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Knowledge, usability, and impact of wearable fitness devices among community exercisers in Ghana

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Abstract

Background There has been a rapid evolution of wearable technologies such as wearable fitness devices (WFDs) in recent years globally. The continuous release of upgraded WFDs with diverse qualities presents new opportunities for research into their knowledge, usability, and impact in developed countries. Although few studies have separately examined the knowledge, usability, and impact of WFDs in Sub-Saharan Africa, more information is needed on combined knowledge, usability, and impact of smart WFDs among Ghanaians. The present study (1) assessed the knowledge, usability, and impact of WFDs among healthy community exercisers, and (2) investigated the factors that affect the usage and barriers to the use of WFDs in Ghana.

Methods The quantitative descriptive design study had 152 healthy community exercisers (mean age = 23.37 ± 5.18 years) as participants. Self-structured questionnaire and System Usability Scale were administered.

Results There were more non-users of WFDs (73.7%) than users (26.3%). Knowledge on WFDs among participants was high, usability was poor (mean SUS score = 66.87 ± 13.67) among users, and a positively fair impact on users was obtained. Performance expectancy was among the other factors that affected the usage of WFDs and price value was among the significant barriers identified.

Conclusion There are more non-users of WFDs than users. Knowledge on WFDs among participants was high, usability was poor among users with positively fair impact on users.

Keywords Exercisers, Impact, Knowledge, Usability, Wearable fitness devices, Wearable technologies

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Introduction

Recent years have seen a rapid evolution of Wearable Technologies (WT) around the globe. It has retained the stance as the number one trend since it was first introduced in 2016 on the Worldwide Survey of Fitness Trends by the American College of Sports Medicine's (ACSM) Health & Fitness Journal® with a few exceptions of experiencing a drop to number three trend in 2018 and also a drop to number two in 2020 [1].

WT have been defined "as those products worn on the body of the user for extended periods of time with the experience of significant enhancement as a result of the product being worn" [2]. A component of these WT is Wearable Fitness Devices (WFDs), which has gained popularity in recent years due to the enormous increase in brands, with more devices being released having supplemental sensors [3]. Most available WFDs promise to measure physical activity variables in novel and much more enhanced approaches using various sensors and algorithms to determine anthropometrics on the grounds of sensor outputs [3, 4].

Wearable sensors are a vital part of WFDs and have been reported as "already revolutionizing the healthcare landscape" [5], classified into three [3] categories: biochemical, physiological and mechanical [6], and are being used to enhance healthcare within and outside traditional healthcare settings, through a wide range of consumer to clinical to research grade devices [5].

Biochemical sensors are frequently used in clinical applications for sensing pH, glucose, alcohol, electrolyte, oxygenation [5]. Physiological sensors utilize a wide range of electrical, optical, and thermal sensing components to determine vital signs such as heart rate (HR), blood pressure (BP), and temperature; bodily functions such as gut and respiratory activities; and bioelectrical activities such as electrocardiogram (ECG), electromyograph, electrodermal activity [5]. Sub-categories of physiological sensors like photoplethysmography (PPG) are commonly used in the detection of HR through changes in thin tissue light absorbance, while bioimpedance sensors are perceived to be useful in the detection of stress and emotions through changes in electrical resistance of neural tissues [5].

Moreover, mechanical sensors commonly use components of inertia measurement units (IMUs) to estimate human translational and rotational motion, biaxial accelerometers to determine planar movements, triaxial accelerometers to measure three-dimensional (3D) movements, gyroscopes to measure rotation and magnetometers to determine relative position [5]. Other mechanical sensors like global positioning systems (GPS) and altimeters are in use today in obtaining exact positioning in space during movement and correction of drift errors [5].

Several WFDs are already in the wearable devices market. In 2019, a total of 336.5 million wearable devices were shipped worldwide by vendors, representing a yearly growth rate increase of 89.0% as compared with the 178.0 million devices shipped in 2018 according to data from the International Data Corporation's (IDC) Worldwide Quarterly Wearable Device Tracker [7]. Additionally, total shipments for just the third quarter of 2020 reached 125 million.

