. protective masks or clothing).<sup>16</sup> As of yet, we are not aware of any studies  
120 linking different data sources, perspectives and methods to provide an in-depth  
121 understanding in which ways companies and their employees deal with their working  
122 conditions during the COVID-19 pandemic and how different experiences and attitudes may  
123 impact variations in the occurrence of infections with SARS-CoV-2. The results of our study  
124 are expected to facilitate the effort of companies and executive managers to protect the

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3 125 health of their employees over the course of the COVID-19 pandemic, also preparing them  
4 126 for future challenges such as the next wave of influenza.

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### 8 128 **Study aim and research questions**

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10 129 The Institute of Occupational and Social Medicine and Health Services Research (IASV),  
11 130 University Hospital Tuebingen, aims to explore how companies adjust to new occupational  
12 131 health and safety standards designed to prevent the spreading of the COVID-19 disease. We  
13 132 will focus on the following research questions:

- 16 133 1. Under which prevailing regulations and recommendations are working conditions  
17 134 adjusted in different work-place settings?  
18  
19 135 2. How do employers and their employees assess and accept their “new normal”?  
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21 136 3. How and why could the risk of infection vary across different company sites and  
22 137 professional activities?  
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## 28 139 **METHODS AND ANALYSIS**

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31 140 Previous contact of the IASV to representatives of the initially participating company’s chief  
32 141 medical services resulted in the development of a cooperative project exploring occupational  
33 142 health and safety issues related to the COVID-19 pandemic. The transdisciplinary project  
34 143 group has academic and practical expertise in occupational medicine, health sciences,  
35 144 health services research, and sociology and jointly discussed and developed the realization  
36 145 of the study design in the participating company.  
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### 42 147 **Study design**

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44 148 The IASV conceptualized an explorative multi-modular mixed methods approach<sup>17 18</sup>  
45 149 following the GRAMMS-guidelines (supplementary file 1) developed by O’Cathain et al.  
46 150 (2008)<sup>19</sup>. Mixed method designs have become an integral part of health-related and health  
47 151 services research, providing a variety of quantitative and qualitative tools complementing  
48 152 each other in order to gain a comprehensive understanding of complex research questions.<sup>19</sup>  
49 153 <sup>20</sup> The approach comprises three modules (modules 1 – 3 in figure 1) which can be applied  
50 154 either as an entire set or companies can choose particular modules depending on their  
51 155 research interest and resources. The approach also allows the extension of additional  
52 156 modules. To begin with, modules 1 – 3 will be implemented in a large multinational  
53 157 engineering and technology company with headquarters and various sites in Germany where  
54 158 several thousands of employees pursue a variety of professional activities differing in their  
55 159 work-related risk of infection with SARS-CoV-2. An additional fourth module (figure 1) will be



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3 160 conducted by the participating companies' medical service. As the approach is transferable  
4 161 to other settings, the team of the IASV plans to extend this research design to other  
5 162 companies, institutions and public authorities.  
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10 164 **Figure 1** Illustration of the applied explorative modular mixed methods design

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12 165 In module 1, prevailing national and local laws as well as occupational health and safety  
13 166 regulations of the respective site will be analyzed. In module 2, qualitative interviews with  
14 167 company stakeholders will be conducted at the beginning and the end of the survey period.  
15 168 In module 3 we will focus on the perspective of employees conducting several waves of a  
16 169 standardized survey. Module 4 will comprise SARS-CoV-2 antibody testing for employees  
17 170 offered as a voluntary occupational health service by the participating company and carried  
18 171 out by the company's medical service. Using these methods in combination, we expect to be  
19 172 able to provide different perspectives, explanations and a deeper understanding of how  
20 173 companies and their employees adjust to working conditions during the COVID-19 pandemic  
21 174 in particular ways and how different attitudes and behaviors may impact their perceived and  
22 175 measured risk of infection.  
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29 176 Each module can stand by itself; however, selecting the entire set (modules 1 – 3) or even  
30 177 extending it (module 4) will provide the most comprehensive understanding of the study  
31 178 objective. The initial company agreed to participate in modules 1 - 3 and to conduct module  
32 179 4. Further companies can combine particular modules depending on their specific interests  
33 180 and resources. For example, if a company was particularly interested in why certain  
34 181 measures of infection protection during the COVID-19 pandemic may be accepted, ignored  
35 182 or rejected it would be advisable to take part at least in modules 1 and 3. For a deeper  
36 183 understanding it would also be advisable to include module 2. In order to evaluate how and  
37 184 why the results of the antibody testing (module 4, carried out by the participating company)  
38 185 and the perceived risk of infection may vary across company sites or areas of professional  
39 186 activities, a combination of all modules or at least modules 1, 3 and 4 would be  
40 187 recommended. As all data collection methods complement each other, data integration (e.g.  
41 188 converting coded qualitative data into variables for statistical analysis<sup>21</sup>, triangulation of  
42 189 qualitative and quantitative data) depends on the number of modules a company chooses to  
43 190 participate in.<sup>22</sup>  
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## 55 192 **Patient and public involvement**

56 193 Neither patients nor the public were and are involved in the planning of the design, the  
57 194 recruitment, instrument development, data analysis, and reporting or dissemination plans of  
58 195 this study.  
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196 **Study duration**

197 As the participating company will take part in the complete set of modules including multiple  
 198 survey and blood sampling waves, we anticipate a study duration of 18 months (Table 2).  
 199 The actual survey period for the company is 13 months.

200  
 201 **Table 1** Study plan including a full set of modules (modules 1-4)

Project month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Study preparation*	x	x	x															
<b>Module 1 – document analysis (prevailing laws and regulations)</b>																		
Document analysis				x	x	x	x	x	x	x	x	x	x	x	x			
<b>Module 2 – qualitative interviews with company stakeholders</b>																		
Qualitative interviews**				T0						T1								
Qualitative analysis					x	x	x	x	x	x	x	x	x	x	x	x	x	
Feedback to company										x								x
<b>Module 3 – employee survey</b>																		
Pretest			x															
Quantitative survey				T0		T1				T2						T3		
Quantitative analysis					x	x	x	x	x	x	x	x	x	x	x	x	x	
Feedback to company								x					x					x
<b>Module 4 –SARS-CoV-2 antibody testing and aggregated analysis</b>																		
Blood sample collection***			T0						T1					T2				
Analysis			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
Feedback to company																		x
<b>Publication</b>														x	x	x	x	x

202 \*Literature research, development and adjustment of the survey instruments to specifics of the  
 203 participating company (employee survey, interview guide), consultation of the responsible data  
 204 protection officer.

205 \*\*In the event of relevant changes in the incidence of infection (e.g. local outbreak) or operational  
 206 procedures (e.g. new infection control measures or procedures), further interviews with company  
 207 stakeholders can be arranged. If the T2-survey in module 3 is conducted earlier, the T1-phase in  
 208 Module 2 will also be shifted forward.

209 \*\*\*Seroprevalence testing is a voluntary occupational health offer which will be undertaken by the  
 210 company's medical officer. The frequency of blood sampling depends on the company's resources  
 211 and operational capacity. As the participants of module 3 could provide information on their SARS-  
 212 CoV-2 antibody status, the survey waves of module 4 precede the survey waves of module 3.  
 213 Presuming individual consent of each participant, the aggregated results of seroprevalence testing  
 214 (by job activity) can be linked to the results of the other modules.

## 217 **Study procedures: setting, sampling, data collection and analysis**

218 As companies are responsible for occupational health and safety to protect their employees,  
219 company owners and executive managers play a crucial part in preparing and responding to  
220 disease outbreaks, such as the COVID-19 pandemic.<sup>23</sup> This includes, for example, the  
221 adaption of workplace settings to protect workers, the development of action plans for  
222 resuming production after a period of closure or managing an increasing number of  
223 teleworkers.<sup>7</sup> Companies and their occupational health service have also been advised to  
224 prepare for the potential physical, mental and psychosocial effects of the “new normal” on  
225 employees.<sup>23</sup>

226 For all groups of employees, the working conditions are changing as a result of new infection  
227 control measures (e.g. distance and hygiene rules, modification of work schedules). On the  
228 one hand, groups of employees are exposed to an increased work-related risk of infection  
229 due to the necessity of working on-site closely together with other personnel (e.g. company  
230 medical service, plant security, personnel working on the assembly line). On the other hand,  
231 there are groups of employees (e.g. administrative staff) who can also work from home.  
232 Although this reduces the work-related risk of infection, new physical and psychological  
233 burdens and challenges arise with regard to working conditions and work design (e.g.  
234 ergonomically adequate workstations at home, organization of childcare, dissolving  
235 boundaries between work and private life, loss of immediate team support).

236 To capture potential regional and activity-related differences in the occupational risk and  
237 perception of infection, purposive sampling<sup>24</sup> will be used to include about six different  
238 company sites of the initially participating company. Inclusion criteria comprise a combination  
239 of sites providing the greatest possible contrast between different fields of activities (e.g.  
240 personnel working in open-plan offices/telework versus personnel on the assembly line).  
241 Furthermore, the company sites' responsible executive managers, employee organization  
242 and medical service will need to agree to the participations of the respective sites.

243 **Module 1** is a continuous literature search and document analysis<sup>25</sup> of prevailing federal and  
244 regional laws, and occupational health and safety and infection control regulations at the  
245 respective sites of the participating companies carried out by the IASV. This will provide a  
246 broader legal, infectiological, and organizational cultural context for the interpretation of the  
247 results of the other modules. An information letter accompanied by a consent form will be  
248 sent to the responsible contact person (e.g. executive manager). With the consent of the  
249 management and the employee organization, the company will be invited to provide  
250 documents and a short questionnaire with general company information (e.g. size of the  
251 company sites, number of employees in different departments and branches, job  
252 descriptions), and information on current health and safety measures (e.g. contact

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3 253 restrictions, telework regulations, working in fixed teams, implementation of hygiene rules).  
4 254 This information will also allow the calculation of response rates for modules 3 and 4.

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7 255 **Module 2** will comprise qualitative interviews with key actors at different company sites (e.g.  
8 256 executive managers, members of the employee organization). The IASV will address them  
9 257 as experts of their respective departments who can provide an overview of daily working  
10 258 procedures and who are involved in problem solution processes.<sup>26</sup> The interdisciplinary  
11 259 project team will develop a semi-structured interview guide according to the SPSS method  
12 260 developed by Hellferich (2004)<sup>27</sup> covering these topics:

- 17 261 - Workplace design and organization of working procedures in the context of the  
18 262 COVID-19 pandemic;
- 20 263 - Assessment of work-related stress and strain;
- 22 264 - Expectations and attitudes towards infection control and occupational health and  
23 265 safety measures;
- 25 266 - Expectations and attitudes towards SARS-CoV-2 antibody tests.

27 267 Purposive sampling<sup>24</sup> will be used to invite interview partners from different company sites  
28 268 and different fields of activities (e.g. administrative responsibilities, organization of work at  
29 269 the assembly line, provision of occupational health services) if they have worked at their  
30 270 current job for at least 6 months and have a knowledge of German at least at B1-level.<sup>28</sup> The  
31 271 participants will receive information on interview procedures, data protection and data  
32 272 management accompanied by an individual consent form. We plan to conduct interviews with  
33 273 the same participants at the beginning and the end of the study period to capture potential  
34 274 changes in their experiences and attitudes. In the event of relevant changes in the incidence  
35 275 of infection (e.g. local outbreak) or adjustment of company procedures (e.g. new measures of  
36 276 infection protection), further interviews could be arranged. All interviews will be conducted by  
37 277 the team of the IASV. Based on experience from previous projects, the duration of the  
38 278 interviews will take about 30-45 minutes.<sup>29</sup> Interviews will be audio taped and transcribed by  
39 279 a professional company according to a simplified system whereby transcription is word by  
40 280 word, but not phonetically<sup>30</sup>. Quality checks, de-personalization and pseudonymization of the  
41 281 data will be undertaken by the team of the IASV conducting the fieldwork. The data will be  
42 282 imported into MAXQDA<sup>31</sup>, and analysis will be carried out by the team of the IASV following  
43 283 the steps of qualitative content analysis, including the development of a coding frame, the  
44 284 segmentation of the material, the testing of the coding frame, the evaluation of the trial  
45 285 coding and the completion of the main coding.<sup>32</sup> Several mutual data analysis sessions with  
46 286 the partners from the company are planned. All data will remain at the IASV.

