

Security and Privacy in Physical Activity Chatbots on Social Media: A Scoping Review

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Abstract. *Background and objective:* Social media physical activity chatbots use both chatbots and social media platforms for physical activity promotion and, thus, could face privacy and security challenges inherent in both technologies. This study aims to provide an overview of physical activity chatbot interventions delivered via social media platforms, specifically focusing on security and privacy measures. *Methods:* We conducted a scoping review on this topic across 4 databases: PubMed, PsycINFO, ACM Digital Library, and IEEE Xplore. We extracted and summarised information on the author, population, country of study, social media platform, intervention, data processed (i.e. gathered or stored), and security/privacy measures. *Results:* Out of 1299 identified articles, 12 were included in the analysis reporting about 9 different chatbots. Although all chatbots applied data processing methods, only a few considered anonymisation. One paper stated compliance with the General Data Protection Regulations. Other studies enforced some verification procedures before chatbot use. *Conclusion:* Current research fails to adequately report security considerations in social media physical activity chatbot design. However, integration of chatbots into social media platforms seems to be declining, possibly due to security concerns.

Keywords. Physical Activity; Chatbot; Social Media; Security; Privacy

1. Introduction

Recent advancements in chatbot technology, like Generative Pre-trained Transformers, have popularised and underscored the limitless potential of chatbots in various domains, including promoting physical activity [1,2]. Unlike previous chatbots that were mostly

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rule-based, current chatbots harness Artificial Intelligence (AI) methods like machine learning and natural language processing to mimic human conversations and perform tasks [3]. However, several chatbot limitations exist, including privacy and security concerns related to the collection and storage of user data [4].

Integrating social media into interventions aimed at promoting physical activity has proved to enhance the efficacy of such interventions [5,6]. Nonetheless, the use of social media poses challenges, such as individual preferences for various platforms and the lack of control over privacy and security policies on commercial platforms [5]. Social media physical activity chatbots use both chatbots and social media platforms for physical activity promotion and, thus, could face privacy and security challenges inherent in both technologies. Furthermore, users may inadvertently divulge sensitive information during chatbot interactions, posing risks to their privacy [7]. Despite laws like the General Data Protection Regulation (GDPR) [8], there remains scant evidence of health intervention chatbots integrating adequate privacy and security measures. This study aims to provide an overview of physical activity chatbot interventions delivered via social media, specifically focusing on security and privacy measures.

2. Methods

We performed a scoping review following the PRISMA extension for scoping reviews (PRISMA-ScR) [9]. DL conducted searches across PubMed, PsycINFO, ACM Digital Library, and IEEE Xplore concurrently on 12th February 2024. The search strategy [10] comprised these keywords: [“conversational agent” OR “virtual agent” OR “chatbot”] AND [“physical activity” OR “exercise” OR “fitness” OR “physical fitness”]. The search did not include language or year limitations. Search results were exported to Endnote 21 to remove duplicates. Further duplicate removal and article screening were carried out in Rayyan. DL conducted the initial screening, including articles if they were primary intervention studies involving a chatbot for physical activity and human participants. Articles were excluded if they only described a technical implementation or not primary studies. To avoid missing studies on unfamiliar social media platforms, DL excluded studies on chatbots not integrated into a social media platform during the full-text screening. The reference lists of included articles were searched for additional publications. All uncertainties during screening were clarified with KD. We extracted and summarised the following: Author, Population, Country, Social media platform, Intervention, Data processed (i.e. gathered or stored), and Security/Privacy measures.

3. Results

The four database searches identified 1299 articles. After removing duplicates and screening titles and abstracts, 36 publications qualified for full-text screening. Of the 36 publications, 12 were included in the review. These 12 articles comprised 512 references that underwent title and/or abstract screening. Only one article underwent full-text screening and was subsequently excluded. See [10] for list of rejected articles and PRISMA flowchart. A summary of the included studies is presented in Table 1.

The 12 included studies, published between 2019 and 2023, targeted adults aged 18 years or older across diverse locations: Australia [11-13], Netherlands [14], Japan [15], Singapore [16], Norway and Switzerland [17,18], South Korea [19,20], New Zealand

[21] and Not reported [22]. Nine chatbots were identified, with intervention durations varying, most lasting 12 weeks [11,12,15,19]. Regarding social media platforms, four chatbots – CoachAI [22], MYA [17,18], an adapted just-in-time walking coach chatbot [14], and a chatbot system including a tracking app [21] - were integrated into Telegram. Additionally, two chatbots – Precilla [16] and Ida [13]- were integrated into Facebook Messenger, while one each - an AI-assisted chatbot, Paola, and Healthy Lifestyle Coaching Chatbot - was integrated into LINE [15], Slack [11,12], and KakaoTalk [19, 20], respectively. The majority of the chatbots (5/9) leveraged AI: machine-learning algorithms [14,22], natural language processing [11-13] and unspecified AI methods [15].

