

# **A Mobile-Based Preventive Program for Young, Arabic-Speaking Asylum Seekers during the COVID-19 Pandemic in Germany: Design, Feasibility, and Implementation**

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# A Mobile-Based Preventive Program for Young, Arabic-Speaking Asylum Seekers during the COVID-19 Pandemic in Germany: Design, Feasibility, and Implementation

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## Abstract

**Background:** A majority of individuals seeking asylum in Germany are living in collective housings and thus exposed to a higher risk of contagion during the COVID-19 pandemic.

**Objective:** To test feasibility and efficacy of a culture-sensitive approach combining app games and a face-to-face group intervention to improve knowledge about COVID-19 and promote vaccination readiness among collectively accommodated Arabic-speaking adolescents and young adults.

**Methods:** We developed a mobile app that was composed of short video clips to explain the biological basis of COVID-19, demonstrate behavior to prevent transmission, and combat misconceptions and myths about vaccination. Explanations were given in a YouTube-like interview setting by a native Arabic-speaking physician. Elements of gamification (quizzes, rewards for solving test items) were also used. Consecutive videos and quizzes were presented over an intervention period of six weeks, the group intervention was scheduled as an add-on for half of participants in week 6. The manual of the group intervention was designed to provide actual behavior planning on the basis of the health action process approach. Sociodemographic information, mental health status, and knowledge about Covid-19 and available vaccines were assessed with questionnaire-based interviews at baseline and after six weeks. Interpreters assisted with the interviews in all cases.

**Results:** Enrollment in the study proved to be very challenging as among other things, the responsible managers of the housing facilities allowed contact with eligible study participants only during certain periods because of the pandemic situation. Also due to tightened contact restrictions, the face-to-face group interventions could not be held as planned.

A total of 88 participants from 8 collective housing institutions were included in the study. 61 participants completed the full intake interview.

Surprisingly, most participants had already been vaccinated at study enrollment (76.5%) and claimed to comply with preventive measures in an unrealistic extent. On the other hand, factual disease knowledge for COVID-19 was limited. Preoccupation with the information materials presented in the app steeply declined after study enrollment (e.g., 19% of participants watched the videos scheduled for week 3). Only 18 participants could be reached for the follow-up interview. Their COVID-19 disease knowledge could not be shown to have increased after the intervention period ( $p=0.558$ ).

**Conclusions:** In sum, vaccination among asylum seekers seems to be heavily depending on organizational determinants. Person centered informative interventions on preventive behaviors seem to be confronted with various obstacles: Learning from mobile phone content based on short instructional videos requires a basic understanding of biological and IT-aspects as well as sufficient literacy and a living situation enabling the practical application of the learned behavioral prevention strategies. Therefore,

transmission prevention in the target group should rely more on structural aspects instead on sophisticated psychological interventions. Clinical Trial: <https://www.drks.de>, identifier: DRKS00028825

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## Original Manuscript

## Original Paper

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# A Mobile-Based Preventive Program for Young, Arabic-Speaking Asylum Seekers during the COVID-19 Pandemic in Germany: Design, Feasibility, and Implementation

## Abstract

### Background:

A majority of individuals seeking asylum in Germany are living in collective housings and thus exposed to a higher risk of contagion during the COVID-19 pandemic.

### Objective:

To test feasibility and efficacy of a culture-sensitive approach combining mobile app-based interventions and a face-to-face group intervention to improve knowledge about COVID-19 and promote vaccination readiness among collectively accommodated Arabic-speaking adolescents and young adults.

### Methods:

We developed a mobile app that was composed of short video clips to explain the biological basis of COVID-19, demonstrate behavior to prevent transmission, and combat misconceptions and myths about vaccination. Explanations were given in a YouTube-like interview setting by a native Arabic-speaking physician. Elements of gamification (quizzes, rewards for solving test items) were also used. Consecutive videos and quizzes were presented over an intervention period of six weeks, the group intervention was scheduled as an add-on for half of participants in week 6. The manual of the group intervention was designed to provide actual behavior planning on the basis of the health action process approach. Sociodemographic information, mental health status, and knowledge about Covid-19 and available vaccines were assessed with questionnaire-based interviews at baseline and after six weeks. Interpreters assisted with the interviews in all cases.

### Results:

Enrollment in the study proved to be very challenging as among other things, the housing facilities allowed contact with potentially eligible participants only during certain periods because of the pandemic situation. Also due to tightened contact restrictions, the face-to-face group interventions could not be held as planned.

A total of 88 participants from 8 collective housing institutions were included in the study. 61 participants completed the full intake interview.

Most participants had already been vaccinated at study enrollment (76.5%). They also yet claimed to comply with preventive measures to a very high extent (e.g., “always wearing masks” was indicated by 66% of participants), but practicing behavior that was not considered as effective against Covid-19 transmission was also frequently reported as a preventive measure (e.g., mouth rinsing). On the other hand, factual disease knowledge for COVID-19 was limited. Preoccupation with the information materials presented in the app steeply declined after study enrollment (e.g., 19% of participants watched the videos scheduled for week 3). Only 18 participants could be reached for the follow-up interview. Their COVID-19 disease knowledge did not shown to have increased after the intervention period ( $p=0.558$ ).

### Conclusions:

The results indicate that vaccine uptake was high and seemed to be depending on organizational

determinants for the target group. The current mobile app-based intervention demonstrated low feasibility, which might have been related to various obstacles faced during the delivery: Learning from mobile phone content based on short videos requires a basic understanding of biological and IT-aspects as well as sufficient literacy and a living situation enabling the practical application of the learned behavioral prevention strategies. Therefore, in case of future pandemics, transmission prevention in the specific target group should rely more on structural aspects instead on sophisticated psychological interventions.

**Trial Registration:** <https://www.drks.de>, identifier: DRKS00028825

**Keywords:** Prevention; COVID-19; refugees; asylum seekers; adolescents; feasibility; app development; behavior planning; vaccination.



## Introduction

The COVID-19 pandemic has affected different parts of the population in Germany with different intensity [1]. Asylum seekers and refugees to Germany live to a large degree in collective housings [2]. Asylum seekers in Europe living in such housing conditions have been shown to be exposed to a higher risk of SARS-CoV-2 transmission due to a much higher contact frequency [3] and longer durations of potentially risky contacts than people living in private flats or houses [4]. In line with this, collectively accommodated asylum seekers suffered from infections with SARS-CoV-2 in a considerably higher attack rate than the general population in Germany [5]. In a review on the prevalence of infectious diseases among refugee groups across the globe, an increased risk for the transmission of more than a dozen of other diseases has been shown even before the COVID-19 outbreak [6], which seems to be attributable to a large degree to the often times precarious living situations (e.g., unsettled housing conditions or work situations) of refugees in the respective host countries [7].

Knowledge about the COVID-19 disease and its transmission has been shown to be limited among asylum seekers and refugees [8-10]. For example, in a study with Arabic- and Farsi-speaking adult refugees in Germany, the refugee groups displayed significantly less knowledge about COVID-19 and less engagement in preventive behaviors than matched non-refugee participants [9]. The mitigation of SARS-CoV-2 transmission has been impeded by a simultaneous wave of misinformation on the disease, which has been labeled an “infodemic” [11], spreading mostly via social media. Asylum seekers are a particularly vulnerable group due to insufficient skills in the language of their host country. Thus, they are at higher risk also for false information [12] on the pandemic and lack on valid information on adequate preventive measures.