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3 288 *Sample size:*

4 289 One interview per addressed field of activity at the time of the initial (T0) and the next-to-last  
5 290 (T2) online survey. The total number of interviews cannot be determined at this stage  
6 291 because it depends on the number of company sites included in the entire study. Due to a  
7 292 rather specific research aim, high sample specificity and quality of dialogue<sup>33</sup>, we assume  
8 293 eight participants from our partner company will provide sufficient information for the aspired  
9 294 analysis. Thus, we expect a minimum number of 16 interviews to reach data saturation<sup>29</sup>  
10 295 (four interviewees at two company sites interviewed at the beginning and the end of the  
11 296 survey period).

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14 297 **Module 3** comprises several waves of a repeated standardized (anonymous) employee  
15 298 survey carried out by the IASV. Closed and open questions are being designed to capture  
16 299 potential changes in the participants' experiences and attitudes towards working conditions  
17 300 during the COVID-19 pandemic as well as their perceived risk of infection at the workplace  
18 301 and outside the working environment.<sup>34</sup> Depending on the participating companies'  
19 302 preferences, a paper-based or online questionnaire is being developed. The questions are  
20 303 based on national and international recommendations regarding occupational health and  
21 304 safety standards and infection control measures, tailored to the risks of SARS-CoV-2  
22 305 infection<sup>6-8</sup>, established recommendations of evaluating work-related stress and strain<sup>35</sup>, as  
23 306 well as existing questionnaires<sup>e.g.36</sup>. According to the explorative design, we did not predefine  
24 307 one specific outcome, but addressed these aspects: the risk of infection perceived by  
25 308 employees, their experiences and attitudes towards infection protection at the workplace,  
26 309 and the associated psychological stress and strain. This will provide context to interpret the  
27 310 occurrence of infections (self-reported antibody status, aggregated results of antibody  
28 311 testing) as well as for recommendations concerning infection protection at the workplace.  
29 312 Main subject areas of the questionnaire are summarized in Table 1.

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314 **Table 2** Subject areas and themes of the questionnaire

Subject areas	Themes
Evaluation of implemented SARS-CoV-2-related occupational health and safety standards	e.g. distance regulations, hygiene rules, organization of telework and teams working on-site, provision of protective equipment, workplace design
Evaluation of work-related stress and strain related to the COVID-19 pandemic	e.g. work-related stress and strain before and during the COVID-19 pandemic concerning work content/task, organization of work, working environment, social relations, new patterns of work
Assessment of perceived and potential risk of infection at the workplace	e.g. concern of being infected at the workplace number of contacts with others, working in fixed teams, working on-site or at home, acceptance and practicability of hygiene rules at work (keeping distance, wearing masks)
Assessment of perceived and potential risk of infection outside the working environment	e.g. concern of being infected outside the working environment, number of social contacts, contact to risk groups, travel behavior, practiced leisure activities (low-contact vs. contact sports)
Sociodemographic and medical information potentially related to the prevalence of SARS-CoV-2 infections	e.g. age, sex, marital status, educational background, work experience, current occupation, number of children and their attendance in day-care centers or schools, relevant underlying medical conditions, if available: SARS-CoV-2 antibody status
Other relevant measures	e.g. control measures for personality factors, resilience and social desirability

315 The questionnaire will be pretested by a group of academic volunteers as well as by  
316 representatives of the target audience. Participation in each survey wave is voluntary. Survey  
317 invitations will be organized by the participating company (e.g. via company e-mail accounts,  
318 company newsletter, posters, postcards). Taking part requires employees to be of legal age  
319 with a knowledge of German at least at B1-level<sup>28</sup>, and – in case of an online-survey -  
320 internet access via PC, tablet, or smartphone. Individual consent to participate is given by the  
321 study participants after sufficient information on data protection and data management at the  
322 beginning of the survey. At the end of the first survey wave, participants will be asked to  
323 generate an 8-digit code which can be used to merge the data of each person anonymously  
324 over subsequent survey waves.<sup>37</sup> The completion of the survey is expected to take  
325 approximately 25 minutes. In case of an online-survey, the individual survey responses will  
326 be managed via the established online tool Unipark.<sup>38</sup> In case of a paper-pencil  
327 questionnaire, each survey sheet will be scanned at the University Hospital Tuebingen using  
328 an OCR system.<sup>39</sup> All data will remain at the IASV and will be analyzed applying appropriate  
329 descriptive and inferential statistics in SPSS.<sup>40</sup> Depending on the sample size, a biometrician  
330 will be involved in discussing the development of hypothesis testing models which can be  
331 applied if a sufficient number of respondents take part in the survey.

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3 334 *Sample size:*

4 335 According to the exploratory design, we aim to invite the entire staff of the participating  
5 336 company sites (n ~ 22.000). Stratification can only be carried out if a sufficient number of  
6 337 cases per subgroup is reached ( $\geq 10$ ).  
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11 339 **Module 4:** SARS-CoV-2 seroprevalence testing will be carried out as a voluntary company  
12 340 offer for employees by the occupational service of the participating company sites; hence, all  
13 341 individual data are subject to doctor-patient confidentiality and will remain with the  
14 342 participating company's medical service. In terms of quality assurance, the IASV research  
15 343 team will advise on database design, selection of antibody tests (type, pharmaceutical  
16 344 supplier) the content of a short participant questionnaire completed when blood sampling  
17 345 takes place (age, sex, work location, field of activity), and analysis procedures. Testing and  
18 346 aggregated epidemiological evaluations at the company level will be carried out according to  
19 347 applicable medical regulations.<sup>41 42</sup> Presuming individual consent of each participant, the  
20 348 results of the antibody tests (aggregated to company specific operational activities, e.g.  
21 349 infections in open plan office versus assembly line) can be analyzed in combination with the  
22 350 results of the other modules by the IASV. As module 4 is of exploratory nature, data will be  
23 351 analyzed applying appropriate descriptive and inferential statistics in SPSS.<sup>40</sup>  
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26 352 *Sample size:*

27 353 Due to the currently low prevalence of SARS-CoV-2 in Germany ( $< 2\%$ )<sup>43</sup>, serological  
28 354 diagnostic and hypothesis testing are only suitable for larger epidemiological studies  
29 355 including a sufficient number of cases allowing for stratification. For example, assuming a  
30 356 small effect size ( $\eta^2 = 0.01$ ) for the detection of potential differences in the seroprevalence  
31 357 across employees from four different areas of activity at a power of 80%, statistical analysis  
32 358 would require a sample size of 271 persons per area of activity (n = 1084 employees) to  
33 359 obtain a statistically significant result performing a single factor ANOVA ( $\alpha = .05$ ).<sup>44</sup>  
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#### 361 **Data protection**

362 Relevant data protection regulations will be observed for all data collected and coordinated  
363 with the responsible ethics committee, academic and company data protection officers, as  
364 well as the respective company physicians and representatives of the employee  
365 organization. Concerning module 1, the company sites will decide whether and how they  
366 provide company-related information. All other data (e.g. federal and regional COVID-19-  
367 related regulations) are available publicly. Depending on the extent of the information  
368 provided by the companies and the official information available, the respective legal and  
369 organizational context of different work-place settings is compiled by the IASV.  
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3 370 Participants taking part in module 2 will provide individual consent to be interviewed by  
4 371 project members of the IASV. The digital audio recordings and original (non-pseudonymized)  
5 372 transcripts will be stored in the secure network of the University Hospital Tuebingen and  
6 373 destroyed after the completion of the analyses. For the analysis, all names, places and  
7 374 references that would allow drawing conclusions about a person or the participating company  
8 375 or company site will be pseudonymized by project members of the IASV. The  
9 376 pseudonymized transcripts will only be accessible to project members of the IASV, stored in  
10 377 the secure network of the University Hospital Tuebingen. All other persons will have access  
11 378 only to the interview excerpts cited in reports or publications. In terms of module 3, the  
12 379 participants provide individual consent to take part in the anonymous employee survey. In  
13 380 case of an online survey, the questionnaire data will be collected via the established survey  
14 381 tool Unipark complying with security requirements according to the information security  
15 382 standard ISO/IEC 27001.<sup>45</sup> In case of a paper-pencil questionnaire, all data will be scanned  
16 383 at the University Hospital Tuebingen.<sup>39</sup> All data will be transferred to SPSS<sup>40</sup> and stored in  
17 384 the secure network or a lockable archive of the University Hospital Tuebingen. Individual  
18 385 data will only be accessible for project members of the IASV.

19 386 The collection and pseudonymization of the individual serum samples during module 4 will  
20 387 be organized by the company's medical service and is subject to medical confidentiality.  
21 388 Presuming individual consent of each participant, project members at the University Hospital  
22 389 Tuebingen will receive data on the seroprevalence of employees aggregated to areas of  
23 390 activity, also including aggregated demographic information (age, sex). If the response rate is  
24 391 low ( $\leq 10/\text{area of activity}$ ), these data will be aggregated with the data from other company  
25 392 sites and if necessary with other areas of activity.

26 393 In line with the German guidelines for storing research data<sup>46</sup>, all data compiled by the IASV  
27 394 (modules 1 – 3) as well as the aggregated data received by the participating company  
28 395 (module 4) will be stored for 10 years after the final publication in the secure network of the  
29 396 University Hospital Tuebingen and destroyed thereafter. These data will be accessible only  
30 397 to IASV-personnel involved in the research project.

## 398 399 **Ethics and dissemination**

### 400 **Research ethical approval**

401 The study and all study-related documents were designed following the principles formulated  
402 in the current version of the Declaration of Helsinki<sup>47</sup>. The approval of the study design was  
403 received in June 2020 from the responsible local ethical committee of the Medical Faculty,  
404 University of Tuebingen and University Hospital Tuebingen (No.: 423/2020BO).

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### 406 **Progression of the study**

407 The development of the research instruments are in progress. The recruitment of the first  
408 wave of participants has commenced 21<sup>th</sup> July 2020 and is anticipated to continue until  
409 October 2020.

### 411 **Dissemination**

412 Study results will be published in peer-reviewed journals and presented at international and  
413 national conferences.

### 415 **Discussion**

416 There are some pros and cons associated with our study approach. Although the  
417 triangulation (and integration) of evidence is an integral part of mixed methods research<sup>17</sup>,  
418 the design of our study is unique in terms of the modular approach we specifically developed  
419 for assessing how companies and their employees experience and adjust to working  
420 conditions during the COVID-19 pandemic. Furthermore, the design is transferable to other  
421 companies, institutions and public authorities. Depending on their areas of interest and  
422 resources, the modular approach enables the implementation of up to three substudies  
423 conducted by the IASV, also allowing for a cross-sectional or a longitudinal study design with  
424 multiple survey and interview waves. Additional substudies such as SARS-CoV-2  
425 seroprevalence testing can be implemented and conducted by the participating companies.  
426 Each of the quantitative (employee survey, SARS-CoV-2 antibody testing) and qualitative  
427 method (document analysis, interviews with company stakeholders) applied can stand by  
428 itself; however, in linking different data sets and methods (document analysis, descriptive  
429 and inferential statistics, content analysis) as well as a variety of perspectives  
430 (researchers, company stakeholders, workers) the integration<sup>21</sup> of the individual results will  
431 provide a detailed analysis of the overall research objective. In terms of resources (e.g. time,  
432 required qualification of the personnel, organizational effort), we expect that the combination  
433 of the methods applied will mitigate some of the limitations inherent for quantitative (numeric  
434 description of phenomena, complexity of statistical analysis dependent on survey response  
435 rate, superficial understanding of participants' experiences, attitudes and causal  
436 relationships) and qualitative research (e.g. small sample, results not statistically  
437 representative of a population, time consuming data collection and analysis).<sup>48</sup>

438 Finally, we want to highlight potential concerns of the participants that may occur over the  
439 course of the study. Since the company's medical service is involved in data collection  
440 (module 4), the participants may be concerned that their test results or their responses from  
441 the interviews and questionnaires (modules 2 and 3) have a negative impact on their working  
442 conditions or employment. We aim to avoid this issue by communicating our comprehensive

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3 443 data protection concept, by providing extensive information on the study, and by  
4 444 emphasizing the participants' right to withdraw from the study without any negative  
5 445 consequences. The project leader and responsible researchers will also be available to  
6 446 answer questions occurring over the course of the study period. Furthermore, the  
7 447 pseudonymized (module 2) and non-aggregated anonymized (module 3) data remains  
8 448 exclusively at the Institute of Occupational Medicine, Social Medicine and Health Services  
9 449 Research, University Hospital Tuebingen and will be evaluated there. The company (i.e.  
10 450 company owners, executive managers, works council, company medical service) will only  
11 451 receive aggregated evaluations. With respect to the antibody testing (module 4), this offer will  
12 452 be a completely voluntary occupational health service for company employees and the  
13 453 physician of the responsible medical service will provide information about the usual risks  
14 454 and side effects of blood sampling.