Surprisingly, these data presented recognize WFDs among the popular categories of the market. For instance, the fourth quarter of 2019 data (18.9 million device shipments) indicates that wrist-worn devices, which include smartwatches and wristbands, captured 43.8% of the total market. These WFDs brands are shipped by top companies such as Apple, Xiaomi, Huawei, Samsung, and Fitbit, presented as the top five companies, respectively, by shipment volume, market share, and year-over year growth according to the third quarter of 2020 data by IDC [7]. Other available brands include Garmin, Misfit, Jawbone, Polar, Withings, Mio [3, 8].

WFDs include fitness or activity trackers, smartwatches, HR monitors, GPS tracking devices, smart wrist/arm bands, among others. A recent narrative systematic review showed that WFDs have been designed for use on all human body parts and can be used by or among children, older adults, patients, and pregnant women for real-time monitoring and determining HR, BP, energy expenditure, position, gait, walking speed, posture, respiratory rate, blood oxygen, among other human readable parameters [9]. Another important group of people who uses WFDs is healthy individuals who want to track their daily lifestyle activities including exercise sessions to control their health [10].

The WFDs landscape is in constant change as new devices and brands are released into the health and fitness market. The release of these new devices and brands and upgrades in device quality of existing ones, present new opportunities for research. From the extant studies reviewed, it is evident that several international studies [11–42] have been conducted focusing on different research areas of interest to WFDs. However, at the time this study was conducted, there has not been any such study on smart WFDs in the Ghanaian and limited in the Sub-Saharan Africa region. Therefore, this study will make relevant contributions to the body of knowledge by filling the research gap in understanding the knowledge, usability, and impact of WFDs among healthy community exercisers in this population. Now, examining the end-user of a technology is the ultimate answer to whether the technology will be useful or usable in the way intended [2]. And because of the dynamism of the WFDs market in the health and fitness industry, it is significant to have a consistent flow of evidential data to support wellness and fitness practitioners' decision making and policy restructuring. This way, practitioners and industry players can keep pace with new devices with upgraded quality and additional sensors. Hence, the main objectives of the study were to (1) assess the knowledge, usability, and impact of WFDs among healthy community exercisers in Ghana, and (2) investigate the factors that affect the usage and barriers to the use of WFDs.

Materials and methods

Study design

A quantitative descriptive design was used in this study. This design was purposely chosen for the study such that the variables studied can be quantified and described from the findings of the study in an easy-to-understand manner, to allow readers to appreciate the results.

Participants

One hundred fifty-two healthy community exercisers in Ghana with age range of participants who were 18–52 years (Mean age = 23.37, SD = 5.18) were recruited for the study. Participants' distribution was across 12 out of the 16 regions in Ghana with the majority in Ashanti Region (75.66%) and Greater Accra Region (11.84%). The highest education status of participants ranged from Senior High School (SHS) Certificate to PhD (Table 2). Study has shown that WFDs are designed to help consumers achieve their fitness goals/health outcomes [2], hence, it is significant to carry out such a study among end-users who are the primary target of these devices and who are likely to purchase these devices to help them take control of their lifestyle and daily workouts. Healthy community exercisers who use WFDs and non-users who are exercisers were included in the study. All other users and non-users of WFDs who non-exercisers are were excluded from the study. This study focused on WFDs, smart wearable devices applicable to wellness and fitness for physical activity and exercise tracking, monitoring, and management. It excludes mobile health (mHealth) Apps, automated websites for health measurements, and digital platforms for health data capturing and sharing.

A purposive sampling was used in this study. Healthy community exercisers in Ghana were asked to respond to a survey questionnaire designed for both online accessibility and hardcopy. The participants verbally consented and expressed willingness to participate in the study, signed informed consent form as part of requirement for ethical approval by the Committee on Human Research, Publication and Ethics, School of Medical Sciences, Kwame Nkrumah University of Science and Technology (Ref: CHRPE/AP/046/22).

Questionnaire

A close-ended survey was used with 'other/specify' options where necessary, to allow robust insights into the variables being studied while mitigating the bias associated with using this survey. The questionnaire on knowledge of WFDs (Appendix 1) was designed to assess whether participants have used WFDs, know how WFDs work, got to know about WFDs, get information on these devices, brands they know and device(s) from these brands that the user category of participants are using currently to achieve their fitness goals/health outcomes. The questionnaires were designed to meet the research objectives and to provide appreciable answers to the research questions since at the time this study was being conducted, there was no standard questionnaire available for assessing knowledge.