Vandormael and colleagues tested a short, non-verbal, and “culture-agnostic” video to counter social media misinformation about COVID-19 with adolescents and young adults from the United States, United Kingdom, Germany, Spain, and Mexico [13]. They found significantly improved levels of disease knowledge in the video condition compared to an attention control and a do-nothing condition [13]. Similarly, Tjaden et al. [14] evaluated a Facebook campaign for COVID-19 vaccine information in a large sample of Arabic-, Turkish-, and Russian-speaking persons in Germany. They showed higher click-through rates for COVID-19 vaccine advertisements relative to rates for average healthcare-related campaigns on Facebook. Arabic- and Russian-speaking participants showed significantly COVID-19 higher click-through rates when vaccine advertisements were displayed in Arabic and Russian compared to the same advertisements presented only in German. Moreover, a review of smartphone-delivered mental health interventions for asylum seekers and refugees included 12 interventions of which three were specially tailored to adolescent and young refugees [15]. The included interventions varied with regard to the degree of guidance, ranging from unguided (i.e. no personal contact or individualized feedback) to guided (i.e. different amounts of personal support; see also [16]). Also, dropout rates varied widely, ranging from 3 to 80%. But overall, the review showed that participants were largely satisfied with the interventions, indicating that such mobile app-based interventions for young asylum seekers could be feasible.

It is against this background that the Deutsche Forschungsgemeinschaft (DFG) initiated a research program dedicated to the “prevention of disease transmission in specific social settings and subgroups of the population” on December 14, 2020 [17]. At this time, studies proving the efficacy of the mRNA vaccines (Pfizer/Biontech) were still in assessment, and conditional authorization was announced not earlier than December, 21 by the European Medical Association.

We proposed the CAYPVAR study (CCOVID Apps for young adults for preventing transmission and

promoting vaccination among refugees) to this research program, and the decision on granting the study was announced on April 27, 2021. As the correction of misinformation and myths about COVID-19 and available vaccines seems to be a critical requirement to promote preventive behavior against transmission of the disease [18-19], the design of our study focused on culture-dependent knowledge on infectious diseases, moral implications of vaccinating, and the most prevalent misinformation in our target group (e.g., becoming sick or impotent due to vaccination), namely young Arabic-speaking asylum seekers. The major study objectives were to answer the three following questions:

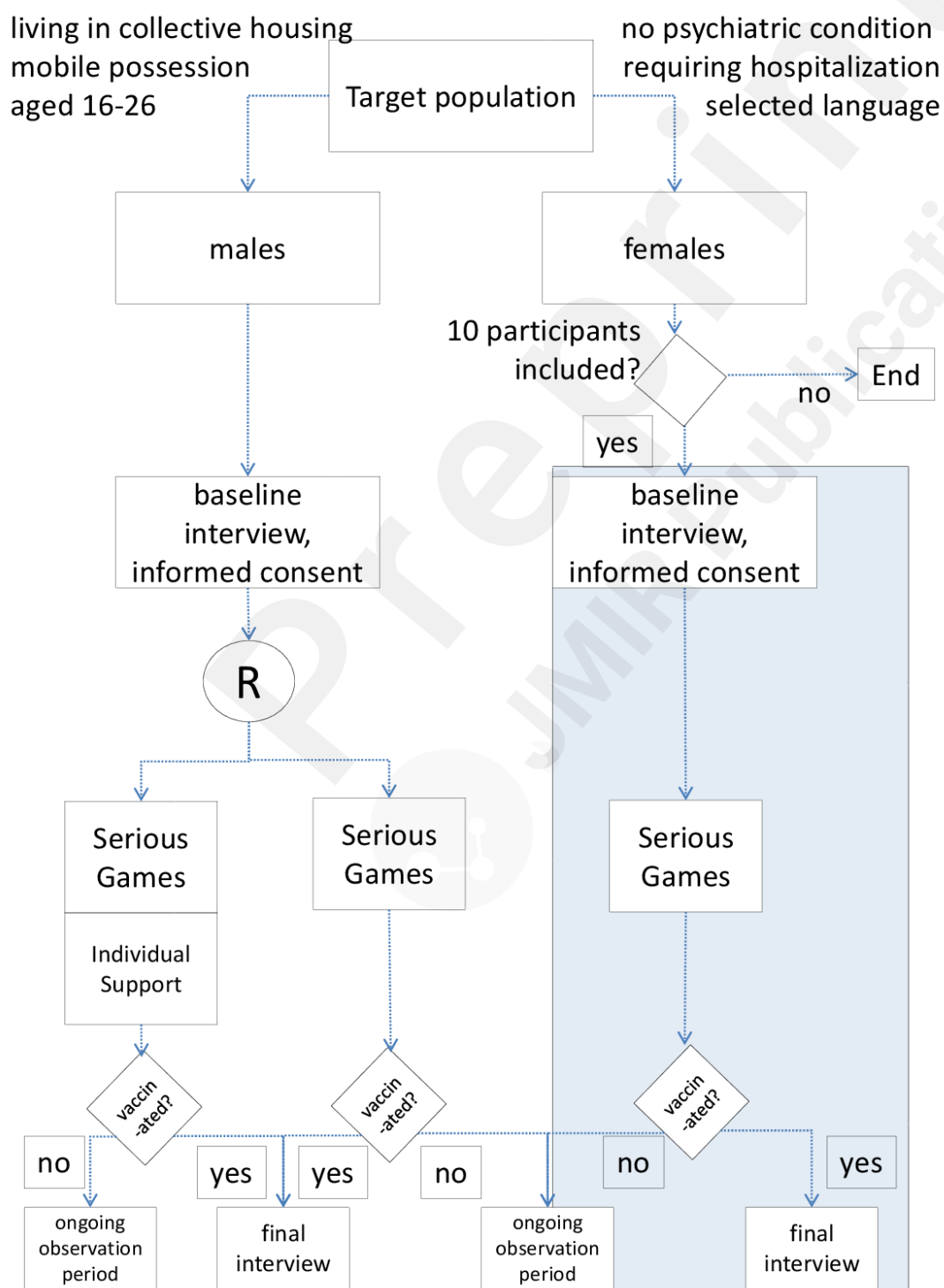
- 1) Can young asylum seekers in Germany be reached to a reasonable extent to roll out a specific prevention campaign during the COVID-19 pandemic?
- 2) Can a mobile-based intervention with elements from serious games (the CAYPVAR app), providing information in a culture-sensitive and age-adapted mode of presentation, contribute to a better understanding of disease mechanisms and an increased willingness to be vaccinated?
- 3) Can potential positive effects of the CAYPVAR app be intensified by a face-to-face group intervention on actual behavior planning? This intervention was planned as a single session and dedicated to addressing structural barriers prevailing in collective housings and individual needs for understanding the disease spread mechanisms. It should contribute to bridge the intention–behavior gap often observable in prevention trials [20].

## Materials and Methods

The study was planned as a phase II analogous feasibility and quasi “dosage finding” study. The potential efficacy of a mobile app-based informative intervention (the CAYPVAR app) was planned as pre-post comparison in a first group of participants (group A). A randomly allocated group B was planned to receive the CAYPVAR app plus a face-to-face group intervention on behavior planning (Figure 1). This should enable a group comparison of an intensified intervention concept. The CAYPVAR app (group A) was implemented over an intervention period of six weeks, the group intervention was scheduled as an add-on for half of participants (group B) in week 6.