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16 455 With this study, we aim to provide an in-depth analysis of occupational health and safety  
17 456 challenges related to the process of resuming and continuing work-related activities during  
18 457 the COVID-19 pandemic. This includes, for example the consideration of work activities  
19 458 requiring on-site presence - possibly in close contact with colleagues, suppliers or the public  
20 459 – as well as issues associated with an increased use of telework. We expect that our study  
21 460 will contribute to the development of working conditions ensuring that job-related activities  
22 461 can be designed as safe as possible to the requirements of occupational health and safety  
23 462 regulations and to the particular needs of companies and their employees.

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## 463 464 **DECLARATIONS**

### 465 **Contributors**

466 All authors contributed to the development of the study design. ER and MR were involved in  
467 obtaining approval from the Ethics Committee of the Medical Faculty, University Hospital of  
468 Tuebingen. ER is the primary investigator and drafted this study protocol with contributions  
469 from all authors. All authors provided critical feedback on the manuscript, read and approved  
470 the final version.

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6 482 Benjamin Lee for his linguistic advice on the manuscript.  
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12 484 **Disclaimer**

13 485 The funding sources had no role in the design of the study and will not be involved in the  
14 486 conduct, collection, management, analysis, interpretation or dissemination of any data or  
15 487 results of the research.  
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21 489 **Competing interests**

22 490 None declared.  
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26 492 **Ethics approval and consent to participate**

27 493 Ethical approval for this study was obtained from the Ethics Committee of the Medical  
28 494 Faculty, University Hospital of Tuebingen (reference number: 423/2020BO). Informed written  
29 495 consent to participate will be obtained from all participants.  
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35 497 **Provenance and peer review**

36 498 Not commissioned; externally peer reviewed.  
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41 500 **Data sharing statement**

42 501 Our manuscript describes a study protocol. As such, we cannot elaborate on unpublished  
43 502 data.  
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3 503 **Supplementary material**

4 504 **Supplementary file S1:** Good Reporting of A Mixed Methods Study (GRAMMS) checklist<sup>19</sup>

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8 506 **References**

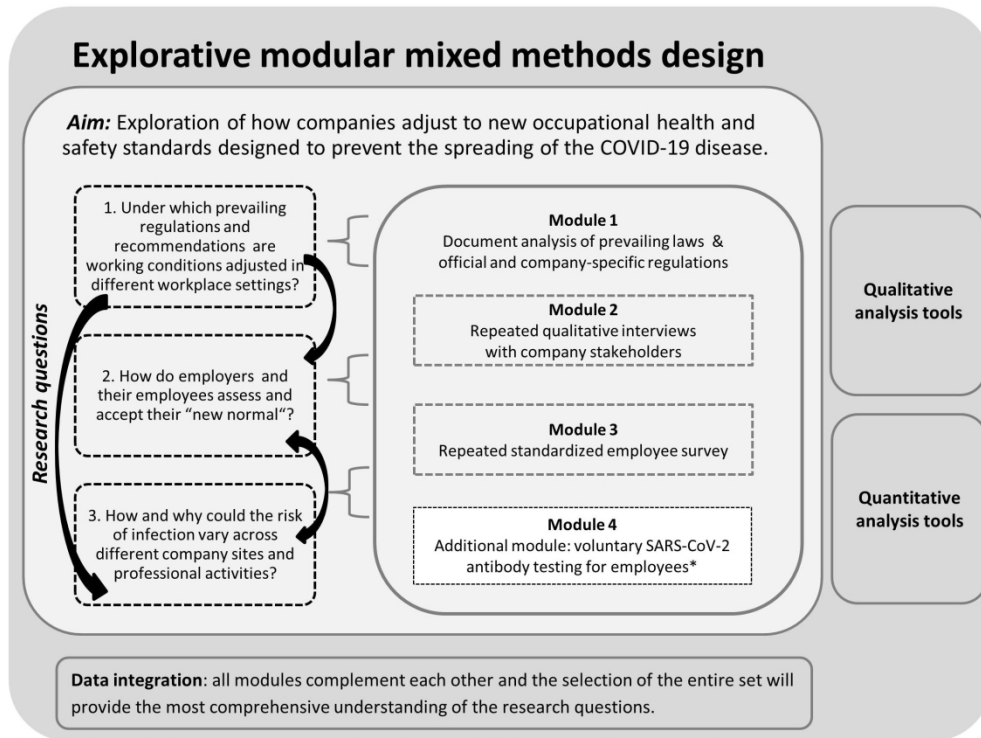
- 9 507 1. World Health Organization. Coronavirus. Available: [https://www.who.int/health-](https://www.who.int/health-topics/coronavirus#tab=tab_1)  
10 508 [topics/coronavirus#tab=tab\\_1](https://www.who.int/health-topics/coronavirus#tab=tab_1) [Accessed 19 May 2020].
- 11 509 2. Dorn F, Khailaie S, Stöckli M, et al. [The common interest of health and economy: A  
12 510 scenario calculation for the containment of the corona pandemic. A joint study of the  
13 511 ifo Institute (ifo) and the Helmholtz Centre for Infection Research (HZI). ifo  
14 512 Schnelldienst digital 6/2020 13 May 2020]. München: ifo Institut 2020.
- 15 513 3. Tagesschau. [VW shutting down again - news from 13.05.2020]. Available:  
16 514 <https://www.tagesschau.de/wirtschaft/vw-produktion-105.html> [Accessed 19 May  
17 515 2020].
- 18 516 4. Veitinger T. [Bosch - environmental protection despite pandemic. Heidenheim News from  
19 517 30.04.2020]. Available: [https://www.hz.de/wirtschaft/wirtschaft-](https://www.hz.de/wirtschaft/wirtschaft-ueberregional/umweltschutz-trotz-pandemie-45870919.html)  
20 518 [ueberregional/umweltschutz-trotz-pandemie-45870919.html](https://www.hz.de/wirtschaft/wirtschaft-ueberregional/umweltschutz-trotz-pandemie-45870919.html) [Accessed 19 May 2020].
- 21 519 5. Verma S, Gustafsson A. Investigating the emerging COVID-19 research trends in the field  
22 520 of business and management: A bibliometric analysis approach. *J Bus Res*  
23 521 2020;**118**:253-61. doi: 10.1016/j.jbusres.2020.06.057. [published Online First:  
24 522 2020/07/02.].
- 25 523 6. Cirrincione L, Plescia F, Ledda C, et al. COVID-19 Pandemic: Prevention and Protection  
26 524 Measures to Be Adopted at the Workplace. *Sustainability* 2020;**12**(9) doi:  
27 525 10.3390/su12093603.
- 28 526 7. EU-OSHA. EU GUIDANCE. Covid-19: Back to the workplace. Adapting workplaces and  
29 527 protecting workers. European Agency for Safety and Health at Work: EU-OSHA 2020.
- 30 528 8. Federal Ministry of Labour and Social Affairs. [SARS-CoV-2- Occupational Safety  
31 529 Standard from 16.04.2020]. Available:  
32 530 [https://www.bmas.de/SharedDocs/Downloads/DE/PDF-Schwerpunkte/sars-cov-2-](https://www.bmas.de/SharedDocs/Downloads/DE/PDF-Schwerpunkte/sars-cov-2-arbeitsschutzstandard.pdf?__blob=publicationFile&v=4)  
33 531 [arbeitsschutzstandard.pdf?\\_\\_blob=publicationFile&v=4](https://www.bmas.de/SharedDocs/Downloads/DE/PDF-Schwerpunkte/sars-cov-2-arbeitsschutzstandard.pdf?__blob=publicationFile&v=4) [Accessed 19 May 2020].
- 34 532 9. Haghani M, Bliemer MCJ, Goerlandt F, et al. The scientific literature on Coronaviruses,  
35 533 COVID-19 and its associated safety-related research dimensions: A scientometric  
36 534 analysis and scoping review. *Saf Sci* 2020:104806. doi: 10.1016/j.ssci.2020.104806.  
37 535 [published Online First: 2020/05/10.].
- 38 536 10. Ambigapathy S, Rajahram GS, Shamsudin UK, et al. How should front-line general  
39 537 practitioners use personal protective equipment (PPE)? *Malays Fam Physician*  
40 538 2020;**15**(1):2-5.
- 41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

- 1  
2  
3 539 11. Chen Y, Pradhan S, Xue S. What are we doing in the dermatology outpatient department  
4 540 amidst the raging of the 2019 novel coronavirus? *J Am Acad Dermatol*  
5 541 2020;**82**(4):1034. doi: 10.1016/j.jaad.2020.02.030. [published Online First:  
6 542 2020/02/23].
- 7  
8  
9 543 12. Cheung JC-H, Ho LT, Cheng JV, et al. Staff safety during emergency airway  
10 544 management for COVID-19 in Hong Kong. *The Lancet Respiratory Medicine*  
11 545 2020;**8**(4) doi: 10.1016/s2213-2600(20)30084-9.
- 12  
13  
14 546 13. Alahmad B, Kurdi H, Colonna K, et al. COVID-19 stressors on migrant workers in Kuwait:  
15 547 cumulative risk considerations. *BMJ Glob Health* 2020;**5**(7):e002995. doi:  
16 548 10.1136/bmjgh-2020-002995.
- 17  
18  
19 549 14. Lemke MK, Apostolopoulos Y, Sonmez S. A novel COVID-19 based truck driver  
20 550 syndemic? Implications for public health, safety, and vital supply chains. *Am J Ind*  
21 551 *Med* 2020;**63**(8):659-62. doi: 10.1002/ajim.23138. [published Online First:  
22 552 2020/05/27].
- 23  
24  
25 553 15. Lemke MK, Apostolopoulos Y, Sonmez S. Syndemic frameworks to understand the  
26 554 effects of COVID-19 on commercial driver stress, health, and safety. *J Transp Health*  
27 555 2020;**18**:100877. doi: 10.1016/j.jth.2020.100877. [published Online First:  
28 556 2020/06/06].
- 29  
30  
31 557 16. Rafeemanesh E, Ahmadi F, Memarzadeh M. A Review of the Strategies and Studies on  
32 558 the Prevention and Control of the New Coronavirus in Workplaces. *Arch Bone Jt Surg*  
33 559 2020;**8**(Suppl1):242-46. doi: 10.22038/abjs.2020.47410.2323.
- 34  
35  
36 560 17. Mayring P. [Triangulation of evidence and mixed methods in health research]. In: Haring  
37 561 R, ed. [Health Sciences]. Berlin, Heidelberg: Springer Berlin Heidelberg 2019:133-41.
- 38  
39  
40 562 18. Niederberger M, Peter L. [Mixed methods studies in the health sciences. A critical map].  
41 563 *Z Evid Fortbild Qual Gesundheitswes* 2018;**133**:9-23. doi: 10.1016/j.zefq.2018.02.008.  
42 564 [published Online First: 2018/04/02].
- 43  
44  
45 565 19. O'Cathain A, Murphy E, Nicholl J. The quality of mixed methods studies in health  
46 566 services research. *J Health Serv Res Policy* 2008;**13**(2):92-8. doi:  
47 567 10.1258/jhsrp.2007.007074. [published Online First: 2008/04/18].
- 48  
49  
50 568 20. Tariq S, Woodman J. Using mixed methods in health research. *JRSM Short Rep*  
51 569 2013;**4**(6):2042533313479197. doi: 10.1177/2042533313479197. [published Online  
52 570 First: 2013/07/26].
- 53  
54  
55 571 21. Bryman A. Integrating quantitative and qualitative research: how is it done? *Qualitative*  
56 572 *Research* 2016;**6**(1):97-113. doi: 10.1177/1468794106058877.
- 57  
58  
59 573 22. Fielding NG. Triangulation and Mixed Methods Designs. *Journal of Mixed Methods*  
60 574 *Research* 2012;**6**(2):124-36. doi: 10.1177/1558689812437101.