Usability of WFDs questionnaire (Appendix 1) was adapted from the System Usability Scale (SUS) [43]. In the SUS, participants scored themselves in 10 items

Table 1 Data reliability test results

Construct	Cronbach's Alpha (α)
Knowledge	0.54
Usability	0.78
Impact	0.87
Usage factors	0.71
Barriers to usage	0.31

Table 2 Demographics information of participants

	Freq	(%)
Age (year)		
Mean ± SD	23.37 ± 5.18	
Gender		
Male	110	72.40
Female	42	27.60
Highest Education Status		
Senior High School (SHS)	24	15.79
Diploma	8	5.26
University Degree	119	78.29
PhD	1	0.66
Region of Respondents		
Ashanti Region	115	75.66
Ahafo Region	2	1.32
Bono Region	3	1.97
Bono East Region	1	0.66
Central Region	3	1.97
Eastern Region	3	1.97
Greater Accra Region	18	11.84
Oti Region	1	0.66
Upper East Region	3	1.97
Volta Region	1	0.66
Western Region	1	0.66
Western North Region	1	0.66

Freq Frequency, % Percentage

with one of five responses that range from Strongly Disagree to Strongly Agree. A five (5) item questionnaire was designed to assess the impact of WFDs using a 5-point Likert-Type Scale with response options from Strongly Disagree to Strongly Agree since at the time of the study, there was no available questionnaire related to this study to assess the impact of WFDs. Therefore, the designed questionnaire has been made available (Appendix 1) and proposed for further testing of its effectiveness and reliability for use in further studies. The factors affecting or influencing usage as well as barriers to usage of WFDs investigated in this study (Appendix 1) were selected from several available literature that have reported findings on them [27, 28, 31–33, 35].

The instrument has 5 constructs that are independently related and were analysed separately with the reliability test results shown in Table 1.

Table 3 Participants Knowledge on WFDs Usage and know-how results

	Freq	(%)
Have Used WFDs		
No	112	73.7
Yes	40	26.3
Know How WFDs Work		
No	31	20.4
Yes	85	55.9
Not Sure	36	23.7

Statistical analysis

Google form was used in the collection of online responses. Microsoft Excel and Statistical Package for Social Sciences (SPSS) version 26.0 were used for data preparation and analyses. A descriptive statistical analysis was conducted on the data and results presented using frequency distribution tables, mean, standard deviation, percentages, and bar charts.

Ethical approval

Ethical approval was obtained from the Committee on Human Research, Publication and Ethics, School of Medical Sciences, Kwame Nkrumah University of Science and Technology (Ref: CHRPE/AP/046/22).

Results

Most of the participants were male (72.4%), had a university degree (78.29%), and lived in Ashanti region of Ghana (75.66%) as shown in Table 2. Table 3 reveals that 26.3% had used WFDs while 55.9% had the knowledge of how WFDs works. Figure 1 shows that 68.3% of the participants have more knowledge of Apple and Samsung brands of WFDs and were mostly used (see Table 4) to achieve the needed fitness goals/health outcomes. From Table 5, most participants got to know about WFDs on social media (53.52%) and website (28.64%) as well as got information on the device through the same platforms (49.32% and 33.03%) respectively.

The average SUS score is 68, which implies that, in terms of percentile ranking, a SUS score of 68 is 50th percentile [44]. A SUS score above 68 is considered above average and < 68 as below average. Therefore, the results of this study showed that 50% of the WFDs users have

