A Model of personalized Mobile Persuasive System for Malaria Prevention and Control in Africa

Ignatius Nwoyibe Ogbaga, John Otozi Ugah

Abstract— Records made available by the World Health Organization (WHO) indicated that malaria-related deaths have remained on the increase since 2015 till date [1]. The worst affected are usually the pregnant mothers and their children within the age of five years. Sub-Saharan Africa has remained the leading edge with Nigeria maintaining the lead position with 25% mortality rates [1]. The above statement of facts animated this research. This research focused on developing a model of mobile persuasion system that will influence people to undertake positive health behaviors as it relates to malaria prevention and control within their environment. The research design was accomplished using user-centered design (UCD) approach. A total of 105 participants were recruited and trained for this study. The responses obtained from our survey instrument was mapped into the appropriate persuasive strategies and then harmonized to develop the model proposed in this study.

Index Terms— Malaria, eHealth, positive health behavior, persuasive strategies, personalized reminders, Positive health behaviour, User Centered Design (UCD).

—————————— ◆ ——————————

1 INTRODUCTION

Malaria remains one of the major public health diseases in sub-Saharan Africa, contributing significantly to the high morbidity and mortality rate in the region. It is a parasitic disease primarily caused by plasmodia of various types – plasmodium ovale, plasmodium malaria, plasmodium vivat, and plasmodium falciparum [2]. Out of these four species of plasmodia, Plasmodium falciparum which is produced by female anopheles mosquitoes is said to cause the severest malaria illness and death throughout the world [3]. Plasmodium falciparum has been identified as being the most devastating parasite in Nigeria [4]. The malaria parasites are transmitted into the human blood via the bite of the female anopheles mosquitoes [5] [6].

Malaria infection in pregnancy compromises the health of the mother and can lead to the death of both or either the mother or the baby [7]. In 2018 alone, an estimate of 11 million pregnant women living in 38 countries of Africa got infected with malaria; an equivalent of 29% of the global pregnancies of that year. Malaria in pregnancy could also impair the health of the fetus, which can eventually lead to preterm (premature) birth and low birth weight, which is a major contributor to neonatal and infant mortality. WHO African Region accounted for 93% of all cases in 2018 where more than half of all cases were in six African countries: Nigeria 25% of the cases; the Democratic Republic of Congo 12%; Uganda 5%; Côte d'Ivoire, while Mozambique and Niger accounted for 4% each (WHO, 2019). This devastating report on malaria cases led the WHO to make recommendations on malaria prevention which include the use of insecticides chemical spray and compulsory sleeping under an Insecticide Treated Net (ITN) [7].
Moreover, the proliferation of mosquitoes with its ever-modifying genetic makeup has increased their resistance to all known malaria drugs thereby increasing malaria-related deaths. Chemotherapy is becoming a second option owing to

the above statement. The major option should be prevention because prevention is generally better than cure.

Some health-related technologies called persuasive technology (PT), a branch of human-computer interaction (HCI) have been deployed by technology-health experts in solving several health-related problems. PT has proven its effectiveness at influencing behavior change in various health domains. For example, researchers have developed systems to help people stop smoking [8] [9], lower the amount of energy they consume [10], manage chronic diseases [11], eat healthily [12] and [13]. Research has also shown that some health-related challenges are better managed than treated because treatment is usually costlier with the accompaniment of pains and discomfort, [14].

This is why an eHealth-based intervention technology must be used to reinforce people's behavior to adopt a positive attitude to health, most especially as it relates to malaria prevention and control. This health intervention technology will serve as an active motivation system. This technology has been used in medical rehabilitation to increase access to therapy for patients who live in geographically isolated areas, increase the intensity of home therapy programs and improve follow-up and communications with patients [15] and is working without impediments.

2 RELATED WORK

The study of how technology can be designed to motivate behavior change has been of interest to both researchers and industry practitioners. The founder of Persuasive Technology (PT) research domain, B. J Fogg defined it as a computing system, device, or application intentionally designed to change a person's attitudes or group of person's behaviors in a prede-

termined way without using coercion or deception [16]. It has been argued that technology is never neutral; it has always influenced people in one way or the other [17]. The conscious and mindful application of various persuasive techniques in PT design to influence human behavior in an intended way differentiates PT from other technologies that may influence people as a result of its use. For instance, people buying umbrellas because of the rainy season is not persuasive because the change in weather is a natural phenomenon but Angela changing her hairdo because of an advert she saw on television or billboard is persuasive.