- 1  
2  
3 575 23. Fadel M, Salomon J, Descatha A. Coronavirus outbreak: the role of companies in  
4 576 preparedness and responses. *The Lancet Public Health* 2020;**5**(4) doi:  
5 577 10.1016/s2468-2667(20)30051-7.  
6  
7  
8 578 24. Guetterman TC. Descriptions of Sampling Practices Within Five Approaches to  
9 579 Qualitative Research in Education and the Health Sciences. *Forum: Qualitative Social*  
10 580 *Research* 2015;**16**(2):<http://nbn-resolving.de/urn:nbn:de:0114-fqs1502256>.  
11  
12 581 25. Wolff S. [Analysis of documents and field analysis]. In: Flick U, von Kardorff E, Steinke I,  
13 582 eds. [Qualitative research A manual (5th edition)]. Reinbek bei Hamburg: Rowohlt  
14 583 Taschenbuch Verlag 2007:502 – 13.  
15  
16 584 26. Britten N. Qualitative interviews in medical research. *BMJ (Clinical research ed)*  
17 585 1995;**311**(6999):251-3. [published Online First: 1995/07/22].  
18  
19 586 27. Hellferich C. [The quality of qualitative data. Manual for conducting qualitative interviews].  
20 587 Wiesbaden: VS Verlag für Sozialwissenschaften. 2004.  
21  
22 588 28. Council of Europe. Common European Framework of Reference for Languages (CEFR).  
23 589 Available: [https://www.coe.int/en/web/common-european-framework-reference-](https://www.coe.int/en/web/common-european-framework-reference-languages)  
24 590 [languages](https://www.coe.int/en/web/common-european-framework-reference-languages) [Accessed 21 July 2020].  
25  
26 591 29. Aldiabat KM, Le Navenec C. Data saturation: The mysterious step in grounded theory  
27 592 methodology. *The Qualitative Report* 2018;**23**(1):245-61.  
28  
29 593 30. Dresing T, Pehl T. [Research in practice: interviews, transcription & analysis. Instructions  
30 594 and control systems for qualitative researchers; 8th edition]. Marburg: dr dresing &  
31 595 pehl GmbH 2018.  
32  
33 596 31. MAXQDA. The Art of Data Analysis. Available: [https://www.maxqda.com/how-to-analyse-](https://www.maxqda.com/how-to-analyse-qualitative-data)  
34 597 [qualitative-data](https://www.maxqda.com/how-to-analyse-qualitative-data) [Accessed 25 Jan 2020].  
35  
36 598 32. Schreier M. Qualitative content analysis in practice. London: Sage 2012.  
37  
38 599 33. Malterud KS, , D; Guassora, AD Sample Size in Qualitative Interview Studies: Guided by  
39 600 Information Power. *Qualitative Health Research* 2016;**26**(13):1753–60.  
40  
41 601 34. Taddicken M. [Online-Survey]. In: Möhring W, Schlütz D, eds. [Handbook of standardised  
42 602 survey procedures in communication science]. Wiesbaden: Springer Fachmedien  
43 603 Wiesbaden 2013:201-17.  
44  
45 604 35. Gemeinsame Deutsche Arbeitsschutzstrategie (GDA), editor. *Occupational Safety and*  
46 605 *Health in Practice. Recommendations for implementing psychosocial risk*  
47 606 *assessment*. Berlin: Management of the GDA Mental Health Working Programme, c/o  
48 607 Federal Ministry of Labour and Social Affairs, 2014.  
49  
50 608 36. COSMO open. COVID-19 Snapshot Monitoring (COSMO) - [Questionnaires 2020].  
51 609 Available: <https://dfncloud.uni-erfurt.de/s/Cmzfw8fPRAgzEpA> [Accessed 25 May  
52 610 2020].  
53  
54  
55  
56  
57  
58  
59  
60



- 1  
2  
3 611 37. Justus-Liebig-Universität Giessen. [Code for panel studies]. Available: [https://www.uni-](https://www.uni-giessen.de/org/admin/stab/stl/servicestelle/panelcode)  
4 612 [giessen.de/org/admin/stab/stl/servicestelle/panelcode](https://www.uni-giessen.de/org/admin/stab/stl/servicestelle/panelcode) [Accessed 21 May 2020].  
5  
6 613 38. UNIPARK & questback. [Developing Online-Surveys easily]. Available:  
7  
8 614 <https://www.unipark.com/?gclid=EAlaIqobChMiiL3u9o7P6QIViK3tCh2cpgD->  
9 615 [EAAYASAAEgKa9\\_D\\_BwE](https://www.unipark.com/?gclid=EAlaIqobChMiiL3u9o7P6QIViK3tCh2cpgD-EAAYASAAEgKa9_D_BwE) [Accessed 25 May 2020].  
10  
11 616 39. OCR System GmbH. OCR System. Available: <https://www.ocr-systeme.de/en/> [Accessed  
12 617 14 Aug 2020].  
13  
14 618 40. IBM. SPSS software. Available: <https://www.ibm.com/analytics/spss-statistics-software>  
15 619 [Accessed 21 July 2020].  
16  
17 620 41. Federal Ministry of Justice and Consumer Protection & Federal Office of Justice.  
18 621 Ordinance on Occupational Health Care (ArbMedVV) - Available:  
19 622 [https://www.gesetze-im-internet.de/englisch\\_arbmedvv/index.html](https://www.gesetze-im-internet.de/englisch_arbmedvv/index.html) [Accessed 19 May  
20 623 2020].  
21  
22 624 42. Federal Ministry of Justice and Consumer Protection & Federal Office of Justice. Act on  
23 625 Occupational Physicians, Safety Engineers and Other Occupational Safety  
24 626 Specialists. Available: <https://www.gesetze-im-internet.de/asig/> [Accessed 19 May  
25 627 2020].  
26  
27 628 43. Blankenfeld H, Grill E, Kaduszkiewicz H, et al. [Antibody Assays Against SARS-CoV-2:  
28 629 Why a Good Test Does not Always Produce Proper Results]. *ZFA* 2020;**96**(5):230-33.  
29 630 doi: 10.3238/zfa.2020.0230-0233.  
30  
31 631 44. Hemmerich WA. [StatistikGuru: Calculating sample size for single factor ANOVA].  
32 632 Available: [https://statistikguru.de/rechner/stichprobengroesse-einfaktorielle-](https://statistikguru.de/rechner/stichprobengroesse-einfaktorielle-anova.html)  
33 633 [anova.html](https://statistikguru.de/rechner/stichprobengroesse-einfaktorielle-anova.html) [Accessed 26 May 2020].  
34  
35 634 45. UNIPARK & questback. [Data protection]. Available:  
36 635 <https://www.unipark.com/datenschutz/> [Accessed 20 May 2020].  
37  
38 636 46. Deutsche Forschungsgemeinschaft (DFG). [Guideline for storing research data].  
39 637 Available:  
40 638 [https://www.dfg.de/download/pdf/foerderung/antragstellung/forschungsdaten/richtlinie](https://www.dfg.de/download/pdf/foerderung/antragstellung/forschungsdaten/richtlinie_n_forschungsdaten.pdf)  
41 639 [n\\_forschungsdaten.pdf](https://www.dfg.de/download/pdf/foerderung/antragstellung/forschungsdaten/richtlinie_n_forschungsdaten.pdf) [Accessed 21 July 2020].  
42  
43 640 47. World Medical Association. Declaration of Helsinki: Ethical principles for medical  
44 641 research involving human subjects. 2013;**310**(20):2191-94, doi:  
45 642 10.1001/jama.2013.281053.  
46  
47 643 48. Vanderstoep SW, Johnston DD. *Research Methods for Everyday Life: Blending*  
48 644 *Qualitative and Quantitative Approaches*. San Francisco: Jossey-Bass 2009.  
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\*Additional module 4: service offered and conducted by the participating company's medical service.

Figure 1 Illustration of the applied explorative modular mixed methods design

201x153mm (300 x 300 DPI)



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3 **Supplementary file S1 - Good Reporting of A Mixed Methods Study (GRAMMS)**  
4 **checklist\***  
5

<b>Guideline</b>	<b>Section: page</b>
Describe the justification for using a mixed methods approach to the research question	METHODS AND ANALYSIS - study design: pg. 5 – 6 and figure 1
Describe the design in terms of the purpose, priority and sequence of methods	METHODS AND ANALYSIS - study duration: pg. 7, figure 1, table 1
Describe each method in terms of sampling, data collection and analysis	METHODS AND ANALYSIS – study procedures: pg. 8 - 13
Describe where integration has occurred, how it has occurred and who has participated in it	METHODS AND ANALYSIS - study design: figure 1 and pg. 6 and discussion, pg. 14; we describe and discuss how we expect data integration to proceed. Describing specific insights is not yet applicable as data collection, analysis and integration has not commenced.
Describe any limitation of one method associated with the present of the other method	Discussion - pg. 14 - 15
Describe any insights gained from mixing or integrating methods	METHODS AND ANALYSIS - study design: pg. 5 - 6 and figure 1 where we describe what we expect from applying a mixed method design. Describing specific insights is not yet applicable as data analysis, data collection, analysis and integration has not commenced.

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34 \* O'Cathain A, Murphy E, Nicholl J. The quality of mixed methods studies in health services  
35 research. J Health Serv Res Policy. 2008;13: 92-98.  
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# BMJ Open

## Adjusting working conditions and evaluating the risk of infection during the COVID-19 pandemic in different work-place settings in Germany – a study protocol for an explorative modular mixed methods approach

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Secondary Subject Heading:	Occupational and environmental medicine, Public health
Keywords:	COVID-19, OCCUPATIONAL & INDUSTRIAL MEDICINE, Infection control < INFECTIOUS DISEASES

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3 1 **Title:** Adjusting working conditions and evaluating the risk of infection during the COVID-19  
4 2 pandemic in different work-place settings in Germany – a study protocol for an explorative  
5 3 modular mixed methods approach  
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35 diseases  
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## 38 **ABSTRACT**

39 **Introduction:** Currently, many countries, affected by the COVID-19 pandemic, discuss ways  
40 how the “lockdown-restrictions” could be lifted to restart the economy and public life after the  
41 first wave of the COVID-19 disease has subsided. This study protocol describes an approach  
42 designed to provide an in-depth understanding of how companies and their employees in  
43 Germany deal with their working conditions during the COVID-19 pandemic. We are also  
44 interested in how and why the risk of infection with SARS-CoV-2 could vary across different  
45 professional activities, company sites and regions with different epidemiological activity or  
46 infection control measures in Germany. We expect the results of this study to contribute to  
47 the development of working conditions protecting the health of employees during and beyond  
48 the COVID-19 pandemic.

49 **Methods and Analysis:** An explorative multimodal mixed methods approach will be applied.  
50 *Module 1* comprises a document analysis of prevailing federal and regional laws and  
51 regulations at the respective location of the participating company. *Module 2* includes  
52 qualitative interviews with key actors at different companies. *Module 3* is a repeated  
53 standardized employee survey designed to capture potential changes in the participants’  
54 experiences and attitudes towards working conditions, occupational safety  
55 regulations/measures, and infection control measures during the COVID-19 pandemic.  
56 *Module 4* comprises SARS-CoV-2 seroprevalence testing. This is carried out by the medical  
57 service of the participating company sites as a voluntary offer for employees. Qualitative data  
58 will be analyzed through document and content analysis. The complexity of the quantitative  
59 analysis depends on the response rates of modules 3 and 4.

60 **Ethics and Dissemination:** The approval of the study design was received in June 2020  
61 from the responsible local ethical committee of the Medical Faculty, University of Tuebingen  
62 and University Hospital Tuebingen (No.: 423/2020BO). The results will be presented at  
63 national and international conferences and published in peer-reviewed journals.

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## STRENGTH AND LIMITATIONS OF THIS STUDY

- One of the first studies to provide a comprehensive understanding of how companies implement and employees perceive and accept the “new normal” regarding working conditions in Germany during the COVID-19 pandemic.
- The linkage of complementary methods (document analysis, interviews with company stakeholders, employee-surveys, testing of antibodies against SARS-CoV-2) will allow an in-depth exploration of work practices and experiences in relation to occupational safety regulations/measures, infection control regulations/measures, and the actual and perceived risk of infection.
- Depending on the areas of interest and resources of the participating companies, the modular approach enables the implementation of up to four substudies, also allowing for a cross-sectional or a longitudinal study design.
- The implementation of multiple modules requires comprehensive resources in terms of time, qualified scientific staff and the organization of the cooperation with different company sites as well as different companies.