## Ethical considerations

The study protocol was approved by HSD ethics committee (decision of February 15, 2021) and registered on the study platform German Clinical Trials Registry (study number: DRKS00028825). All participants provided written informed consent before commencing the study. Study data were collected in a pseudonymized way with different individual codes for the different data sources (i.e. interviews, smartphone data, and mobile websites). Personal contact data were never disclosed to team members analyzing the data. The code list for data merging was only accessible to UF, DS, LB, and HC, and destroyed after the follow-up interviews. Participants were granted free mobile data or WIFI access via pre-paid cards or WLAN routers installed by the study team for the intervention period. In addition, participants received a one-time voucher of 10€ for continued app use and a voucher of 20€ for participation in the follow-up interview.”



## Figure 1: Study Design

Inclusion criteria for participants were 1) aged 16-26, 2) in possession of a mobile phone, 3) speaking Arabic, 4) living in a collective housing facility, and 5) not suffering from a psychiatric condition requiring hospitalization. Female asylum seekers aged 16 to 26 years are living seldomly in collective accommodations, as was known from earlier studies with refugees to Germany undertaken by the working group of the Catholic University Eichstätt-Ingolstadt [21-23]. Therefore, no face-to-face intervention group with female participants was planned. Female participants would only be tracked regarding their use of the CAYPVAR app, if at least 10 female participants could be enrolled.

## Recruitment Strategy

In collective accommodations in Germany, most residents are young men who are waiting for a decision on their asylum request or have obtained a temporary residence permit [24]. Thus, their living situation is unsettled, along with constant uncertainty regarding their possible future residence.

As most asylum requests in Germany have been submitted by Arabic-speaking persons in the last couple of years [2], the largest subpopulation in the collective accommodations approached for recruitment and stating their willingness to participate in this study (altogether 8 institutions) were Arabic-speaking adolescents and young adults (migrating from Algeria, Somalia, Syria, Iraq, Eritrea, Yemen, and Lebanon; see also [24]). Therefore, all spoken information and video clips as well as written materials (e.g., quizzes, informed consent forms) were prepared in Arabic. One exception was a short sequence from a classic American science fiction movie (injection scene of a miniaturized submarine into the anterior jugular vein of a Czech scientist, “Fantastic Journey”, 1966, directed by Richard Fleischer), which was embedded into a video on myths and conspiracy theories on vaccines against SARS-CoV-2 (e.g., 5G chip implantation) using the unsynchronized English version. During the recruiting visits to the institutions, a professional interpreter was present or one of the longer-established inhabitants not qualifying for the study (mainly because of age) with sufficient or good knowledge of both Arabic and German served as interpreter.

## Intervention Strategy

The majority of young asylum seekers possess a mobile phone because this had been an important source of information during the flight [25] and is a central mode of connecting with family members in and receiving news from the home countries [26-27]. Mobile phones of refugees mostly work with prepaid cards as remuneration path. This led us to the idea of installing WLAN routers in the collective accommodation facilities to provide an incentive for study participating as there was usually no or only instable internet connection in these facilities.

The intervention period was conceptualized over six weeks, while new informative video clips were presented each week (see Table 1). Beyond the basic setting of an interview situation in the clips, some elements of gamification were used. For example, sound effects, slap-stick-like GIF-scenes of inadequate greeting rituals under the pandemic, links to existing online games, or animated cartoons from other educational sources that were embedded into the interview talk were used. All interactive

elements strictly respected the privacy of participants. At the end of each week, a short quiz on the informative videos was asked that allowed to enter the next learning topic. Additionally, a link was offered for playing a free online game (“2020 game”) that recapitulated the world-wide events including SARS-CoV-2 epidemics, lockdowns, quarantine etc. in a jump-and-run format (see: 2020game.io/presskit.html). Finally, a photo and painting competition was started among participants. As award for the best pictures on the topic “My life and Corona”, we offered 10€ vouchers. This should result in a gallery of the project and thus was intended to sustain participation over the period of six weeks by constituting some “sense of being chosen” as member of the project.

## Information Material

To ensure an age-adapted mode of presentation, the videos were scripted as YouTube-style interviews by a female interviewer (D.S., subtitled as “psychologist”) asking a male physician (K.A., subtitled as “physician” – “Dr. Khalifa”), with both partners sitting in distance on a sofa. They both could easily be recognized as non-white persons. Most interviews contained short sequences such as animated cartoons that explained and visually repeated the verbal information given by the physician. These sequences stemmed from scientific educational institutions (e.g., FWU Institute for film and pictures in science and education, or Swiss Office for Public Health). The interviewer asked the questions in German, which were translated to Arabic in voice-over technique. The answers of the interviewee were given freely formulated (but scripted) in simple language in Arabic.

In addition, there were videos presenting solo statements of the physician. These clips described real case histories that the physician had treated (e.g., for long COVID), a short description of drug/vaccine approval procedures and the safety precautions from his experience as a study physician, and explained how vaccination from the viewpoint of Islam is justified (i.e. protection of other people).

To optimize the video clips for mobile phones, the clips were restricted to a maximum length of 3:00 minutes with the exception of a video on vaccination myths, which included a sci-fi movie scene from the 1960ies (see above) and therefore lasted a little longer than 7 minutes.

The videos were cumulatively made accessible during the 6 weeks of intervention period, which started individually for each participant from the day of installing the CAYPVAR app on the mobile phone. As shown in Table 1, the sequence of the video clips followed a didactic concept in six steps.

Table 1: Overview of the video clips’ content and presentation

Week	Involved Persons	Content	Availability
1	K.A. and D.S.	Biological basis of human cells: organelles and DANN	restricted access
	K.A. and D.S.	Virusses: parasite proliferation and reproduction	unrestricted
2	K.A. and D.S.	SARS-CoV2: pathogeneity and clinical impact	unrestricted
	K.A. and D.S.	SARS-CoV2: infectiousness over course of illness *)	unrestricted
3	K.A. and D.S.	SARS-CoV2: symptoms and differential risk status	unrestricted
	K.A. and D.S.	COVID-19: potential long term effects	unrestricted
	K.A. solo	Case histories of several of K.A.’s own patients	restricted access
4	K.A. and D.S.	Preventive measures: social/physical distancing	unrestricted
	K.A. and D.S.	Prevention: hand washing	unrestricted
	K.A. and D.S.	Prevention: airborne transmission and masks	unrestricted
5	K.A. and D.S.	Vaccination: general mechanism and techniques	unrestricted
	K.A. and D.S.	Vaccination: mRNA technology and risks **)	unrestricted

	K.A. solo	Vaccination: islamic justification for vaccines	restricted access
6	K.A. and D.S.	Vaccination: herd immunity	unrestricted
	K.A. and D.S.	Specific myths on vaccination in arabic communities	restricted access
	K.A. solo	Approval of vaccines, fake news among own patients	restricted access

K.A. and D.S.: Casual clothing, interview situation, YouTube style

K.A. solo: K.A. in doctor's overall

\*) during construction of videos, only "natural" and alpha variant were known

\*\*) risks according to evidence in 2021

Restricted access: due either to copyright reasons or to privacy protection

A collection of these videos not under specific copyright restrictions is accessible on <http://www.caypvar.de/video/>.

