Original Article

Evaluating scope of mobile technology for bridging health care gaps in impoverished population in LMICs

Dharamjeet S. Faujdar[1], Manmeet Kaur[2], Tarundeep Singh[2], Sundeep Sahay[3], Rajesh Kumar[4]

[1]Department of Community Medicine, Armed Forces Medical College, Pune, Maharashtra, [2]Department of Community Medicine and School of Public Health, Post Graduate Institute of Medical Education and Research, Chandigarh, [4]State Health System Resource Center, Department of Health and Family Welfare Government of Punjab, India, [3]Department of Informatics, University of Oslo, Norway

Abstract

Background: mHealth has potential to improve health care delivery but little is known about its effectiveness on health amongst marginalized communities. This study was carried out to determine the scope and usefulness of mHealth implementation in underprivileged slum population. **Material and Methods:** A cross-sectional study was carried out in an urban slum of Northern India where the government primary health care facility was digitized and mHealth component was integrated into the system to improve the health care service delivery. The survey was conducted using a pre-tested questionnaire among 921 persons who were sent SMSs within the last 2 months prior to survey to assess the reach and acceptability of mHealth in the underprivileged slum populations, and the role it can play to improve the healthcare services provided through primary health care facility. **Results:** In the surveyed population majority (59.8%) were young (18–30 years), females (79.3%), Hindu (94%) belonged to Scheduled caste (77.8%) and a significant percentage of them were illiterates (30%). Mobile phones were available with 87% of the surveyed population and more than 50% had smartphones. Though, only 59.5% of individuals confirmed the receipt of SMS, a very high proportion of survey population (98.3%) were willing to receive health-related SMS. About 72% individuals received SMSs and remembered the content of the message. Adherence to health advise sent through SMS was significantly higher among females (OR = 2.4 (95% CI: 1.2,5.1), $P = 0.01$), those who read messages themselves (OR = 1.9 (95% CI: 1.0, 3.3), $P = 0.03$), and who received SMS more than once in a month (OR = 2.2 (95% CI: 1.2, 4.2), $P = 0.01$). Majority of those who received SMS (83%) expressed that the health-related SMS were beneficial to them. **Conclusion:** mHealth has high potential to improve reach and increase accessibility of health care services for marginalized communities.

Keywords: eHealth, health promotion, information technology, mHealth, mobile phone, short message service, urban slum

Introduction

To develop an effective healthcare system, the delivery of healthcare has to move beyond the traditional methods of healthcare delivery.[1] In healthcare, digital health is now widely used to facilitate patient communication, improving diagnosis and treatment, and better data management. The use of technology also becomes important because of the shortage of health workforce and poor distribution of health services.[2,3] Technologies based innovative methods for healthcare delivery have rapidly evolved in the last decade due to widely introduced high-speed Internet and ubiquitous mobiles phone ownership. Even in developing countries like India the Internet and mobile

Address for correspondence: Dr. Dharamjeet S. Faujdar, Department of Community Medicine, Armed Forces Medical College, Pune, Maharashtra, India.
E-mail: vintoof5@yahoo.com

Received: 02-05-2021 **Revised:** 05-07-2021
Accepted: 12-07-2021 **Published:** 31-01-2022

Access this article online

Quick Response Code:

Website: www.jfmpc.com

DOI: 10.4103/jfmpc.jfmpc_809_21

How to cite this article: Faujdar DS, Kaur M, Singh T, Sahay S, Kumar R. Evaluating scope of mobile technology for bridging health care gaps in impoverished population in LMICs. J Family Med Prim Care 2022;11:90-6.

usage has grown tremendously in the last decade. As per Internet and mobile association of India there are about 456 million mobile Internet users and wireless subscription has already crossed one billion mark as per Telecom Regulatory Authority of India (TRAI) report of December 2017.[4]