## 90 INTRODUCTION

### 91 Background

92 At the beginning of 2020, the disease COVID-19 (Corona Virus Disease 2019), triggered by  
93 the coronavirus SARS-CoV-2 (severe acute respiratory syndrome coronavirus 2), has  
94 developed into a pandemic.<sup>1</sup> Without specific therapeutics or an effective vaccine available in  
95 the first quarter of 2020, many health care systems and governments responded to the rapid  
96 spread of the virus and the significant lethality of COVID-19 with the traditional means of  
97 containment: identification of cases and if necessary treatment under quarantine conditions,  
98 contact tracing and isolation of suspect cases, closure of schools and other educational  
99 institutions, non-system-relevant public institutions and businesses. In addition, most of the  
100 governments imposed contact restrictions and curfews considerably affecting everyday life of  
101 the population. For such a package of measures the term "lockdown" has become  
102 established. A lockdown lasting several weeks does not only result into a temporary  
103 restriction of civil rights such as freedom of assembly, but also into a considerable  
104 impairment of the economy.<sup>2-5</sup> Currently, debates revolve around which conditions and in  
105 which way the "lockdown-restrictions" could be lifted to restart the economy and public life  
106 after the first wave of the COVID-19 disease has subsided. This poses new challenges for  
107 local and global society: How can restrictions be relaxed without triggering another, even  
108 stronger and possibly uncontrollable wave of infection? Under these conditions, enterprises  
109 cannot simply "go back to business as usual"<sup>2</sup>, and national and international  
110 recommendations regarding occupational health and safety standards tailored to the risks of  
111 SARS-CoV-2 infection have been developed.<sup>6-8</sup> The term "new normal" arose, meaning that  
112 as long as there will be no vaccination for SARS-CoV-2 and no effective treatment, the state  
113 of exception will last, including implementation of and adherence to strict hygiene measures,  
114 as well as social and physical distancing in private life and workplaces for individual and  
115 collective protection.

116 New studies on coronaviruses and COVID-19 have explored a variety of safety-related  
117 dimensions including social public safety, psychological health and domestic safety,  
118 medicine treatment and vaccine safety or the occupational safety of employees.<sup>9</sup> The latter  
119 focuses particularly on working conditions and safety of healthcare professionals in clinical or  
120 ambulant settings.<sup>10-12</sup> Furthermore, research has looked at COVID-19 stressors on migrant  
121 workers<sup>13</sup> and commercial drivers<sup>14 15</sup>, and at measures to control the spreading of the  
122 corona virus in workplaces including engineering and administrative controls (e.g. proper  
123 ventilation, restricting staff gatherings) as well as the provision of personal protective  
124 equipment (e.g. protective masks or clothing).<sup>16</sup> As of yet, we are not aware of any studies  
125 linking different data sources, perspectives and methods to provide an in-depth  
126 understanding in which ways companies and their employees deal with their working



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3 127 conditions during the COVID-19 pandemic and how different experiences and attitudes may  
4 128 impact variations in the occurrence of infections with SARS-CoV-2. The results of our study  
5 129 are expected to facilitate the effort of companies and executive managers to protect the  
6 130 health of their employees over the course of the COVID-19 pandemic, also preparing them  
7 131 for future challenges such as the next wave of influenza.

132

### 133 **Study aim and research questions**

134 The Institute of Occupational and Social Medicine and Health Services Research (IASV),  
135 University Hospital Tuebingen, aims to explore how companies in Germany adjust to new  
136 occupational health and safety standards designed to prevent the spreading of the COVID-  
137 19 disease. We will focus on the following research questions:

- 138 1. Under which prevailing regulations and recommendations are working conditions  
139 adjusted in different work-place settings in Germany?
- 140 2. How do employers and their employees in Germany assess and accept their “new  
141 normal”?
- 142 3. How and why could the risk of infection vary across different German company sites  
143 and professional activities?

144

## 145 **METHODS AND ANALYSIS**

146 Previous contact of the IASV to representatives of the initially participating company’s chief  
147 medical services resulted in the development of a cooperative project exploring occupational  
148 health and safety issues related to the COVID-19 pandemic. The transdisciplinary project  
149 group has academic and practical expertise in occupational medicine, health sciences,  
150 health services research, and sociology and jointly discussed and developed the realization  
151 of the study design in the participating company.

152

### 153 **Study design**

154 The IASV conceptualized an explorative multi-modular mixed methods approach<sup>17 18</sup>  
155 following the GRAMMS-guidelines (supplementary file 1) developed by O’Cathain et al.  
156 (2008)<sup>19</sup>. Mixed method designs have become an integral part of health-related and health  
157 services research, providing a variety of quantitative and qualitative tools complementing  
158 each other in order to gain a comprehensive understanding of complex research questions.<sup>19</sup>  
159 <sup>20</sup> The approach comprises three modules (modules 1 – 3 in figure 1) which can be applied  
160 either as an entire set or companies can choose particular modules depending on their  
161 research interest and resources. The approach also allows the extension of additional

1  
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3 162 modules. The complete explorative multi-modular approach is initially tested and evaluated in  
4 163 one company. Modules 1 – 3 will be carried out in a large German leading global supplier of  
5 164 technology and services. The company employs roughly 400,000 associates in  
6 165 approximately 60 countries worldwide, thereof 132,000 in Germany in more than 100  
7 166 locations where employees pursue a variety of professional activities differing in their work-  
8 167 related risk of infection with SARS-CoV-2...An additional fourth module (figure 1) will be  
9 168 conducted by the participating company's medical service. As the approach is transferable to  
10 169 other settings, the team of the IASV plans to extend this research design to other companies,  
11 170 institutions and public authorities.

171

172 **Figure 1** Illustration of the applied explorative modular mixed methods design

173 In module 1, prevailing national and local laws as well as occupational health and safety  
174 regulations of the respective site will be analyzed. In module 2, qualitative interviews with  
175 company stakeholders will be conducted at the beginning and in the middle of the survey  
176 period. In module 3 we will focus on the perspective of employees conducting three waves of  
177 a standardized survey. Module 4 will comprise SARS-CoV-2 antibody testing for employees  
178 offered as a voluntary occupational health service by the participating company and carried  
179 out by the company's medical service. Using these methods in combination, we expect to be  
180 able to provide different perspectives, explanations and a deeper understanding of how  
181 companies and their employees adjust to working conditions in Germany during the COVID-  
182 19 pandemic in particular ways and how different attitudes and behaviours may impact their  
183 perceived and measured risk of infection.

184 Each module can stand by itself; however, selecting the entire set (modules 1 – 3) or even  
185 extending it (module 4) will provide the most comprehensive understanding of the study  
186 objective. The initial company agreed to participate in modules 1 - 3 and to conduct module  
187 4. Further companies can combine particular modules depending on their specific interests  
188 and resources. For example, if a company was particularly interested in why certain  
189 measures of infection protection during the COVID-19 pandemic may be accepted, ignored  
190 or rejected it would be advisable to take part at least in modules 1 and 3. For a deeper  
191 understanding it would also be advisable to include module 2. In order to evaluate how and  
192 why the results of the antibody testing (module 4, carried out by the participating company)  
193 and the perceived risk of infection may vary across company sites or areas of professional  
194 activities, a combination of all modules or at least modules 1, 3 and 4 would be  
195 recommended. As all data collection methods complement each other, data integration (e.g.  
196 converting coded qualitative data into variables for statistical analysis<sup>21</sup>, triangulation of

197 qualitative and quantitative data) depends on the number of modules a company chooses to  
 198 participate in.<sup>22</sup>

199

## 200 Patient and public involvement

201 Neither patients nor the public were and are involved in the planning of the design, the  
 202 recruitment, instrument development, data analysis, and reporting or dissemination plans of  
 203 this study.

## 204 Study duration

205 As the participating company will take part in the complete set of modules including multiple  
 206 survey and blood sampling waves, we anticipate a study duration of 18 months (Table 1).  
 207 The actual survey period for the company is 13 months.

208

209 **Table 1** Study plan including a full set of modules (modules 1-4)

Project month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Study preparation*	x	x	x															
<b>Module 1 – document analysis (prevailing laws and regulations)</b>																		
Document analysis				x	x	x	x	x	x	x	x	x	x	x	x			
<b>Module 2 – qualitative interviews with company stakeholders</b>																		
Qualitative interviews**						T0						T1						
Qualitative analysis						x	x	x	x	x	x	x	x	x	x	x	x	
Feedback to company									x									x
<b>Module 3 – employee survey</b>																		
Pretest			x															
Quantitative survey				T0	T0	T0			T1	T1	T1			T2	T2	T2		
Quantitative analysis					x	x	x	x	x	x	x	x	x	x	x	x	x	
Feedback to company									x				x					x
<b>Module 4 –SARS-CoV-2 antibody testing and aggregated analysis</b>																		
Blood sample collection***			T0	T0	T0				T1	T1	T1			T2	T2	T2		
Analysis			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
Feedback to company																		x
<b>Publication</b>														x	x	x	x	x

210 \*Literature research, development and adjustment of the survey instruments to specifics of the  
 211 participating company (employee survey, interview guide), consultation of the responsible data  
 212 protection officer.

213 \*\*In the event of relevant changes in the incidence of infection (e.g. local outbreak) or operational  
 214 procedures (e.g. new infection control measures or procedures), further interviews with company  
 215 stakeholders can be arranged.

216 \*\*\*Seroprevalence testing is a voluntary occupational health offer which will be undertaken by the  
217 company's medical officer. The frequency of blood sampling depends on the company's resources  
218 and operational capacity. Presuming individual consent of each participant, the aggregated results of  
219 seroprevalence testing (by job activity) can be linked to the results of the other modules.

221

## 222 **Study procedures: setting, sampling, data collection and analysis**

223 As companies are responsible for occupational health and safety to protect their employees,  
224 company owners and executive managers play a crucial part in preparing and responding to  
225 disease outbreaks, such as the COVID-19 pandemic.<sup>23</sup> This includes, for example, the  
226 adaption of workplace settings to protect workers, the development of action plans for  
227 resuming production after a period of closure or managing an increasing number of  
228 teleworkers.<sup>7</sup> Companies and their occupational health service have also been advised to  
229 prepare for the potential physical, mental and psychosocial effects of the "new normal" on  
230 employees.<sup>23</sup>

231 For all groups of employees, the working conditions are changing as a result of new infection  
232 control measures (e.g. distance and hygiene rules, modification of work schedules). On the  
233 one hand, groups of employees are exposed to an increased work-related risk of infection  
234 due to the necessity of working on-site closely together with other personnel (e.g. company  
235 medical service, plant security, personnel working on the assembly line). On the other hand,  
236 there are groups of employees (e.g. administrative staff) who can also work from home.  
237 Although this reduces the work-related risk of infection, new physical and psychological  
238 burdens and challenges arise with regard to working conditions and work design (e.g.  
239 ergonomically adequate workstations at home, organization of childcare, dissolving  
240 boundaries between work and private life, loss of immediate team support).

241 To capture potential regional and activity-related differences in the occupational risk and  
242 perception of infection risk, purposive sampling<sup>24</sup> will be used to include about six different  
243 company sites of the initially participating company. Inclusion criteria comprise a combination  
244 of sites providing the greatest possible contrast between different fields of activities (e.g.  
245 personnel working in open-plan offices/telework versus personnel on the assembly line).  
246 Furthermore, the company sites' responsible executive managers, employee organization  
247 and medical service will need to agree to the participations of the respective sites.

248 **Module 1** is a continuous literature search and document analysis<sup>25</sup>. The objective is to  
249 present workplace-related, legal, infectiological and social conditions facing companies in the  
250 context of the COVID-19 pandemic following the first lockdown in Germany. Three  
251 researchers from the IASV analyse and discuss prevailing federal and regional laws (e.g.,  
252 from the Federal Ministry of Health and from the Federal Ministry of Labour and Social

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3 253 Affairs), the development of infection rates in Germany (e.g., from the Robert Koch Institute),  
4 254 and occupational health and safety and infection control regulations at the respective sites of  
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6 255 the participating companies. This will provide a broader legal, infectiological, and  
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8 256 organizational cultural context for the interpretation of the results of the other modules. An  
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10 257 information letter accompanied by a consent form will be sent to the responsible contact  
11  
12 258 person (e.g. executive manager). With the consent of the management and the employee  
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14 259 organization, the company will be invited to provide documents and a short questionnaire  
15  
16 260 with general company information (e.g. size of the company sites, number of employees in  
17  
18 261 different departments and branches, job descriptions), and information on current  
19  
20 262 implemented health and safety measures (e.g. contact restrictions, telework regulations,  
21  
22 263 working in fixed teams, implementation of hygiene rules). This information will also allow the  
23  
24 264 calculation of response rates for modules 3 and 4.