## Culture-sensitive approach

In the early year of 2021, there were no information materials on COVID-19 in Arabic available in Germany [28]. Therefore a serious and evidence based source in mother tongue was a necessary start into a culture-sensitive prevention intervention. Offering this information in age-adapted simple language and presentation by culturally matched protagonists, that is from the same (Arabic) or similar (Kurdish) cultural origin, enables a better credibility of the reported facts offered in the video clips [29, also see 30]. Such strategies of using simple language and age-adapted modes of presentation as well as respected trainers have been successful, for example, in adapting trauma-focused preventive interventions for minor refugees in Germany [31].

Typical misunderstandings and fears among the Islamic community had been identified by a Kurdish journalist and blogger in social media formats like Facebook or Telegram groups [32]. The journalist advised the study team on scripting clips on myths and on the manual for the group intervention part. For example, by approaching the issue of popular misunderstandings or fears on vaccination by an Arabic physician, we expected these fears (e.g., "will I become impotent due to the vaccine?") would be better counteracted than by neutral, distant information.

## IT Infrastructure and Data collection

Two components were prepared for an adequate IT infrastructure. First, a newly connected DSL connection and a 4G router were installed in the collective accommodations where there was no or only an unstable Internet connection, with the support of the Bechtle company (as part of an unconditional sponsorship program).

The CAYPVAR app was downloaded by participants from the official Google and Apple app stores using an account provided by the project team during the baseline interview. After the initial login, the app downloaded the quiz questions.

The questionnaire-based baseline and follow-up interviews were collected on separate tablets handed to participants (intake interview) or interpreters (follow-up interview) for each interview. Interpreters were present throughout the provision of study information and the interviews. During the interviews, sociodemographic information (age, education, country of origin, religious orientation) and vaccination status was obtained. Vaccination readiness ("Do you want to get vaccinated?") was assessed with a 4-point scale ("yes, absolutely", "yes, but only with a specific vaccine", "I am still undecided", "no"). The Patient Health Questionnaire-4 (PHQ-4, [33]) was used to assess symptoms of depression and anxiety during the past 2 weeks on a 4-point scale ("not at all" to "nearly every day"). The Somatic Symptom Scale-8 (SSS-8, [34]) was employed for measuring somatic complaints during the past week on a 5-point scale ("not at all" to "very much"). The General Self-Efficacy Scale (GSE) was used to measure perceived self-efficacy based on 10 items rated on a 4-point scale [29]. A 9-item questionnaire on attitudes towards preventive behaviors against transmission and

actual engagement in preventive behaviors was obtained, which included two behaviors not feasible to mitigate transmission as retention checks (i.e., “healthy food” and “mouth rinsing”; all items are shown in the Results section). To assess knowledge of disease mechanisms and transmission paths, a 12-item knowledge test was employed, while the amount of one’s own knowledge about infectious diseases was assessed with 12 items (all items of the two tests are listed in the Results section).

Videos of the educational events were loaded (streamed) only when needed. The results of the completed quiz questions and other collected data were cached by the apps and transferred to the server when connected online. Further details on the IT infrastructure and methods for maintaining participant privacy will be published elsewhere in a separate, more technically oriented paper. In general, our apps follow the technical principles described in Pryss et al., 2018 [36].

## Add-on Face-to-Face Group Intervention

The manual of the group intervention was based on the principles of the health action process approach (HAPA) [37-38]. It is available upon request from H.C. The group intervention was designed to foster the translation of prevention intentions into actual preventive behavior by providing planning on the basis of the HAPA model [e.g., 39]. It included two components. First, action planning of preventive activities of wearing masks, washing hands, and keeping a distance (where, when, how often, how long, in contact with whom for each activity). Second, coping planning by identifying possible obstacles (e.g., what could prevent you from wearing the mask as planned? Aching ears?) and planning alternative actions (e.g., wearing a mask with a headgear).

The setting was prepared as a single group session with 8 participants at maximum lasting for up to 90 minutes. Sessions were to be conducted by D.S. with the assistance of an interpreter.

## Statistical Considerations

While planning this feasibility study, a vaccine against COVID-19 was not yet approved. However, rumours on side effects of the potential vaccines had already been spread via social media. Therefore, the baserate of the first major study endpoint, willingness to get vaccinated, was set to a very low number (2%) for power calculation. A pre-post comparison (i.e., baseline and after six weeks) of increasing the willingness to only half of the included participants would have reached a statistical power of 0.95 in a sample of  $n=8$  (Fisher’s exact test). All power analyses were performed with G\*Power 3.1.

The second major study endpoint, knowledge on disease mechanisms, was expected to reach low levels at intake (i.e., 4 correct answers in the 12-item knowledge test, with relatively large  $SD = 4.0$ ). Expecting that processing of the contents of the video clips presented via the app would enable to solve at least 8 test items (same  $SD = 4.0$ ),  $n=12$  participants would be needed to reach a power of 0.95.

In order to detect significant differences between both groups in the follow-up interview (i.e., after six weeks) with a power of at least 0.90, we expected an increase of the willingness to get vaccinated from 50% (group A) to 80% (group B). This required  $n=47$  participants in each group. For an additional increase in disease knowledge (study endpoint 2) of 3 more correctly solved items, a good statistical power (0.95) could be reached by including 40 participants per group. For analysis of group differences, t-tests for independent samples or (depending on score distribution) a Kruskal-Wallis test was planned.

## Results

### Access to the target population and enrollment of participants

During the recruitment period (October to December 2021), a total of 8 institutions (4 in Bavaria, 4 in Berlin) out of 56 collective housing facilities contacted (thereof 15 in Berlin) agreed to offer their residents the participation in the CAYPVAR study and allowed the study staff to enter the facility. The Bavarian centers were large (up to 1000 inhabitants), while the considerable smaller Berlin centers contributed 5 participants at maximum. Therefore, these small 4 institutions in Berlin were treated as one common Berlin center in comparisons of institutions. This reflects the differing legal regulations in Berlin as compared to Bavaria during the observation period.

Study enrollment proved difficult in a dynamic pandemic situation and under changing legal regulations. Collective housing institutions, especially in Bavaria with a greater number of asylum seekers living in one building, were quite reluctant to allow access to their inhabitants. Some centers even withdraw their willingness to participate in the study due to increased regional incidence rates.

The enrollment of participants started on November 8, 2021. Simultaneously to the start of enrollments, Germany's second (partial) lockdown was put into effect. During the precedent time, when information material had been prepared, the prevailing virus variant was Alpha (B.1.1.7). This had changed to the Delta variant (B.1.617.2) when the last baseline interview took place (December 16, 2021). The Delta variant had a considerably higher contagiousity than Alpha causing also a higher death toll in vulnerable persons. Therefore, collective housing facilities in Bavaria severely tightened contact restrictions, which rendered face-to-face group sessions unfeasible. In addition, various housing institutions linked their study acceptance to the precondition that all of their inhabitants should profit from the incentives (free or improved WLAN access) of CAYPVAR. Thus, randomization of participants into two groups would have been possible only as cluster randomization covering only a very limited number of housing centers. Due to the difficult enrollment situation in combination with a rapidly changing residence population (e.g., short term relocations of study participants to other regions) and tightened contact restrictions, it was decided to abandon the randomized additional intervention (group B) but solely evaluate the efficacy of the mobile app-based intervention (i.e., CAPYVAR app, group A).