In the last few years, several PT interventions have been developed with the potential of promoting users' behavior in several domains, including marketing, health, safety, security, and environmental sustainability [9] [10] [18] [12]. Marketing is the first domain and probably the domain with the most salient applications. Generally, in the marketing domain, PTs are designed to motivate customers to purchase products and services by automating a variety of strategies into one intervention. The most popular of these strategies is tracking and monitoring: PTs are designed to track consumers' online activities and their preferences across multiple stores and recommend products and services to customers based on their interest [19][20]. This is achieved using the browser cookies history, user profile, and user clicking events in a particular e-commerce website.

Security and safety (SS) is another significant domain of application of PT. In this domain, PTs are employed to promote security and safety to prevent accidents. For instance, *DriveRS* is a persuasive mobile application for discouraging young drivers from over speeding [21]. Environmental sustainability is yet another significant field of application of PT to motivate people to preserve or maintain the natural ecosystem. An example is "*UbiGreen*" [22], a technology that motivates users to ride on a bicycle instead of a car by depicting the carbon emission from the car and its effect on the ecosystem.

Security and safety (SS) is another significant domain of application of PT. In this domain, PTs are employed to promote security and safety to prevent accidents. For instance, *DriveRS* is a persuasive mobile application for discouraging young drivers from over speeding [21]. Environmental sustainability is yet another significant field of application of PT to motivate people to preserve or maintain the natural ecosystem. An example is "*UbiGreen*" [22], a technology that motivates users to ride on a bicycle instead of a car by depicting the carbon emission from the car and its effect on the ecosystem.

2.2 Relevance of Persuasive Technology in Malaria Control

Persuasive practices are as old as the existence of mankind

- *Ignatius Nwoyibe Ogbaga is lecturer in the Department of Computer Science, Ebonyi State University, Nigeria, PH-234 7066663858. E-mail: ogbagaignatius@gmail.com*
- *Co-Author John Otozi Ugah is a Senior Lecturer with the Department of Computer Science, Ebonyi State University, Abakaliki, Nigeria. PH-234 8037959012. E-mail: ugahjohn@gmail.com*
  (This information is optional; change it according to your need.)

which can only come to reality once the persuadee(s) interest is sufficiently motivated. Persuasion is biblical, Genesis 1:26 "Let us make man in our image, after our likeness" (Holy Bible). Whenever we communicate with a clear intended outcome, we are engaging in persuasion [23]. This plays out whenever we engage in an argument, trying to convince our argumentator to believe in our ideology. Early research on persuasion focused on human-to-human persuasion, in form of a face-to-face discussion between the persuader(s) and the persuadee(s). Therefore, persuasive researchers concentrated on addressing methodologies aimed at changing the mental state of the persuadees through communication [24].

Discovering the fact that similar to human persuader, computing technologies can be designed to bring about the same constructive changes in human behaviors. This has led to an increasing interest in various ways of designing technology to influence human behaviors.

However, our proposed system through its persuasive techniques will deploy some persuasive strategies that will sufficiently motivate and persuade users to imbibe and adopt positive health behavior through its daily customized and real-time text messages reminders that are sent to every user at a time that is most convenient for them-just-in-time notifications.

3 RESEARCH METHODS

We evaluated factors hindering people from engaging in positive health behaviors concerning malaria preventive measures and the impact of mobile technologies to offer guidelines for designing a mobile intervention to encourage positive health behaviors. The study adopted multiple methodological approaches otherwise known as triangulation. The researchers used qualitative content analysis, survey, and interview. We used semi-structured interviews to understand the factors which influence positive health behaviors as they relate to malaria prevention and control. The interview involved 50% of our respondents– 20% of which are community health workers (nurses and doctors) from local health facilities and 30% pregnant women and nursing mothers.

For the survey, some pregnant women and nursing mothers were selected from three local government in Ebonyi state through a convenient sampling technique. The questionnaire was designed with minimal user-typed inputs to minimize data entry errors. The questions were formed in simple English Language for easy understanding and self-administration purpose but where the respondents could not read, oral administration was used by the researchers.