25  
26 265 **Module 2** will comprise qualitative interviews with key actors at different company sites (e.g.  
27  
28 266 executive managers, members of the employee organization). The IASV will address them  
29  
30 267 as experts of their respective departments who can provide an overview of daily working  
31  
32 268 procedures and who are involved in problem solution processes.<sup>26</sup> The interdisciplinary  
33  
34 269 project team will develop a semi-structured interview guide according to the SPSS method  
35  
36 270 developed by Hellferich (2004)<sup>27</sup> covering these topics:

- 37  
38 271 - Workplace design and organization of working procedures in the context of the  
39  
40 272 COVID-19 pandemic;  
41  
42 273 - Assessment of work-related stress and strain;  
43  
44 274 - Expectations and attitudes towards infection control and occupational health and  
45  
46 275 safety measures;  
47  
48 276 - Expectations and attitudes towards SARS-CoV-2 antibody tests.

49  
50 277 Purposive sampling<sup>24</sup> will be used to invite interview partners from different company sites  
51  
52 278 and different fields of activities (e.g. administrative responsibilities, organization of work at  
53  
54 279 the assembly line, provision of occupational health services) if they have worked at their  
55  
56 280 current job for at least 6 months and have a knowledge of German at least at B1-level.<sup>28</sup> The  
57  
58 281 participants will receive information on interview procedures, data protection and data  
59  
60 282 management accompanied by an individual consent form. We plan to conduct interviews with  
283  
284 the same participants at the beginning and in the middle of the study period to capture  
285  
286 potential changes in their experiences and attitudes. In the event of relevant changes in the  
287  
288 incidence of infection (e.g. local outbreak) or adjustment of company procedures (e.g. new  
measures of infection protection), further interviews could be arranged. All interviews will be  
conducted by the team of the IASV. Based on experience from previous projects, the  
duration of the interviews will take about 30-45 minutes.<sup>29</sup> Interviews will be audio taped and

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3 289 transcribed by a professional company according to a simplified system whereby  
4 290 transcription is word by word, but not phonetically<sup>30</sup>. Quality checks, de-personalization and  
5 291 pseudonymization of the data will be undertaken by the team of the IASV conducting the  
6 292 interviews. Interviewees will have the opportunity to re-read their interviews and give  
7 293 feedback on passages they consider as risky. The data will be imported into MAXQDA<sup>31</sup>, and  
8 294 analysis will be carried out by two researchers of the IASV following the steps of qualitative  
9 295 content analysis, including the development of a coding frame, the segmentation of the  
10 296 material, the testing of the coding frame, the evaluation of the trial coding and the  
11 297 completion of the main coding.<sup>32</sup> Preliminary results will be presented to further members of  
12 298 the study team to discuss remaining open questions and ensure quality control. All data will  
13 299 remain at the IASV.

20  
21 300 *Sample size:*

22 301 If applicable, we plan to include two company sites and several fields of activity in each site  
23 302 (e.g. production halls, open space offices, workplaces with high frequency of customer  
24 303 contacts) to the sample. We plan to conduct one interview per addressed field of activity at  
25 304 the time of the initial online survey (T0) and a follow-up interview with the same person after  
26 305 the second online survey (T1). The total number of interviews cannot be determined at this  
27 306 stage because it depends on the number of company sites included in the entire study. Due  
28 307 to a rather specific research aim, high sample specificity and quality of dialogue<sup>33</sup>, we  
29 308 assume eight participants per company will provide sufficient information for the aspired  
30 309 analysis. Thus, we expect a minimum number of 16 interviews to reach data saturation<sup>29</sup>  
31 310 (four interviewees at two company sites interviewed at the beginning and the end of the  
32 311 survey period).

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41 312 **Module 3** comprises three waves of a repeated standardized (anonymous) employee survey  
42 313 carried out by the IASV. T0 allows to capture the initial status in summer/autumn 2020 in  
43 314 Germany. T1 will cover the winter months, while T2 will again be carried out in summer 2021.  
44 315 This approach makes it possible to identify different phases and probably also peaks during  
45 316 the ongoing COVID-19 pandemic. Closed and open questions on our questionnaire are  
46 317 being designed to capture potential changes in the participants' experiences and attitudes  
47 318 towards working conditions during the COVID-19 pandemic as well as their perceived risk of  
48 319 infection at the workplace and outside the working environment.<sup>34</sup> Depending on the  
49 320 participating companies' preferences, a paper-based or online questionnaire is being  
50 321 developed. The questions are based on national and international recommendations  
51 322 regarding occupational health and safety standards and infection control measures, tailored  
52 323 to the risks of SARS-CoV-2 infection<sup>6-8</sup>, established recommendations of evaluating work-  
53 324 related stress and strain<sup>35</sup>, as well as existing questionnaires<sup>e.g.36</sup>. According to the



1  
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3 325 explorative design, we did not predefine one specific outcome, but addressed these aspects:  
4 326 the risk of infection perceived by employees, their experiences and attitudes towards  
5 327 infection protection at the workplace, and the associated psychological stress and strain.  
6  
7 328 This will provide context to interpret the occurrence of infections (self-reported antibody  
8 329 status, aggregated results of antibody testing) as well as for recommendations concerning  
9 330 infection protection at the workplace. Main subject areas of the questionnaire are  
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11 331 summarized in Table 2.  
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333 **Table 2** Subject areas and themes of the questionnaire

Subject areas	Themes
Evaluation of implemented SARS-CoV-2-related occupational health and safety standards	e.g. distance regulations, hygiene rules, organization of telework and teams working on-site, provision of protective equipment, workplace design
Evaluation of work-related stress and strain related to the COVID-19 pandemic	e.g. work-related stress and strain before and during the COVID-19 pandemic concerning work content/task, organization of work, working environment, social relations, new patterns of work
Assessment of perceived and potential risk of infection at the workplace	e.g. concern of being infected at the workplace number of contacts with others, working in fixed teams, working on-site or at home, acceptance and practicability of hygiene rules at work (keeping distance, wearing masks)
Assessment of perceived and potential risk of infection outside the working environment	e.g. concern of being infected outside the working environment, number of social contacts, contact to risk groups, travel behaviour, practiced leisure activities (low-contact vs. contact sports)
Sociodemographic and medical information potentially related to the prevalence of SARS-CoV-2 infections	e.g. age, sex, marital status, educational background, work experience, current occupation, number of children and their attendance in day-care centers or schools, relevant underlying medical conditions, if available: SARS-CoV-2 antibody status
Other relevant measures	e.g. control measures for personality factors, resilience and social desirability

334 The questionnaire will be pretested by a group of academic volunteers as well as by  
335 representatives of the target audience. Participation in each survey wave is voluntary. Survey  
336 invitations will be organized by the participating company (e.g. via company e-mail accounts,  
337 company newsletter, posters, postcards). Taking part requires employees to be of legal age  
338 with a knowledge of German at least at B1-level<sup>28</sup>, and – in case of an online-survey -  
339 internet access via PC, tablet, or smartphone. Individual consent to participate is given by the  
340 study participants after sufficient information on data protection and data management at the  
341 beginning of the survey. At the end of the first survey wave, participants will be asked to  
342 generate an 8-digit code which will be the same for all survey waves and can be used to  
343 merge the data of each person anonymously over subsequent survey waves.<sup>37</sup> Participants  
344 can (but do not have to) provide the result of the seroprevalence testing to the questionnaire.  
345 The completion of the survey is expected to take approximately 25 minutes. In case of an  
346 online-survey, the individual survey responses will be managed via the established online  
347 tool Unipark.<sup>38</sup> In case of a paper-pencil questionnaire, each survey sheet will be scanned at  
348 the University Hospital Tuebingen using an Optical Character Recognition (OCR) system.<sup>39</sup>  
349 All data will remain at the IASV and will be analyzed applying appropriate descriptive and  
350 inferential statistics in SPSS.<sup>40</sup> Depending on the sample size, a biometrician will be involved  
351 in discussing the development of hypothesis testing models which can be applied if a  
352 sufficient number of respondents take part in the survey.

353



354

355 *Sample size:*

356 According to the exploratory design, we aim to invite the entire staff of the participating  
357 company sites (n ~ 22.000). Stratification can only be carried out if a sufficient number of  
358 cases per subgroup is reached ( $\geq 10$ ).

359

360 **Module 4:** SARS-CoV-2 seroprevalence testing will be carried out as a voluntary company  
361 offer for employees by the occupational service of the participating company sites; hence, all  
362 individual data are subject to doctor-patient confidentiality and will remain with the  
363 participating company's medical service. In terms of quality assurance, the IASV research  
364 team will advise on database design, selection of antibody tests (type, pharmaceutical  
365 supplier) the content of a short participant questionnaire completed when blood sampling  
366 takes place (age, sex, work location, field of activity), and analysis procedures. Testing and  
367 aggregated epidemiological evaluations at the company level will be carried out according to  
368 applicable medical regulations.<sup>41 42</sup> Presuming individual consent of each participant, the  
369 results of the antibody tests (aggregated to company specific operational activities, e.g.  
370 infections in open plan office versus assembly line) can be analyzed in combination with the  
371 results of the other modules by the IASV. As module 4 is of exploratory nature, data will be  
372 analyzed applying appropriate descriptive and inferential statistics in SPSS.<sup>40</sup>

373 *Sample size:*

374 Due to the currently low prevalence of SARS-CoV-2 in Germany ( $< 2\%$ )<sup>43</sup>, serological  
375 diagnostic and hypothesis testing are only suitable for larger epidemiological studies  
376 including a sufficient number of cases allowing for stratification. For example, assuming a  
377 small effect size ( $\eta^2 = 0.01$ ) for the detection of potential differences in the seroprevalence  
378 across employees from four different areas of activity at a power of 80%, statistical analysis  
379 would require a sample size of 271 persons per area of activity (n = 1084 employees) to  
380 obtain a statistically significant result performing a single factor ANOVA ( $\alpha = .05$ ).<sup>44</sup>

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### 382 **Data protection**

383 Relevant data protection regulations will be observed for all data collected and coordinated  
384 with the responsible ethics committee, academic and company data protection officers, as  
385 well as the respective company physicians and representatives of the employee  
386 organization. Concerning module 1, the company sites will decide whether and how they  
387 provide company-related information. All other data (e.g. federal and regional COVID-19-  
388 related regulations) are available publicly. Depending on the extent of the information

389 provided by the companies and the official information available, the respective legal and  
390 organizational context of different work-place settings is compiled by the IASV.

391 Participants taking part in module 2 will provide individual consent to be interviewed by  
392 project members of the IASV. The digital audio recordings and original (non-pseudonymized)  
393 transcripts will be stored in the secure network of the University Hospital Tuebingen and  
394 destroyed after the completion of the analyses. For the analysis, all names, places and  
395 references that would allow drawing conclusions about a person or the participating company  
396 or company site will be pseudonymized by project members of the IASV. The  
397 pseudonymized transcripts will only be accessible to project members of the IASV, stored in  
398 the secure network of the University Hospital Tuebingen. All other persons will have access  
399 only to the interview excerpts cited in reports or publications. In terms of module 3, the  
400 participants provide individual consent to take part in the anonymous employee survey. In  
401 case of an online survey, the questionnaire data will be collected via the established survey  
402 tool Unipark complying with security requirements according to the information security  
403 standard ISO/IEC 27001.<sup>45</sup> In case of a paper-pencil questionnaire, all data will be scanned  
404 at the University Hospital Tuebingen.<sup>39</sup> All data will be transferred to SPSS<sup>40</sup> and stored in  
405 the secure network or a lockable archive of the University Hospital Tuebingen. Individual  
406 data will only be accessible for project members of the IASV.

407 The collection and pseudonymization of the individual serum samples during module 4 will  
408 be organized by the company's medical service and is subject to medical confidentiality.  
409 Presuming individual consent of each participant, project members at the University Hospital  
410 Tuebingen will receive data on the seroprevalence of employees aggregated to areas of  
411 activity, also including aggregated demographic information (age, sex). If the response rate is  
412 low ( $\leq 10/\text{area of activity}$ ), these data will be aggregated with the data from other company  
413 sites and if necessary with other areas of activity.

414 In line with the German guidelines for storing research data<sup>46</sup>, all data compiled by the IASV  
415 (modules 1 – 3) as well as the aggregated data received by the participating company  
416 (module 4) will be stored for 10 years after the final publication in the secure network of the  
417 University Hospital Tuebingen and destroyed thereafter. These data will be accessible only  
418 to IASV-personnel involved in the research project.

419

## 420 **Ethics and dissemination**

### 421 **Research ethical approval**

422 The study and all study-related documents were designed following the principles formulated  
423 in the current version of the Declaration of Helsinki<sup>47</sup>. The approval of the study design was

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3 424 received in June 2020 from the responsible local ethical committee of the Medical Faculty,  
4 425 University of Tuebingen and University Hospital Tuebingen (No.: 423/2020BO).