The number of potentially eligible Arabic-speaking adolescents and young adults in the participating institutions was estimated by the facilities' staff at a total of 411 persons at the day of being contacted by our study team. Personal recruitment visits of the project team successfully asked  $n=146$  participants for their willingness to participate, but many of those did not show up at the agreed appointment (Figure 2). Of those having signed a written informed consent form ( $n=88$ ), 23 participants stopped their baseline interview early. Altogether 65 baseline interviews were completed ( $n=61$  males,  $n=4$  females), in all cases with the help of either a professional interpreter (three persons) or sometimes by a cohabitant speaking Arabic and German good enough for translation. At follow-up, the interviews were mostly conducted via telephone to account for contact restrictions and relocations of participants. Only the trained interpreters called the study participants in a priori fixed number (up to 8 times) and pattern (2 different daytimes) of attempts. For the following analyses, the answers of all participants who answered the respective items or interview part were included, resulting in  $n>61$  in Tables 4, 6, and 7.



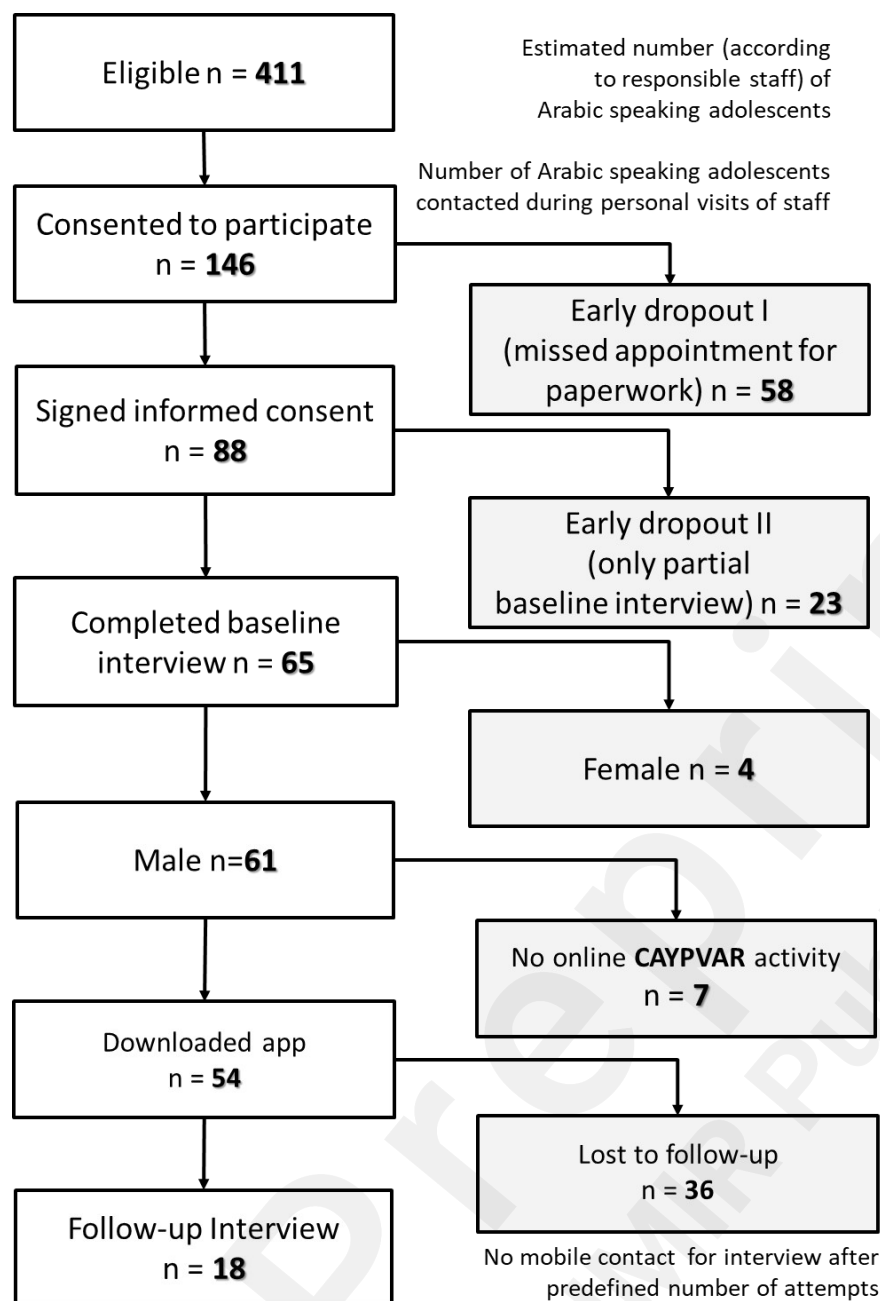


Figure 2: CONSORT Chart of Participants in Feasibility Study

## Characteristics of Study Participants

Sociodemographic and migration-related characteristics of participants are displayed in Table 2. At the baseline interview, participants were on average 24.3 years (SD = 4.5) old. Two screening instruments for participants' mental health at baseline yielded hints for a depressive disorder in 31.1 % (PHQ4 > 6; [33]) and for a "high tendency" in somatizing (SSS8 > 11 points; [34]) in 62.2% . The mean score of perceived self-efficacy [35] were relatively low in this sample. The majority participants were of Syrian origin (55.7%), with Yemen (19.7%) and Iraq (8.2%) following. The remaining participants were born in many different states of the Arabic-speaking world. Over 90% stated Islam as their religious orientation, mostly Sunni Islam (84.5%). Nearly 30% had an education of not more than 9 years of school, while 56% reported that they had visited secondary school for 13 years.

Table 2. Sociodemographic and migration-related characteristics (n=61)

	Characteristic	
	% / M	N / SD
<b>Age in years, M (SD)</b>	24.3	4.5
<b>Education in years, M (SD)</b>	11.4	2.2
<b>Country of origin, % (n)</b>		
Syria	55.7 %	34
Yemen	19.7 %	12
Iraq	8.2 %	5
Somalia	4.9 %	3
Eritrea	3.3 %	2
Algeria	4.9 %	3
Lebanon	1.6 %	1
Palestine	1.6 %	1
<b>Religious faith, % (n)</b>		
Islam	95.1%	58
Christian	1.6%	1
Other/none	3.3%	2
<b>Months since arrival in Germany, M (SD)</b>	7.1	14.7
<b>Depressive symptoms, M (SD) <sup>a</sup></b>	5.03	3.8
<b>Somatic complaints, M (SD) <sup>b</sup></b>	15.0	6.7
<b>Generalized self-efficacy, M (SD) <sup>c</sup></b>	29.6	6.6

<sup>a</sup> Assessed with the PHQ-4 [33]. <sup>b</sup> Assessed with the SSS-8 [34]. <sup>c</sup> Based on the GSE [35].

## Utilization of the CAYPVAR App

As shown in Table 3, there was a steep decrease in participation after the baseline interview. Only 54 participants downloaded the CAYPVAR app to their mobile phones with diminishing utilization tendency. A minority of less than 20% of participants watched the videos of week 3 to week 6. No participants got involved to win the award of the photo competition. The frequency of playing the online 2020game.io could not be determined, as this was an external link. A total of 26 participants clicked at least once on the link to that game.

Table 3. Usage of information material in the app and participation in gaming elements

	Participants' involvement	
	N	%
<b>Downloaded the app</b>	54	88.5
<b>Watched ≥ 1 video provided for this week</b>		
Week 1	32	52.5
Week 2	16	26.2
Week 3	12	19.7
Week 4	11	18.0
Week 5	10	16.4
Week 6	11	18.0
<b>Games and incentives</b>	32	52.5

Online game <sup>a</sup>	≥ 26	≥ 42.6
Participated in photo competition	0	0.0

<sup>a</sup> External link opened, but actual use could not be determined.