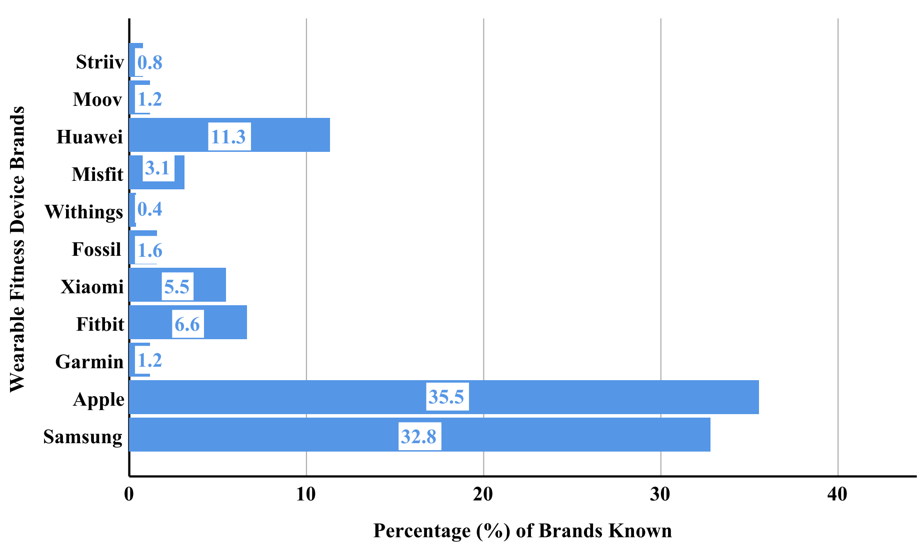

Fig. 1 A graph of WFDs brands known among participants

Table 4 WFDs currently used by the user category of participants

WFDs Used	Responses[a]	
	Freq	(%)
Samsung Galaxy Fit 2	13	34.21
Apple Watch Series 6	11	28.95
Garmin Vivosmart 4	1	2.63
Fitbit Charge 4	6	15.80
Techno Fitness Watch	1	2.63
Fossil Gen 5 Smartwatch	1	2.63
Withings Steel HR Sport	1	2.63
Oraimo	1	2.63
Apple Watch SE	1	2.63
Huawei Band 4 Pro	1	2.63
Apple Watch Series 5	1	2.63

[a] Multiple response

Table 5 Knowing and sourcing info on WFDs

Get Information on WFDs	Responses[a]	
	Freq	(%)
Website	73	33.03
Social Media	109	49.32
Television	39	17.65
Got to know about WFDs		
Website	61	28.64
Social Media	114	53.52
Television	38	17.84

[a] Multiple response

Table 6 The frequency of participants under each SUS score, the grade, and the adjective ranking of the scores

SUS Score	Grade	Adjective Rating	Frequency
> 80.3	A	Excellent	5
68 – 80.3	B	Good	15
68	C	Okay	0
51 – 68	D	Poor	14
< 51	F	Awful	6

a SUS score above average and 50% below average (see Table 6). But the mean value of their SUS scores and standard deviation was found to be 66.87 ± 13.67, which is below the recommended average, indicating a poor usability among users according to the adjective ranking.

Out of the participants who were users of WFDs, 32 (80%) had an average impact score above 3 (which is the neutral or undecided scale value) while 8 (20%) had an average impact score from 3 and below. But the mean value of their impact scores and standard deviation was 3.79 ± 0.74 which indicates a positively fair impact of WFDs on users. Depicted in Table 7 above is the distribution (frequency and percentage) of participants' responses to the impact of WFDs questionnaire.

As depicted in Fig. 2, performance expectation (20.9%), price value (17.3%), and personalization (14.5%) were factors that influenced the usage of WFDs. Price value (46.5%), however, stood out as the main barrier to the usage of WFDs (see Fig. 3 above).

Discussion

Findings showed that 55.9% had knowledge of how WFDs work (see Table 3) and obtained information on WFDs through social media (49.32%) (see Table 5). This outcome confirms that social media has become a popular platform that many people use daily for accessing handy information. Website and television were found to be other sources of information on WFDs. Therefore, the knowledge on WFDs among participants can be said to be high; which is contrary to the findings of [17, 25].

The results of this study showed that 50% of the WFDs users have a SUS score above the recommended average of 68 and 50% had a SUS score below average. But the mean value of their SUS scores and standard deviation was found to be 66.87 ± 13.67, which is below the recommended average, indicating a poor usability among users according to the adjective ranking (see Table 6). This outcome aligns with the findings of [18]. Most extant studies investigated user experience, which is a component of usability in general and found some positive results [12, 20, 39]. It was found that 80.0% of WFDs users had an average impact score above 3 (which is the neutral or undecided scale value) while the remaining (20%) had an average impact score from 3 and below. But the mean value of their impact scores and standard deviation was found to be 3.79 ± 0.74, which is indicative of a positively fair impact of WFDs on users. This positive outcome also aligns with the findings of [22, 24].