Moreover, the research questions focused on some major issues such as the hindrances militating against the adoption of positive health behaviors as it relates to malaria prevention and control and the motivational strategies that could be used to nudge out those negative tendacies. The researchers sought answers to the following questions as they relate to malaria control. The questions include:

   i.   *Ownership of ITN*

ii.   *Forgetfulness in using ITN,*

iii. *Ignorance of malaria preventive measures,*

iv.   *Are there any Religious and cultural factors affecting people from adopting malaria preventive measures?*

We adapted the questions from (Rachel et al., 2015; David et al., 2018) and modified them to suit the domain of our study; malaria prevention and control. On the way forward, the researcher requested possible remedial suggestions from the respondents. Such suggestive questions include:

i.   *Do you have a mobile phone?*

ii.   *What kind of phone do you have?*

iii. *Would you like someone to remind you to use your ITN?*

iv.   *What time would you like to be receiving the message?*

v.   *How often do you want to be receiving the message?*

vi.   *What type of notification message do they prefer?*

To enable the deployment of appropriate persuasive strategies in the research design some questions were equally incorporated. Such questions include:

i.   *What motivates you?*

ii.   *Do you get motivated by a friend's actions (social learning)?*

iii. *Do you get moved by what you saw online or read on the pages of the newspaper?*

iv.   *Do you get motivated by an advertisement on radio/television?*

v.   *How often do you use your mobile phone?*

These questions helped in eliciting the right information from the respondents for effective research design and prototype development. It is noteworthy that there are so many persuasive strategies by Fogg and Oinas Kokkonen but you cannot exhaust all of them in one research [25]. You can only adopt the ones that are closely related to your study.

With the above in mind, the research is aimed at developing a tailored personalized intervention system that delivers tailored text messages precisely at the point of decision in response to the needs of the user at that particular moment-otherwise known as a just-in-time message. We applied the participatory system design (PSD) approach to create such a tool. Our target audiences are selected people from Abakaliki, Ebonyi State Nigeria who are to serve as pilot respondents.

4   RESULTS

The result of this study revealed thus:

i.   factors such as lack of motivations, discomfortness, forgetfulness and belief system prevent people from sleeping under ITN

ii.   Phone reminders, persuasion, phone calls, social media notifications and face-to-face interactions can be used to motivate people to perform an expected actions.

iii. Strategies such as rewards/gifts, praises and watching others perform an action are persuasion strategies.   (1)

5   DISCUSSIONS

The research question number one sek to determine the number of people that have ITN from among 105 recruited participants. The outcome of this showe that only 58% of them have ITN while 44% of those that have it make use of the net. The reason for not using the net varies. While 81 complained that they don't feel comfortable sleeping under the net, 15% just affirmed that they just hate using the net. The researcher further inquird to know the reason behind the low compliance. The following results were obtained.
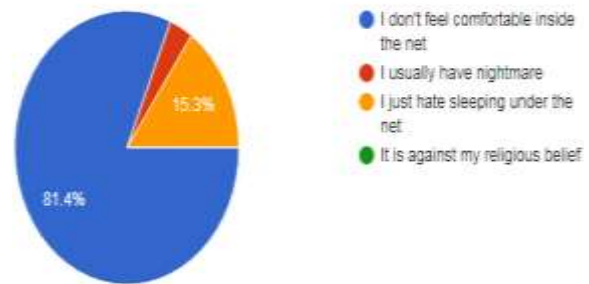

Fig. 1.

Reason behind non usage of ITN

From figure 1 above, 81% of respondets don't usually sleep under their net because of lack of comfortabiliy while sleeping while 15% just hate sleeping the net. There was no reason for the hatred. The remaining 4% claimed that they usually have nightmare each time they sleep under the net. The design implication for this must target user acceptance. The technology must address the users' attitudes and perceptions over the intervention system. This research addressed this through enlightment on how to handle/treatment of ITN before usage. This is because improper treatment could lead to discomfort during usage.

The second research question sought to determine the number of those who normally forget to set their ITN before going to bed. Responses were gathered and after analysis, 53% indicated that they usually forget to setup their net. Many of hem could not even remember when last they used their mosquito net. The design implication for this is the integration of a reminder system in the model intervention system. The User Cetered Design approach we employed alluded to this fact.

The third research question was to determine the participants' knowledge on malaria preventive measures. This is to guide the research to understand the primary motives of the participants. The result of the analysis of the data collected on this subject indicated that 45% still belived that malaria is a normal sickness. The design implication of this is to develop a technological intervention system that educates the population in ore to change the perception.

Finally, the fourth research question sought to find out if there is any religious or cultural practices that discourages people from complying with established malaria preventive measures. The research was unable to establish any because none of the respondents alluded to it.