## Outcome of Major Study Endpoint I (Vaccination Readiness)

At the baseline interview, 76.5 % of participants had already been vaccinated against COVID-19. An additional 13 participants stated their willingness to get vaccinated as soon as possible. Only 3 participants were reluctant against vaccination. There were no indications of differing attitudes or behaviors between different housing facilities.

## Outcome of Major Study Endpoint II (Knowledge of Disease Mechanisms)

With regard to preventive behaviors, participants were asked about their attitudes of and engagement in various behavioral measures mitigate the spread of COVID-19 (see Table 4). In the baseline interview, all these measures were extremely favored, and participants claimed to practice these measures “always” at least by 40% of the sample. This was also true for two control measures with no or doubtful efficacy against transmission of the virus (i.e. “healthy food” and “mouth rinsing”).

Table 4. Attitudes towards preventive behaviors and engagement in preventive behaviors at the baseline interview (n=65)

	Attitude (%) <sup>a</sup>		Practiced behavior (%) <sup>b</sup>			
	Against	In favor	Never/ rarely	Sometime s	Always	Not possible
<b>Preventive behavior</b>						
... keep physical distance	5.9	94.1	7.4	29.3	47.1	16.2
... wear masks	5.9	94.1	1.5	19.1	66.2	13.2
... frequent hand washing	5.9	94.1	2.9	23.6	63.2	10.3
... frequent ventilating	5.9	94.1	7.4	20.6	58.8	13.2
... healthy food	7.4	92.6	7.5	33.6	47.1	11.8
... avoid mass gatherings	10.3	89.7	5.9	20.6	52.9	20.6
... contact free greeting rituals	11.8	88.2	13.2	19.2	52.9	14.7
... sneezing into elbow	19.1	80.9	14.7	27.9	41.2	16.2
... mouth rinsing	23.5	76.5	41.1	0	47.1	11.8

<sup>a</sup> Attitudes towards preventive (“Since the beginning of the Corona pandemic, I think it makes sense to ...”) were assessed on a 4-point scale (“applies not at all”, “applies rather not”, “rather applies”, “applies totally”). Scores were dichotomized for the analysis (i.e., “against” and “in favor”).

<sup>b</sup> Actual practice of preventive behaviors (“Since Corona, I have gotten in the habit of...”) was assessed on a 5-point scale (“never”, “rarely”, “sometimes”, “always”, “not possible in the housing facility”), while the first two categories (“never” and “rarely”) were summed up for the analysis.

As statistical power was too low for testing pre-post differences between baseline and follow-up interviews (i.e., only 15 participants were successfully matched instead of the 40 required for a power of 0.9), Table 5 gives only descriptive values on attitudes about and engagement in preventive behaviors among the follow-up interviewees. Attitudes favoring the behaviors were relatively lower, and no participant claimed to practice any of the behaviors “always”. The proportion of participants that rated themselves as hindered by their housing situation to practice the measures (column “not possible”) was relatively comparable between baseline and follow-up interviews.

Table 5. Attitudes towards preventive behaviors and engagement in preventive behaviors at the follow-up interview (n=18)

	Attitude (%) <sup>a</sup>		Practiced behavior (%) <sup>b</sup>			
	Against	In favor	Never/ rarely	Sometime s	Always	Not possible
<b>Preventive behavior</b>						
... keep physical distance	38.9	61.1	27.8	55.5	0.0	16.7
... wear masks	11.1	88.9	16.7	77.8	0.0	5.5
... frequent hand washing	27.8	72.2	11.1	77.8	0.0	11.1
... frequent ventilating	5.5	94.4	11.1	83.3	0.0	5.5
... healthy food	50.0	50.0	44.4	50.0	0.0	5.5
... avoid mass gatherings	38.9	61.1	38.9	44.4	0.0	16.7
... contact free greeting rituals	11.1	88.9	16.7	66.7	0.0	16.7
... sneezing into elbow	22.2	77.8	11.1	83.3	0.0	16.7
... mouth rinsing	33.3	66.7	33.3	55.5	0.0	5.5

<sup>a</sup> Attitudes towards preventive (“Since the beginning of the Corona pandemic, I think it makes sense to ...”) were assessed on a 4-point scale (“applies not at all”, “applies rather not”, “rather applies”, “applies totally”). Scores were dichotomized for the analysis (i.e., “against” and “in favor”).

<sup>b</sup> Actual practice of preventive behaviors (“Since Corona, I have gotten in the habit of...”) was assessed on a 5-point scale (“never”, “rarely”, “sometimes”, “always”, “not possible in the housing facility”), while the first two categories (“never” and “rarely”) were summed up for the analysis.

Concerning a possible selection bias of participants answering the follow-up interview, we found no indication of different scores with regard to mental-health measures (depression, PHQ-4; somatization, SSS-8). Of the 18 participants answering the follow-up interview, 15 participants (83%) declared they had learned new facts on COVID-19 from the physician (Dr. Khalifa) while watching the video clips via the CAYPVAR app. A high proportion (89%) expressed their trust in the physician and these new facts. Self-confidence in one’s own knowledge of disease mechanisms, though not statistically tested, tended to increase between baseline and follow-up interview on a descriptive level with one exception: participants during the follow-up interview less often stated that they had knowledge about infectious diseases (Table 6).

Table 6. Self-assessed own knowledge about infectious diseases at the baseline (n=67) and follow-up

(n=18) interviews

	Self-assessment “yes” <sup>a</sup>	
	Baseline (%)	Follow-up (%)
<b>Knowledge about infectious diseases</b>		
I know the function of the immune system.	52.2	72.2
I understand what antibodies are.	35.8	33.3
I know the difference of viruses and bacteria.	43.3	72.2
I understand what viruses are.	52.2	77.8
I know the composition of human cells.	16.4	16.7
I know how antibodies work.	22.4	27.8
I understand what DNA is.	50.8	66.7
I know the difference of DNA and RNA.	17.9	38.9
I know the replication process of viruses.	23.9	33.3
I know about infectious diseases.	52.2	38.9

<sup>a</sup> One’s own knowledge of infectious diseases (“Please read each statement carefully and check how much the statement applies to you.”) was assessed on a 3-point scale (“no”, “more or less”, “yes”).

Besides confidence in one’s disease knowledge (see Table 6), a knowledge test on potential transmission paths of three different infectious diseases (HIV, herpes, and COVID-19) yielded heterogeneous results as shown in Table 7. There was a high proportion of ignorance for all three infections, especially when transmission paths had to be excluded for a correct answer. For COVID-19, the only correct answer was to include all three pathways that were named. Thus, the alternatives “solely via the air” and “via droplets and smear infections” were wrong. In sum, correctly identified transmission paths at baseline increased slightly from 6.8 answers (SD = 2.6) to a mean value of 7.2 correct answers (SD = 1.6) at the follow-up interview. For participants answering the follow-up interview, a t-test for dependent groups was with  $t_{15} = -0.60$  not significant ( $p = 0.558$ ).