Findings indicate that performance expectancy, price value, and personalization were the most influential factors affecting the usage of WFDs (see Fig. 2), keeping consistency with previous research [26, 27, 31–33, 35]. This outcome disagrees with some previous research that found price value to be an insignificant factor influencing usage or adoption intentions [27, 29, 31]. Other factors found to be of some significances are compelling design or device appearance [28], operationality, wearability, social influence [27, 31, 35] and privacy concerns.

Again, the outcome of this study disagrees with some previous studies that found social influence as a trivial factor having insignificant association or influence on usage or adoption intentions [29, 30] as well as privacy

Table 7 Distribution of Participants' Responses to Impact of WFDs

Statements	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
The wearable fitness device helped and is helping me to achieve my fitness goal	1 2.5%	1 2.5%	5 12.5%	21 52.5%	12 30.0%
I feel the wearable fitness device has become part of my daily lifestyle	1 2.5%	4 10.0%	13 32.5%	14 35.0%	8 20.0%
I become more conscious of my health whenever I use the wearable fitness device	- -	5 12.5%	11 27.5%	16 40.0%	8 20.0%
I had positive health outcomes using the wearable fitness device	- -	4 10.0%	14 35.0%	15 37.5%	7 17.5%
I would like to use this wearable fitness device and any of such devices again to improve my health	1 2.5%	2 5.0%	3 7.5%	24 60.0%	10 25.0%