Table 1. A summary of the 12 included studies

Author/Year	Country	Social media	Data processed	Security/Privacy measures
Collombon 2023 [14]	Netherlands	Telegram	All data obtained and stored anonymously	GDPR-compliant data exchange between intervention software and chatbot database
Fadhil 2019 [22]	Not reported	Telegram	All data collected and anonymised	No ethical approval or informed consent information
Larbi 2021 [18]	Norway/	Telegram	Unencrypted non-personal data collected and stored using Google Sheets	All collected data treated confidentially
Larbi 2022 [17]	Switzerland			
Wlasak 2022 [21]	New Zealand	Telegram	Chatbot feedback based on Google Fit data. Data stored using pseudonyms	No personal identifiers retained; all data treated confidentially
Dhinakaran 2021 [16]	Singapore	Facebook Messenger	Not specified	Not Specified
To 2021 [13]	Australia	Facebook Messenger	Fitbit activity data synced to chatbot to monitor progress	Chatbot connection via secure verification process. Collected personalisation data only accessible to research team
Anan 2021 [15]	Japan	LINE	Not specified	Quick response code and passcode to access program
Davis 2020 [11]	Australia	Slack	Automatic record and download of interactions to Microsoft Excel	Unique identifying number assigned when Slack account created
Maher 2020 [12]				
Piao 2020 [20]	South Korea	KakaoTalk	Completed action pictures uploaded to chat room	Connect to chatbot via a QR code. Edited posted pictures before sharing
Piao2020b [19]				

Apart from three studies [12,15,16], all studies provided information about the data collected and stored during the chatbot use. Two studies implemented procedures to anonymise collected data [14,22], and one used pseudonyms to safeguard anonymity [21]. The studies employed various data processing methods: Google Sheets for storing unencrypted non-personal data [17,18], automatic recording and downloading of chatbot interactions to Microsoft Excel [11], uploading pictures to a chat room [19,20], and

synchronisation of activity data from wearables like Fitbit [13] and Google Fit [21] with the chatbot for monitoring and feedback. One study [22] lacked mention of ethical approval or informed consent, while another [14] explicitly stated adherence to GDPR for data exchange between the intervention software and the chatbot database. Other studies enforced some verification procedures prior to chatbot use: a quick response code and passcode [15], unique identifying number [11,12], QR code [19,20], and unspecified secure verification process [13]. Two studies ensured confidentiality by not collecting personal data [17,18] and one by not retaining personal identifiers [21].

4. Discussion and Conclusions

Twelve studies comprising nine social media physical activity chatbots were identified in the literature search. Most chatbots used AI methods and were integrated into Telegram, Facebook Messenger, LINE, Slack, and KakaoTalk. Only one study explicitly reported compliance with a data protection regulation for data exchange with the chatbot database. Most studies enforced verification procedures before chatbot use, while others refrained from collecting or retaining personal data.

In our review, we found that most studies did not provide a detailed report of the development and processing of data by the social media physical activity chatbots. Similarly, reviews of chatbots for lifestyle behaviour changes have identified issues such as lack of details on the development process and ethical considerations, including privacy [1,3]. In instances where reporting was done, insufficient measures were used to ensure privacy [2,3]. Likewise, a review of chatbots for public health noted the lack of reporting security issues [23]. Nevertheless, in the studies in this review, diverse security and privacy measures were implemented, albeit sometimes insufficient. The included studies are fairly recent, which could explain the observed ethical awareness.

We found very few studies, all carried out in Europe or the Asia-Pacific region. The fact that most social media platforms hosting the physical activity chatbots did not originate from the study country raises questions about third-party access to and storage destination of user data. It also raises questions about factors that influence the choice of the social media platform, such as ease of integration, costs associated with hosting the chatbot and target population preference. There is a scarcity of resources that provide practical guidance to researchers on using social media in health intervention delivery [5]. Information about such factors could help future researchers make decisions on developing social media physical activity chatbots to facilitate behaviour change.

Notably, many studies were published during the COVID-19 pandemic (8/12 studies between 2020 and 2021). Social media physical activity chatbots could have been the preferred intervention to overcome challenges like lockdowns and remote intervention delivery, given the minimal security concerns then. Afterwards, there seems to be a decline in development of physical activity chatbots on social media platforms, possibly due to increased government scrutiny like social media bans [24] and investigations [25].

Although we searched four databases and the included studies' references, we might have missed relevant publications. Social media chatbots, leveraging the benefits of both technologies, can offer a cost-effective way to promote physical activity globally. Yet, existing research lacks adequate reporting of security measures in such chatbot designs, questioning their safety. Establishing standards for development and reporting that prioritise privacy from the outset could ensure the safe use of social media for physical activity promotion.

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