5.1 Proposed Design Model

Since the research employed UCD approach, the paicipant suggested the kind of intervention system they would expect. This was realized from our question *"woud you like someone o remind you to use your ITN?"* this approved consent informed the choice of technologica model for his research. The result obtained from this question indicated that 50% of the respondents are interested in being reminded.
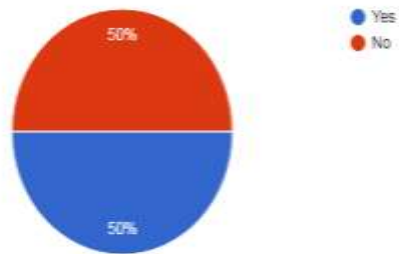
Fig. 2. Participants that want reminder

The research furthered to determine the kind of notification system they preferd. This is to help achieve higher acceptability after he deign. Secondly, since the intervention would be deployed through a technological device, the choice of uch device would be determined by the type of intervention system the users want. Howver, the result obtained indicated that 51% preferred text message notifications, 21% prferred phone call while 14% each preferred face-to-face and WhatsApp message notifications.
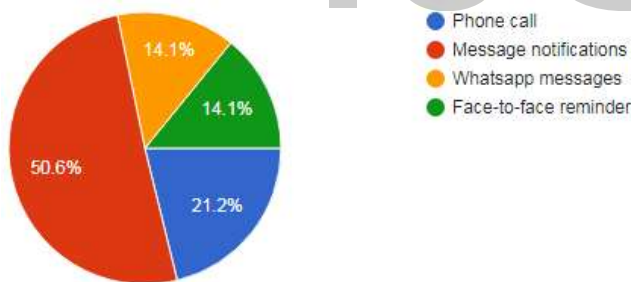

Fig. 3. Choice of technological intervention

This informd our mobile phone as the deployemt device for this model. Research has indicated that majority of the people now own an operate mobile phone both in rural and urban communities.

6.4 Choice of Persuasive Strategies

To ensure that proper persuasive strategies were adopted in the technology design, certain questions were incorporated into our research design. Since the research employed a user-centered design approach, the targeted audiences were made to be part of the system design. So, some questions were designed to ascertain their motivating factors. These questions are to animate our persuasive strategies such as personalization, customization, reward, praises and social learning.
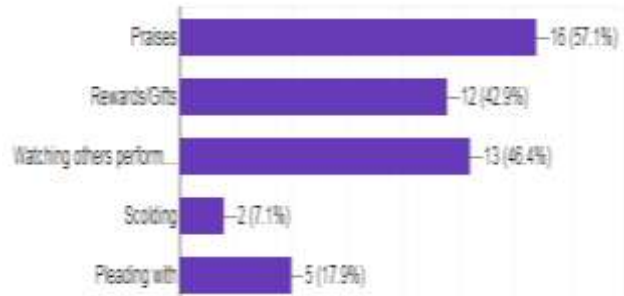

Fig. 4. Motivating factors

The result of user responses showed that 57% of the respondents are motivated by praises strategy, 46% are motivated by watching others act (social learning), 42% are motivated by rewards/gifts strategy while 18% are motivated by being pleaded with (petting). These responses help us to map user motivations to their corresponding strategies. These were adequately incorporated in our persuasive reminders to the target audiences.

4 CONCLUSION

The purpose of this study is to propose a model intervention sysem that could be deployed in the area of malaria prevention and control. This technology focused on user behaviour change through persuasion. To achive the aim of this study, the factors preventing people from engaging in positive health behaviors as it relates to malaria prevention and control was first of all addressed. This was achieved through a focused user study involving some selected participants under a convenient sampling technique. The design of our proposed model was realized using user-centered design approach where our selected participants were engaged in an in-depth interview and survey. Their responses animated our system design proposition.

ACKNOWLEDGMENT

REFERENCES

[1]   WHO (2020) World malaria report 2020: 20 years of global progress and challenges ISBN 978-92-4-001579-1 (electronic version) ISBN 978-92-4-001580-7 (print version) © World Health Organization 2020

[2]   Federal Ministry of Health and National Malaria Control Programme, Abuja, Nigeria, Strategic Plan 2009-2013 "A Road Map for Malaria Control in Nigeria". Abridged Version, Yaliam Press Ltd Abuja Nigeria.

[3]   Federal Ministry of Health (2003). Malaria Control in Nigeria.