5 426

### 6 427 **Progression of the study**

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8 428 The development of the research instruments are in progress. The recruitment of the first  
9 429 wave of participants has commenced 21<sup>th</sup> July 2020 and is anticipated to continue until  
10 430 October 2020.

11 431

### 12 432 **Dissemination**

13 433 Study results will be published in peer-reviewed journals and presented at international and  
14 434 national conferences.

15 435

### 16 436 **Discussion**

17 437 There are some pros and cons associated with our study approach. Although the  
18 438 triangulation (and integration) of evidence is an integral part of mixed methods research<sup>17</sup>,  
19 439 the design of our study is unique in terms of the modular approach we specifically developed  
20 440 for assessing how companies and their employees experience and adjust to working  
21 441 conditions in Germany during the COVID-19 pandemic. Furthermore, the design is  
22 442 transferable to other companies, institutions and public authorities in Germany. However, this  
23 443 is not an international study. Therefore, the gained results from Germany may not be  
24 444 translatable to other countries. Depending on their areas of interest and resources, the  
25 445 modular approach enables the implementation of up to three substudies conducted by the  
26 446 IASV, also allowing for a cross-sectional or a longitudinal study design with multiple survey  
27 447 and interview waves. Additional substudies such as SARS-CoV-2 seroprevalence testing can  
28 448 be implemented and conducted by the participating companies. Each of the quantitative  
29 449 (employee survey, SARS-CoV-2 antibody testing) and qualitative method (document  
30 450 analysis, interviews with company stakeholders) applied can stand by itself; however, in  
31 451 linking different data sets and methods (document analysis, descriptive and inferential  
32 452 statistics, content analysis) as well as a variety of perspectives (researchers, company  
33 453 stakeholders, workers) the integration<sup>21</sup> of the individual results will provide a detailed  
34 454 analysis of the overall research objective. In terms of resources (e.g. time, required  
35 455 qualification of the personnel, organizational effort), we expect that the combination of the  
36 456 methods applied will mitigate some of the limitations inherent for quantitative (numeric  
37 457 description of phenomena, complexity of statistical analysis dependent on survey response  
38 458 rate, superficial understanding of participants' experiences, attitudes and causal  
39 459 relationships) and qualitative research (e.g. small sample, results not statistically  
40 460 representative of a population, time consuming data collection and analysis).<sup>48</sup>

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3 461 Finally, we want to highlight potential concerns of the participants that may occur over the  
4 462 course of the study. Since the company's medical service is involved in data collection  
5 463 (module 4), the participants may be concerned that their test results or their responses from  
6 464 the interviews and questionnaires (modules 2 and 3) have a negative impact on their working  
7 465 conditions or employment. We aim to avoid this issue by communicating our comprehensive  
8 466 data protection concept, by providing extensive information on the study, and by  
9 467 emphasizing the participants' right to withdraw from the study without any negative  
10 468 consequences. The project leader and responsible researchers will also be available to  
11 469 answer questions occurring over the course of the study period. Furthermore, the  
12 470 pseudonymized (module 2) and non-aggregated anonymized (module 3) data remains  
13 471 exclusively at the Institute of Occupational Medicine, Social Medicine and Health Services  
14 472 Research, University Hospital Tuebingen and will be evaluated there. The company (i.e.  
15 473 company owners, executive managers, works council, company medical service) will only  
16 474 receive aggregated evaluations. With respect to the antibody testing (module 4), this offer will  
17 475 be a completely voluntary occupational health service for company employees and the  
18 476 physician of the responsible medical service will provide information about the usual risks  
19 477 and side effects of blood sampling.

20 478 With this study, we aim to provide an in-depth analysis of occupational health and safety  
21 479 challenges related to the process of resuming and continuing work-related activities during  
22 480 the COVID-19 pandemic. This includes, for example the consideration of work activities  
23 481 requiring on-site presence - possibly in close contact with colleagues, suppliers or the public  
24 482 – as well as issues associated with an increased use of telework. We expect that our study  
25 483 will contribute to the development of working conditions ensuring that job-related activities  
26 484 can be designed as safe as possible to the requirements of occupational health and safety  
27 485 regulations and to the particular needs of companies and their employees.

28 486

## 29 487 **DECLARATIONS**

### 30 488 **Contributors**

31 489 All authors contributed to the development of the study design. ER, CP, AW, AS, BS and  
32 490 MAR conceptualised modules 1 - 3 and KK, FP, KA, AK and JK had the initial idea for  
33 491 module 4. ER and MAR were involved in obtaining approval from the Ethics Committee of  
34 492 the Medical Faculty, University Hospital of Tuebingen. ER is the primary investigator and  
35 493 drafted the manuscript. All authors provided critical feedback on the manuscript, read and  
36 494 approved the final version.

37 495

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1  
2  
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15 505 officers who provided valuable advice on the study design. We would also like to thank  
16 506 Benjamin Lee for his linguistic advice on the manuscript.

19 507

### 22 508 **Disclaimer**

23 509 The funding sources had no role in the design of the study and will not be involved in the  
24 510 conduct, collection, management, analysis, interpretation or dissemination of any data or  
25 511 results of the research.

29 512

### 31 513 **Competing interests**

32 514 None declared.

34 515

### 36 516 **Ethics approval and consent to participate**

37 517 Ethical approval for this study was obtained from the Ethics Committee of the Medical  
38 518 Faculty, University Hospital of Tuebingen (reference number: 423/2020BO). Informed written  
39 519 consent to participate will be obtained from all participants.

43 520

### 45 521 **Provenance and peer review**

46 522 Not commissioned; externally peer reviewed.

48 523

### 51 524 **Data sharing statement**

52 525 Our manuscript describes a study protocol. As such, we cannot elaborate on unpublished  
53 526 data.

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3 527 **Supplementary material**

4 528 **Supplementary file S1:** Good Reporting of A Mixed Methods Study (GRAMMS) checklist

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8 530 **References**

- 9 531 1. World Health Organization. Coronavirus. Available: [https://www.who.int/health-](https://www.who.int/health-topics/coronavirus#tab=tab_1)  
10 532 [topics/coronavirus#tab=tab\\_1](https://www.who.int/health-topics/coronavirus#tab=tab_1) [Accessed 19 May 2020].
- 11 533 2. Dorn F, Khailaie S, Stöckli M, et al. [The common interest of health and economy: A  
12 534 scenario calculation for the containment of the corona pandemic. A joint study of the  
13 535 ifo Institute (ifo) and the Helmholtz Centre for Infection Research (HZI). ifo  
14 536 Schnelldienst digital 6/2020 13 May 2020]. München: ifo Institut 2020.
- 15 537 3. Tagesschau. [VW shutting down again - news from 13.05.2020]. Available:  
16 538 <https://www.tagesschau.de/wirtschaft/vw-produktion-105.html> [Accessed 19 May  
17 539 2020].
- 18 540 4. Veitinger T. [Bosch - environmental protection despite pandemic. Heidenheim News from  
19 541 30.04.2020]. Available: [https://www.hz.de/wirtschaft/wirtschaft-](https://www.hz.de/wirtschaft/wirtschaft-ueberregional/umweltschutz-trotz-pandemie-45870919.html)  
20 542 [ueberregional/umweltschutz-trotz-pandemie-45870919.html](https://www.hz.de/wirtschaft/wirtschaft-ueberregional/umweltschutz-trotz-pandemie-45870919.html) [Accessed 19 May 2020].
- 21 543 5. Verma S, Gustafsson A. Investigating the emerging COVID-19 research trends in the field  
22 544 of business and management: A bibliometric analysis approach. *J Bus Res*  
23 545 2020;**118**:253-61. doi: 10.1016/j.jbusres.2020.06.057. [published Online First:  
24 546 2020/07/02.].
- 25 547 6. Cirrincione L, Plescia F, Ledda C, et al. COVID-19 Pandemic: Prevention and Protection  
26 548 Measures to Be Adopted at the Workplace. *Sustainability* 2020;**12**(9) doi:  
27 549 10.3390/su12093603.
- 28 550 7. EU-OSHA. EU GUIDANCE. Covid-19: Back to the workplace. Adapting workplaces and  
29 551 protecting workers. European Agency for Safety and Health at Work: EU-OSHA 2020.
- 30 552 8. Federal Ministry of Labour and Social Affairs. [SARS-CoV-2- Occupational Safety  
31 553 Standard from 16.04.2020]. Available:  
32 554 [https://www.bmas.de/SharedDocs/Downloads/DE/PDF-Schwerpunkte/sars-cov-2-](https://www.bmas.de/SharedDocs/Downloads/DE/PDF-Schwerpunkte/sars-cov-2-arbeitsschutzstandard.pdf?__blob=publicationFile&v=4)  
33 555 [arbeitsschutzstandard.pdf?\\_\\_blob=publicationFile&v=4](https://www.bmas.de/SharedDocs/Downloads/DE/PDF-Schwerpunkte/sars-cov-2-arbeitsschutzstandard.pdf?__blob=publicationFile&v=4) [Accessed 19 May 2020].
- 34 556 9. Haghani M, Bliemer MCJ, Goerlandt F, et al. The scientific literature on Coronaviruses,  
35 557 COVID-19 and its associated safety-related research dimensions: A scientometric  
36 558 analysis and scoping review. *Saf Sci* 2020:104806. doi: 10.1016/j.ssci.2020.104806.  
37 559 [published Online First: 2020/05/10.].
- 38 560 10. Ambigapathy S, Rajahram GS, Shamsudin UK, et al. How should front-line general  
39 561 practitioners use personal protective equipment (PPE)? *Malays Fam Physician*  
40 562 2020;**15**(1):2-5.