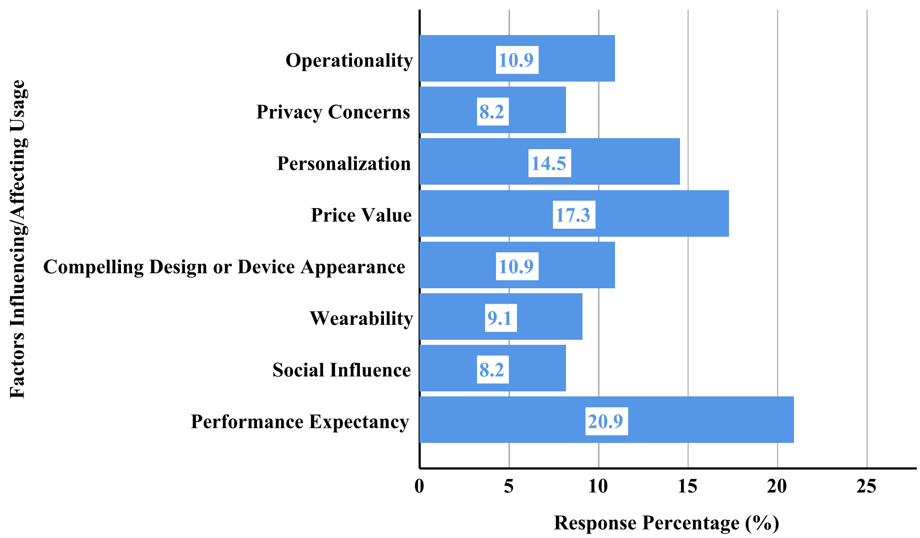

Fig. 2 Factors affecting or influencing the usage of WFDs

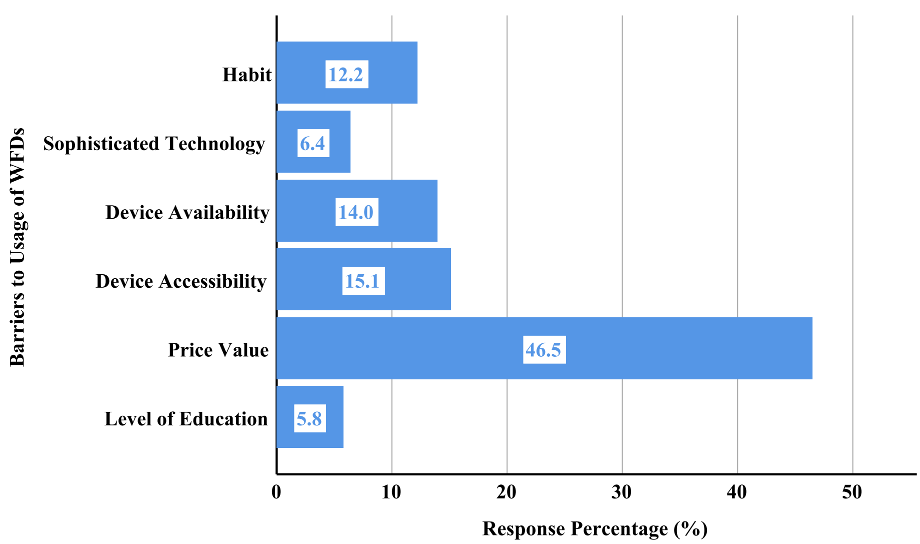

Fig. 3 Barriers to usage of WFDs

concerns [27]. The most influential factors found in this study shed light on the value consumers of WFDs perceive prior to their intention to use, which can be related to any technological and health product on the market as consumers buy for the ultimate value they can get from products. In fact, all factors investigated, in a way, have an influence on the usage of WFDs.

The study investigated barriers to usage construct among non-user category of participants to understand further their reasons for not using WFDs despite the knowledge they have on its promising benefits and found price value to be the greatest barrier to usage of WFDs (see Fig. 3). Participants perceived WFDs to be expensive. [29] found the factor described in their study as *expensiveness* to have an insignificant association with usage or adoption intentions, which this current finding disagrees with. Price value was found in this study to be both an influencing factor and a barrier to usage. As a barrier, it is more specifically due to expensiveness. Other factors such as device accessibility, device availability and habit were found to be significant. In terms of device availability and accessibility, it is reflective of how WFDs are not readily available and accessible on the Ghanaian market. Previous studies [27, 31, 32] found habit as a factor influencing adoption intentions, but the current study investigated it further and found it to be more specifically, a barrier. To clear doubts or confusions, barriers to usage can be argued to be similar or the same to factors influencing or affecting usage in context, but it was purposely separated in this study to give a more specific insight. Sophisticated (complex) technology and level of education were found to be trivial and less significant.

Conclusion

There are more non-users of WFDs than users. Knowledge on WFDs among participants was high, usability was poor among users, and has a positively fair impact on users. Performance expectancy, price value, and personalization were the most influential factors affecting the usage of WFDs. On barriers to usage of WFDs, the price value was the greatest. Other factors such as device accessibility, device availability, and habit were found to be significant barriers to usage. In terms of device availability and accessibility, it is reflective of how WFDs are not readily available and accessible on the Ghanaian market. Efforts should be made by manufacturers to reduce barriers to usage or adoption intentions to increase usage and acceptance of WFDs. Fitness practitioners should develop a thorough knowledge and understanding of WFDs to encourage and help their clients to choose and use WFDs effectively to increase usability and impact. Promotional efforts on WFDs should be well targeted to increase awareness as increased awareness could benefit adoption intentions.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s44247-023-00018-z.

Additional file 1. Appendix.

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This work was completed as part of the employment of the authors at the Kwame Nkrumah University of Science and Technology, Kumasi, Ghana.

Authors' contributions
Conceived and designed the analysis (J.K.W, C.A., B.O.A.,M.O.M), Collected data (J.K.W, C.A., B.O.A., O-L.O.L.,M.O.M), Performed data analysis (J.K.W, C.A., B.O.A., M.O.M), Wrote the initial manuscript (J.K.W, C.A., O-L.O.L.,M.O.M), Supervised the study processes (C.A., B.O.A., O-L.O.L.,M.O.M), Reviewed the initial manuscript for submission (J.K.W, C.A., B.O.A., O-L.O.L.,M.O.M). The authors read and approved the final manuscript.

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Availability of data and materials
The data used to support the findings of the study can be obtained from the corresponding author upon request.

Declarations

Ethics approval and consent to participate
Ethical approval was obtained from the Committee on Human Research, Publication and Ethics, School of Medical Sciences, Kwame Nkrumah University of Science and Technology (Ref: CHRPE/AP/046/22). Participants were included in the study after the authors had sought their verbal informed consent and willingness to participate. In addition, all methods and procedures were carried out in accordance with relevant guidelines and regulations including that of the university aforementioned.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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