Table 7. Knowledge of disease mechanisms and transmission paths at the baseline (n=67) and follow-up (n=18) interviews

	Correct answer <sup>a</sup>	
	Baseline (%)	Follow-up (%)
<b>Knowledge of HIV</b>		
Kissing <sup>c</sup>	34.8	38.9
Hand shakes <sup>c</sup>	69.7	77.8
Blood contact (e.g., sex) <sup>b</sup>	92.4	83.3
Only men susceptible <sup>c</sup>	56.1	83.3
<b>Knowledge of Herpes</b>		
Transmission by droplets <sup>c</sup>	40.9	38.9
Sexual contact <sup>b</sup>	86.4	61.1
Only shared drinking vessels <sup>c</sup>	34.9	72.2
Only aerosols <sup>c</sup>	51.5	72.2
<b>Knowledge of COVID-19</b>		
Droplets, aerosols, smear <sup>b</sup>	95.5	83.3
No transmission beyond 2m distance <sup>c</sup>	37.8	44.4

Exclusively droplets, smear infection <sup>c</sup>	7.6	0.0
Only aerosols <sup>c</sup>	63.6	61.1

<sup>a</sup> One's own knowledge of infectious diseases ("Please read each statement carefully and check what you think is the correct answer. How are HIV/ Herpes / Corona viruses transmitted?") was assessed on a 2-point scale ("true", "not true").

<sup>b</sup> The right answer was "true".

<sup>c</sup> The right answer was "not true".

## Discussion

The CAYPVAR study aimed at imparting knowledge about COVID-19 and available vaccines by implementing a mobile-based intervention with elements from serious games. This feasibility study yielded two main results. First, the vaccination rate or readiness among participants was very high at baseline. Second, an evaluation of the feasibility of our preventive intervention strategy could not be successfully achieved with regard to knowledge of disease mechanisms and attitudes towards preventive behaviors due to the small number of participants taking part in the follow-up interview. Enrollment of participants in this study showed to be very difficult, and the dropout rate from the study among enrolled participants was high.

## Vaccination rates

The high vaccination rate reported by participants at baseline (76.5%) is in contrast to the current literature. A review of general vaccine uptake in migrant populations in Europe showed that asylum seeker or refugee status increased the risk for undervaccination [40]. Acceptance of human papillomavirus, measles, and influenza vaccines was particularly low among Muslim migrants [40]. With regard to COVID-19, a qualitative interview study with recently arrived migrants and refugees in the UK reported that 72% of participants were hesitant to uptake a COVID-19 vaccine before the start of large-scale vaccination campaigns [41]. A recent French study reported a significantly lower COVID-19 vaccination rate among precariously housed and collectively accommodated migrants than the French general population [42].

There are two possible explanations for the high vaccination rate in the current study. First, participants might have perceived staff working in their collective housing facilities as reliable state representatives and information sources and thus followed their advice to get vaccinated. Tjaden et al. [14] evaluated a Facebook campaign for COVID-19 vaccine information in a large sample of Arabic-, Turkish-, and Russian-speaking persons in Germany. In addition, they investigated the effect of the language and messenger (family, physician, government or religious authority) of the advertisements. They showed for Arabic-speaking participants that advertisements in Arabic led to more clicks on information pages and accesses to vaccination centers with online booking than those in German. Also, a state representative as messenger of the advertisements was superior to religious leaders, doctors, or family as messengers.

Second, we conducted informal talks after the baseline interviews in this study. We have learned that many participants had feared a negative impact on their asylum proceedings if they had refused to participate in the vaccination campaigns organized by staff of their collective housing facilities. A review of general vaccine uptake in migrant populations in Europe identified distrust in the health-care system and fear of being questioned about one's legal status as a barrier to accepting vaccination [40]. The opposite, that is the fear of negative impacts on one's legal status if not vaccinated, might have served as a facilitator to vaccination in the current study. In any case, the fact that the majority of participants in this study had been vaccinated seems to have diminished their motivation for gaining further knowledge on preventive measures against COVID-19 as presented in the CAYPVAR app.

## Potential reasons for insufficient feasibility

An evaluation of the feasibility of the presented intervention strategy could not be achieved due to severe difficulties with enrollment in this study. Regarding recruitment, the following two obstacles may have hampered enrollment in this study. First, there was a large contrast between potentially eligible asylum seekers living in the housing facilities and those agreeing to participate in the study. This could be explained by limited presence of asylum seekers during daytime in their housing institution during which the study team tried to make personal contact in form of a recruitment visit. But the striking difference between those individuals stating their interest to participate in the study ( $n=146$ ) and those actually signing the informed consent form ( $n=88$ ) cannot be explained by this. In several cases, participants have been relocated to another institution during the week following the recruitment visit as reported by housing staff. But it also seemed that agreeing to the invitation to participate in the study during the first recruitment visit might not have been binding enough to show up to the agreed appointment some days later. It can be speculated that refugees' "lives on hold" provoked "disintegration of time" that already in 2010 has been described in a Swedish study [43]. Early dropout during the baseline interview ( $n=23$ ) in the current study might be attributable to mistrust towards the study team, related to the fear of a possible negative impact on their asylum procedure. To counter such problems, we had to change the enrollment procedure towards conducting every baseline interview immediately after the first encounter with a potential participant instead of a separate recruitment visit beforehand.

Second, perhaps the participants in this study did not feel a "need for cognition" [33] about COVID-19 because most of them already had been vaccinated and therefore also had undergone a consultation with the vaccinating physician. This study showed limited general and Covid-related factual knowledge on infectious diseases and transmission paths of young refugees. For example, 30.3% of participants stated that HIV could be transmitted via handshakes or 36.4% claimed that COVID-19 was only transmittable via aerosols. This finding is in line with other studies on refugees' knowledge [8-10]. Kananian et al. [9], for instance, reported that Arabic- and Farsi-speaking adult refugees in Germany had less knowledge about COVID-19 than matched non-refugee participants. In addition, the fact that the majority of participants in the current study had been vaccinated could also mean that participants have felt "invulnerable" due to the vaccination and thus did not see the need to learn more about the virus and pandemic through CAYPVAR app.

Moreover, continued participation in this study was low, leading to high numbers of dropout during the intervention period and at the follow-up assessment. Lending on research on psychological interventions for refugees with mental health problems, further potential explanations for the low adherence of participants can be found. First, prominent post-migration stressors of asylum seekers are overcrowded and inadequate housing conditions or the prolonged or uncertain asylum process [e.g., 44]. A review on contextual factors on mental health outcomes of asylum seekers in Germany has identified, among other factors, living in a shared accommodation, poor language skills, and an uncertain asylum status as risk factors for psychological symptoms [45]. In the current study, all participants were waiting for their asylum request to be processed (95%) or in appeal against a rejected asylum request (5%). Psychological symptoms in asylum seekers, in turn, are associated with various difficulties, among them communication and learning problems (e.g., difficulties learning German or finding employment, [46]). Thirty-one percent of participants in the present study reported clinically relevant depressive symptoms and 62% a high somatic symptom burden. As in other studies on mental health of refugees, resulting concentration problems and therefore difficulties focusing on the video clips or short quizzes presented in the CAYPVAR app seem plausible.

Second, participants in this study had settled in Germany only recently, on average seven months ago. One could speculate that the problems of these newly settled asylum seekers (i.e., unclear residence status, precarious and temporary housing conditions, no mobile phone contracts or stable WIFI access) might have constituted specific barriers not only to enrollment but also to continued participation. Thus, the current intervention strategy might have not been feasible for the specific group under investigation, but this does not necessarily apply to other groups of asylum seekers and refugees. For example, the initial settlement period (e.g., long waiting periods for an asylum decision, collective housing conditions, short-term relocations) has been described as additional source of stress for asylum seekers [e.g., 47]. Therefore, it has been proposed to assess refugees' mental health after arrival and again after the initial resettlement period [47]. It seems plausible that refugees who had been in Germany for a longer time and had more stable living conditions (e.g., having been granted residence permits, allowance to seek employment) would have responded differently to the intervention strategy of the current study.