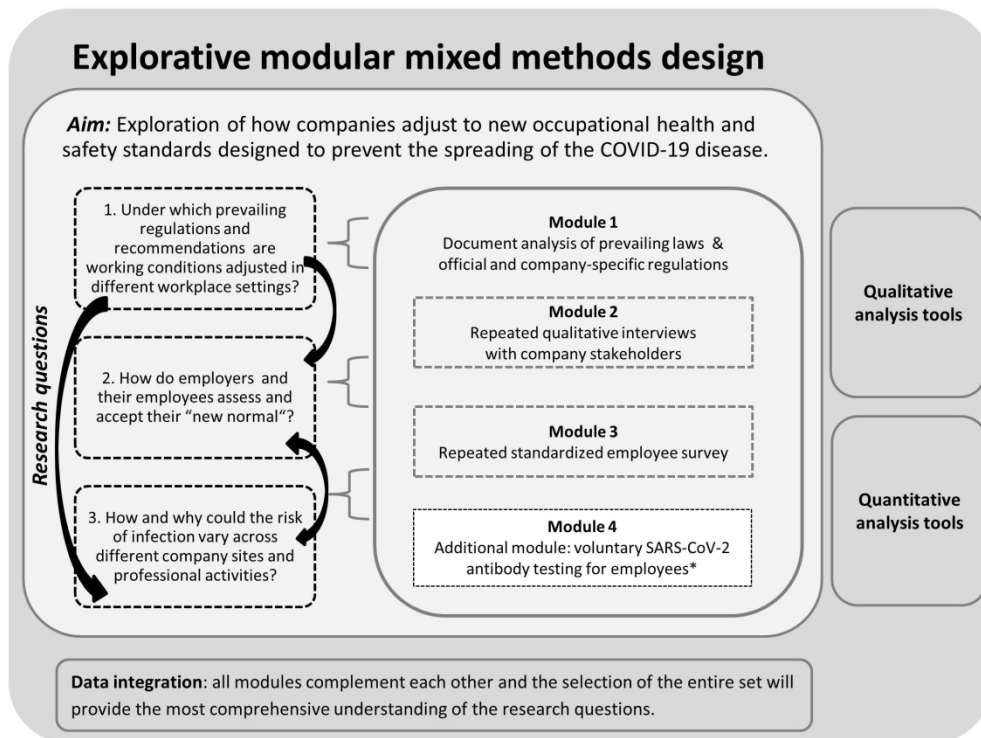


- 1  
2  
3 563 11. Chen Y, Pradhan S, Xue S. What are we doing in the dermatology outpatient department  
4 564 amidst the raging of the 2019 novel coronavirus? *J Am Acad Dermatol*  
5 565 2020;**82**(4):1034. doi: 10.1016/j.jaad.2020.02.030. [published Online First:  
6 566 2020/02/23.].
- 7  
8  
9 567 12. Cheung JC-H, Ho LT, Cheng JV, et al. Staff safety during emergency airway  
10 568 management for COVID-19 in Hong Kong. *The Lancet Respiratory Medicine*  
11 569 2020;**8**(4) doi: 10.1016/s2213-2600(20)30084-9.
- 12  
13  
14 570 13. Alahmad B, Kurdi H, Colonna K, et al. COVID-19 stressors on migrant workers in Kuwait:  
15 571 cumulative risk considerations. *BMJ Glob Health* 2020;**5**(7):e002995. doi:  
16 572 10.1136/bmjgh-2020-002995.
- 17  
18  
19 573 14. Lemke MK, Apostolopoulos Y, Sonmez S. A novel COVID-19 based truck driver  
20 574 syndemic? Implications for public health, safety, and vital supply chains. *Am J Ind*  
21 575 *Med* 2020;**63**(8):659-62. doi: 10.1002/ajim.23138. [published Online First:  
22 576 2020/05/27.].
- 23  
24  
25 577 15. Lemke MK, Apostolopoulos Y, Sonmez S. Syndemic frameworks to understand the  
26 578 effects of COVID-19 on commercial driver stress, health, and safety. *J Transp Health*  
27 579 2020;**18**:100877. doi: 10.1016/j.jth.2020.100877. [published Online First:  
28 580 2020/06/06.].
- 29  
30  
31 581 16. Rafeemanesh E, Ahmadi F, Memarzadeh M. A Review of the Strategies and Studies on  
32 582 the Prevention and Control of the New Coronavirus in Workplaces. *Arch Bone Jt Surg*  
33 583 2020;**8**(Suppl1):242-46. doi: 10.22038/abjs.2020.47410.2323.
- 34  
35  
36 584 17. Mayring P. [Triangulation of evidence and mixed methods in health research]. In: Haring  
37 585 R, ed. [Health Sciences]. Berlin, Heidelberg: Springer Berlin Heidelberg 2019:133-41.
- 38  
39  
40 586 18. Niederberger M, Peter L. [Mixed methods studies in the health sciences. A critical map].  
41 587 *Z Evid Fortbild Qual Gesundheitswes* 2018;**133**:9-23. doi: 10.1016/j.zefq.2018.02.008.  
42 588 [published Online First: 2018/04/02.].
- 43  
44  
45 589 19. O'Cathain A, Murphy E, Nicholl J. The quality of mixed methods studies in health  
46 590 services research. *J Health Serv Res Policy* 2008;**13**(2):92-8. doi:  
47 591 10.1258/jhsrp.2007.007074. [published Online First: 2008/04/18.].
- 48  
49  
50 592 20. Tariq S, Woodman J. Using mixed methods in health research. *JRSM Short Rep*  
51 593 2013;**4**(6):2042533313479197. doi: 10.1177/2042533313479197. [published Online  
52 594 First: 2013/07/26.].
- 53  
54  
55 595 21. Bryman A. Integrating quantitative and qualitative research: how is it done? *Qualitative*  
56 596 *Research* 2016;**6**(1):97-113. doi: 10.1177/1468794106058877.
- 57  
58  
59 597 22. Fielding NG. Triangulation and Mixed Methods Designs. *Journal of Mixed Methods*  
60 598 *Research* 2012;**6**(2):124-36. doi: 10.1177/1558689812437101.

- 1  
2  
3 599 23. Fadel M, Salomon J, Descatha A. Coronavirus outbreak: the role of companies in  
4 600 preparedness and responses. *The Lancet Public Health* 2020;**5**(4) doi:  
5 601 10.1016/s2468-2667(20)30051-7.  
6  
7  
8 602 24. Guetterman TC. Descriptions of Sampling Practices Within Five Approaches to  
9 603 Qualitative Research in Education and the Health Sciences. *Forum: Qualitative Social*  
10 604 *Research* 2015;**16**(2):<http://nbn-resolving.de/urn:nbn:de:0114-fqs1502256>.  
11  
12 605 25. Wolff S. [Analysis of documents and field analysis]. In: Flick U, von Kardorff E, Steinke I,  
13 606 eds. [Qualitative research A manual (5th edition)]. Reinbek bei Hamburg: Rowohlt  
14 607 Taschenbuch Verlag 2007:502 – 13.  
15  
16 608 26. Britten N. Qualitative interviews in medical research. *BMJ (Clinical research ed)*  
17 609 1995;**311**(6999):251-3. [published Online First: 1995/07/22.].  
18  
19 610 27. Hellferich C. [The quality of qualitative data. Manual for conducting qualitative interviews].  
20 611 Wiesbaden: VS Verlag für Sozialwissenschaften. 2004.  
21  
22 612 28. Council of Europe. Common European Framework of Reference for Languages (CEFR).  
23 613 Available: [https://www.coe.int/en/web/common-european-framework-reference-](https://www.coe.int/en/web/common-european-framework-reference-languages)  
24 614 [languages](https://www.coe.int/en/web/common-european-framework-reference-languages) [Accessed 21 July 2020].  
25  
26 615 29. Aldiabat KM, Le Navenec C. Data saturation: The mysterious step in grounded theory  
27 616 methodology. *The Qualitative Report* 2018;**23**(1):245-61.  
28  
29 617 30. Dresing T, Pehl T. [Research in practice: interviews, transcription & analysis. Instructions  
30 618 and control systems for qualitative researchers; 8th edition]. Marburg: dr dresing &  
31 619 pehl GmbH 2018.  
32  
33 620 31. MAXQDA. The Art of Data Analysis. Available: [https://www.maxqda.com/how-to-analyse-](https://www.maxqda.com/how-to-analyse-qualitative-data)  
34 621 [qualitative-data](https://www.maxqda.com/how-to-analyse-qualitative-data) [Accessed 25 Jan 2020].  
35  
36 622 32. Schreier M. Qualitative content analysis in practice. London: Sage 2012.  
37  
38 623 33. Malterud KS, , D; Guassora, AD Sample Size in Qualitative Interview Studies: Guided by  
39 624 Information Power. *Qualitative Health Research* 2016;**26**(13):1753–60.  
40  
41 625 34. Taddicken M. [Online-Survey]. In: Möhring W, Schlütz D, eds. [Handbook of standardised  
42 626 survey procedures in communication science]. Wiesbaden: Springer Fachmedien  
43 627 Wiesbaden 2013:201-17.  
44  
45 628 35. Gemeinsame Deutsche Arbeitsschutzstrategie (GDA), editor. *Occupational Safety and*  
46 629 *Health in Practice. Recommendations for implementing psychosocial risk*  
47 630 *assessment*. Berlin: Management of the GDA Mental Health Working Programme, c/o  
48 631 Federal Ministry of Labour and Social Affairs, 2014.  
49  
50 632 36. COSMO open. COVID-19 Snapshot Monitoring (COSMO) - [Questionnaires 2020].  
51 633 Available: <https://dfncloud.uni-erfurt.de/s/Cmzfw8fPRAgzEpA> [Accessed 25 May  
52 634 2020].  
53  
54  
55  
56  
57  
58  
59  
60



- 1  
2  
3 635 37. Justus-Liebig-Universität Giessen. [Code for panel studies]. Available: [https://www.uni-](https://www.uni-giessen.de/org/admin/stab/stl/servicestelle/panelcode)  
4 636 [giessen.de/org/admin/stab/stl/servicestelle/panelcode](https://www.uni-giessen.de/org/admin/stab/stl/servicestelle/panelcode) [Accessed 21 May 2020].  
5  
6 637 38. UNIPARK & questback. [Developing Online-Surveys easily]. Available:  
7  
8 638 <https://www.unipark.com/?gclid=EAlaIqobChMiiL3u9o7P6QIViK3tCh2cpgD->  
9 639 [EAAYASAAEgKa9\\_D\\_BwE](https://www.unipark.com/?gclid=EAlaIqobChMiiL3u9o7P6QIViK3tCh2cpgD-EAAYASAAEgKa9_D_BwE) [Accessed 25 May 2020].  
10  
11 640 39. OCR System GmbH. OCR System. Available: <https://www.ocr-systeme.de/en/> [Accessed  
12 641 14 Aug 2020].  
13  
14 642 40. IBM. SPSS software. Available: <https://www.ibm.com/analytics/spss-statistics-software>  
15 643 [Accessed 21 July 2020].  
16  
17 644 41. Federal Ministry of Justice and Consumer Protection & Federal Office of Justice.  
18 Ordinance on Occupational Health Care (ArbMedVV) - Available:  
19 645 [https://www.gesetze-im-internet.de/englisch\\_arbmedvv/index.html](https://www.gesetze-im-internet.de/englisch_arbmedvv/index.html) [Accessed 19 May  
20 646 2020].  
21 647  
22  
23 648 42. Federal Ministry of Justice and Consumer Protection & Federal Office of Justice. Act on  
24 649 Occupational Physicians, Safety Engineers and Other Occupational Safety  
25 650 Specialists. Available: <https://www.gesetze-im-internet.de/asig/> [Accessed 19 May  
26 651 2020].  
27  
28 652 43. Blankenfeld H, Grill E, Kaduszkiewicz H, et al. [Antibody Assays Against SARS-CoV-2:  
29 653 Why a Good Test Does not Always Produce Proper Results]. *ZFA* 2020;**96**(5):230-33.  
30 654 doi: 10.3238/zfa.2020.0230-0233.  
31  
32 655 44. Hemmerich WA. [StatistikGuru: Calculating sample size for single factor ANOVA].  
33 656 Available: [https://statistikguru.de/rechner/stichprobengroesse-einfaktorielle-](https://statistikguru.de/rechner/stichprobengroesse-einfaktorielle-anova.html)  
34 657 [anova.html](https://statistikguru.de/rechner/stichprobengroesse-einfaktorielle-anova.html) [Accessed 26 May 2020].  
35  
36 658 45. UNIPARK & questback. [Data protection]. Available:  
37 659 <https://www.unipark.com/datenschutz/> [Accessed 20 May 2020].  
38  
39 660 46. Deutsche Forschungsgemeinschaft (DFG). [Guideline for storing research data].  
40 661 Available:  
41 662 [https://www.dfg.de/download/pdf/foerderung/antragstellung/forschungsdaten/richtlinie](https://www.dfg.de/download/pdf/foerderung/antragstellung/forschungsdaten/richtlinie_n_forschungsdaten.pdf)  
42 663 [n\\_forschungsdaten.pdf](https://www.dfg.de/download/pdf/foerderung/antragstellung/forschungsdaten/richtlinie_n_forschungsdaten.pdf) [Accessed 21 July 2020].  
43  
44 664 47. World Medical Association. Declaration of Helsinki: Ethical principles for medical  
45 665 research involving human subjects. 2013;**310**(20):2191-94, doi:  
46 666 10.1001/jama.2013.281053.  
47  
48 667 48. Vanderstoep SW, Johnston DD. *Research Methods for Everyday Life: Blending*  
49 668 *Qualitative and Quantitative Approaches*. San Francisco: Jossey-Bass 2009.  
50 669  
51  
52  
53  
54  
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\*Additional module 4: service offered and conducted by the participating company's medical service.

Figure 1 Illustration of the applied explorative modular mixed methods design

201x153mm (300 x 300 DPI)

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3 **Supplementary file S1 - Good Reporting of A Mixed Methods Study (GRAMMS)**  
4 **checklist**  
5

6 **Guideline**

7 Describe the justification for using a mixed  
8 methods approach to the research question

9 Describe the design in terms of the  
10 purpose, priority and sequence of methods

11 Describe each method in terms of  
12 sampling, data collection and analysis

13 Describe where integration has occurred,  
14 how it has occurred and who has  
15 participated in it  
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21 Describe any limitation of one method  
22 associated with the present of the other  
23 method

24 Describe any insights gained from mixing or  
25 integrating methods  
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6 **Section: page**

METHODS AND ANALYSIS - study design:  
pg. 5 – 6 and figure 1

METHODS AND ANALYSIS - study  
duration: pg. 7, figure 1, table 1

METHODS AND ANALYSIS – study  
procedures: pg. 8 - 13

METHODS AND ANALYSIS - study design:  
figure 1 and pg. 6 and discussion, pg. 15;  
we describe and discuss how we expect  
data integration to proceed. Describing  
specific insights is not yet applicable as  
data collection, analysis and integration has  
not commenced.

Discussion - pg. 15 - 16

METHODS AND ANALYSIS - study design:  
pg. 5 - 6 and figure 1 where we describe  
what we expect from applying a mixed  
method design. Describing specific insights  
is not yet applicable as data analysis, data  
collection, analysis and integration has not  
commenced.