[4]   Federal Ministry of Health (2004). Malaria Control in Nigeria: A strategy for Behavior Change Communication, 2004-2005

[5]   Ahmad, T., Hussain, A., and Ahmad, S (2013). Epidemiology of Malaria in LalQilla. Int. J. Sci. Tech.Res., 2(11): 199-202,

[6] Aribodor D. N., Ugwuanyi I. K., and Aribodor O. B (2016). "Challenges to Achieving Malaria Elimination in Nigeria." *American Journal of Public Health Research*, vol. 4, no. 1: 38-41. DOI: 10.12691/ajphr-4-1-6

[7] WHO (2019) World malaria report 2020: 20 years of global progress and challenges ISBN 978-92-4-001579-1 (electronic version) ISBN 978-92-4-001580-7 (print version) © World Health Organization 2019

[8] Dijkstra, A (2006). Technology Adds New Principles to Persuasive Psychology: Evidence from HealthEducation. *Proceedings of the International Conference on Persuasive Technology*, (2006), **16** – 26.

[9] Khaled, R. Culturally-Relevant Persuasive Technology (2008). *A thesis submitted to the Victoria The University of Wellington*

[10] Bang, M., Torstensson, C., and Katzeff, C(2006). The Powerhouse: A Persuasive Computer game designed to Raise Awareness of Domestic Energy Consumption. *Proceedings of the International Conference on Persuasive Technology*, (2006), 123–132

[11] Brownson, R.C. and Kumanyika, S. (2007). Obesity Prevention: Charting a Course to a Healthier Future: *Handbook of Obesity Prevention*. Springer US, 515–528.

[12] Orji, R., Vassileva, J., and Mandryk, R.L. LunchTime (2012): a slow-casual game for long-term dietary behavior change. *Personal and Ubiquitous Computing*, 10.1007/s00779–012–0590–6. *The University of Wellington*,

[13] Ignatius I. O and Ifeyinwa A. A (2021). Co-Designing a Mobile Intervention to Support the Prevention and Control of Malaria in Low-Middle- Income Communities in Nigeria. *International*

[14] Ogbaga I, Makuochi N, Ajah I. and Rita O (2021). Co-Developing With the Victims: A Persuasion System to Address the Behavioural Delinquencies of Africans towards Malaria. EasyChair preprints November 28, 2021. DOI: 10.13140/RG.2.2.20631.50081

[15] Peretti, A., Amenta, F., Tayebati, S. K., Nittari, G., & Mahdi, S. S. (2017). Telerehabilitation: Review of the state-of-the-art and areas of application. *Journal of Medical Internet Research Rehabilitation and Assistive Technologies*, 4(2), e7. https://doi.org/10.2196/rehab.7511

[16] Fogg BJ (2003) Persuasive technology: using computers to change what we think and do.
Morgan Kaufmann Pub, Los Altos

[17] Oinas-Kukkonen, H. and Harjumaa, M (2008),. A systematic framework for designing and evaluating persuasive systems. *Proceedings of the International Conference on Persuasive Technology*, (164–176

[18] Grimes, A., Kantroo, V., and Grinter, R.E (2010) Let's play!: mobile health games for adults. *Proceedings of the 12th {ACM} International Conference on Ubiquitous Computing*, ACM 241–250.

[19] Khaled, R. Culturally-Relevant Persuasive Technology (2008). *A thesis submitted to the Victoria The University of Wellington*,

[20] Kaptein, M (2012). Personalized persuasion in Ambient Intelligence. *Journal of Ambient Intelligence and Smart Environments 4*, 279–280. http://iospress.metapress.com/index/8673017ML2543812.pdf.

[21] Bergmans, A. and Shahid, S (2013). Reducing Speeding Behaviour in Young Drivers Using a Persuasive Mobile Application. *Human-Computer Interaction. Applications and Services*, (2013), 541–550.

[22] Froehlich, J., Dillahunt, T., and Klasnja, P (2009). UbiGreen: investigating a mobile tool for tracking and supporting green transportation habits. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, (2009), 1043–1052

[23] Torning, K., Hall, C., and Oinas-kukkonen, H (2009). Persuasive System Design: State of the Art and Future Directions. *Information Systems*

[24] Guerini, M., Stock, O., and Zancanaro, M (2007). a Taxonomy of Strategies for Multimodal Persuasive Message Generation. *Applied Artificial Intelligence 21*, 2 (2007), 99–136.

[25] Orji, R., Nacke, L.E., DiMarco, C (2017). Towards Personality-driven Persuasive Health Games and Gamified Systems. Proceedings of the SIGCHI Conference on Human Factors in Computing Systems.