Third, the dropout was extremely high in this study despite precautions taken such as age-adapted information materials (i.e., video clips) and incentives in the form of quizzes and competitions. In addition, we established a cultural match between participants and assessors (DS) and persons shown in the video clips (DS and KA) and employed culture-sensitive modes of delivery of the intervention such as simple language [e.g., 29-30]. Moreover, we employed a medium degree of guidance by providing individualized feedback with the quizzes after each video clip and personal contact with the study team for the baseline- and follow-up interviews. This was based on evidence that digital interventions with at least a minimal degree of personal contact yielded greater symptom reductions than unguided interventions in adult non-refugees with depression [48]. Yet, the high dropout in this study corresponds to the one reported by Lindegaard et al. [49], which evaluated a smartphone-based cognitive-behavioral intervention for young Farsi-speaking refugees with symptoms of mental disorders. They reported a dropout rate of 80% and were thus unable to evaluate potential efficacy, concluding that their intervention was not feasible. Most important barriers to continued participation were the lack of human contact and symptoms such as concentration problems.

## Conclusions

In conclusion, the concept of the current study aimed at developing and evaluating the feasibility of a primary preventive intervention against COVID-19. The design of the study does not allow to unambiguously decide, which or which exact combination of the observed obstacles was pivotal for the low feasibility. Yet, a combination of psychological and structural reasons should be considered: a combination of sample characteristics (e.g., low need for cognition), external barriers (e.g., living conditions allowing for no retreats to watch the videos undisturbed), and a dynamic pandemic situation with rapidly changing legal regulations as a new virus variant became dominant could have fostered low involvement in this study. Due to difficulties with enrollment and continued participation, mobile app-based infotainment for providing information (i.e. the CAYPVAR app) could not be applied to an extent that could be regarded as "minimum dose" for achieving behavioral effects, even if we had a more lenient design [50]. Establishing continuously updated platforms in the first language that offer health-related tailored "infotainment" plus other practical information about the host country might be a more promising approach for the target group (e.g., [51]).

In addition, some of the obstacles encountered were beyond the study design such as the speed of spread of new variants or rapidly changing legal regulations. Also, the precarious and unstable living conditions of our target group, recently arrived young asylum seekers, could not be changed. Therefore, we do not recommend to optimize the present intervention strategy for this group, but do not rule out its potential feasibility for refugees with more stable living conditions.



Thus, we doubt the usefulness of a preventive mobile app-based intervention concept in the target group. Possibly, improvements would be reached if the focus would be shifted from behavioral (even primary) prevention to primordial prevention [52]. A simple illustration of this argument can be seen, when the size of the housing institution is less than 10 persons, as compared to collective housings with several hundred inhabitants. Already by housing people in smaller institutions, the primary prevention technique of contact reduction is unobtrusively enforced, without any educational campaign and any formal “no-contact rule” for the inhabitants. If preventive measures are thought of from rather an organizational perspective [53], this could open a more promising way of mitigating spread of disease in the target group.

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## Data Availability

The data sets generated and analyzed during the current study are available from the corresponding author on reasonable request.

## Conflicts of Interest

None declared.

## Abbreviations

Not applicable.

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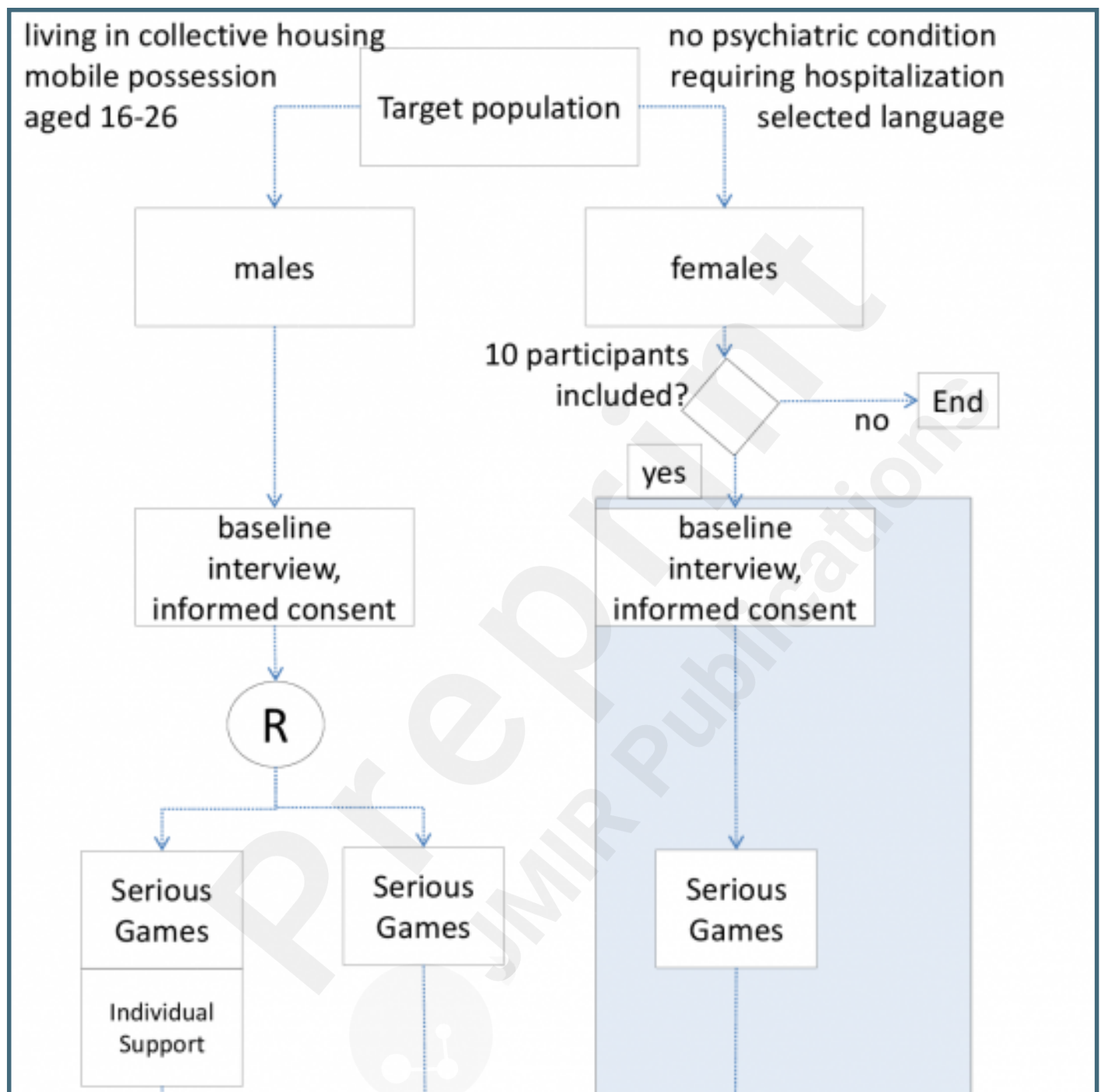
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## Supplementary Files

## Figures

## Study design.



## Study flow.