An effective and efficient communication method has been argued to be fundamental and critical for delivery of healthcare.[5] The rapid advances in mobile technologies and applications has given rise to new opportunities for the integration of mobile health into digital health services. Now mobile technology is not expensive, majority of the population have mobile phones although it is mainly used for communication purpose. Its potential can be exploited in health communication because of its faster and wider reaches. The mobile technologies are actively pursued in many low- and-middle income countries (LMICs) to support health services as it has taken health care beyond the premises of health facility, opened avenues for outreach in remote areas and has given access to health information anywhere and wherever needed.[6]

Many digital health initiative around the world are focused on mobile technologies and is being referred as mHealth which is "use of mobile devices in administering healthcare services". Global Observatory for eHealth has defined mHealth *as "medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants (PDAs), and other wireless devices.*[7,8]

The mHealth services have often being used for treatment compliance, community mobilization, appointment reminders, health promotion, raising health awareness, information access, patient monitoring, health surveys data collection, mobile patient records, surveillance, and decision support systems.[8]

The mHealth is viewed as a feasible way to target the current challenges of poor lifestyles and mHealth services may complement health services to reduce high-risk behaviours through health promotion and improved measures of primary prevention.[9] Although there is no established design process for SMS behavioural intervention, the six steps behavioural intervention process i.e. (1) needs assessment, (2) specifying performance and change objectives, (3) selecting theory-based intervention methods and practical applications, (4) designing and organizing the intervention, (5) specifying adoption and implementation plans, and (6) generating an evaluation plan, can provide a framework for designing behaviour change intervention.[10,11]

As per World Health Organization, Global Observatory on mHealth, 60% of developed countries and 30% of LMICs have reported using Short Messaging Service (SMS) messages or other mobile health communication tools for improving treatment compliance.[11] Systematic reviews have indicated that SMS messages and other technology-based methods for communicating with patients following visits to health centres can improve physiological outcomes and health behaviours.[8]

There are several studies where use of SMS in health services had led to improvement in attendance, adherence, risk factors, chronic disease follow-up and adoption of healthy life styles.[6,12,13] However, very few studies have evaluated their effectiveness in poor and underprivileged slum population where most of the people are daily wagers, live in overcrowded unhygienic condition and health remains the last priority in their mind.[6]

This study was aimed at understanding the reach and acceptability of mHealth in the underprivileged slum populations, and the role it can play to improve the healthcare services provided through primary health care facility.

Methodology

This study was carried out in an urban slum population of northern India, where an integrated health information system for primary health care (IHIS4PHC) using an open and free software DHIS2 tracker was installed in the government primary health care facility. The IHIS4PHC application was installed on a local server and was designed to cover all health services provided by the health care facility such as Registration, OPD, Pharmacy, Maternal child health services and services provided under various other national health programmes e.g. NPCDCS and RNTCP.[14] To improve the follow-up and to impart health education (targeted and non-targeted) Short Message Service (SMS) functionality was integrated into the IHIS4PHC system and SMS gateway from Mobile Seva (a Government of India undertaking) was subscribed. A need assessment was made based on the profile of the patients/clients registered with the system. Hypertension, diabetes, tobacco addiction, anemia in pregnancy, antenatal and postnatal care, immunization, care in childhood diarrhoea and delayed diagnosis of tuberculosis were identified as important health conditions requiring health intervention in the community. The SMSs based intervention modality was incorporated into the system to bring about behaviour change in the community. The SMSs were developed in easy to understand local language [Figure 1].

The system sent two types of SMSs, one for sending reminders of scheduled appointment i.e. whenever a beneficiary/patient was scheduled for a visit, the system sent an individualized message to the person one day prior to the scheduled visit. The second type of messages were non-individualized targeted health promotion messages sent to various groups of patients such as all the hypertensives, diabetics, tobacco addicts, anaemic antenatal cases, and children under 5 years of age enrolled in the system. The schedule and frequency followed for sending health education SMS is shown in Table 1.

The IHIS4PHC had 22353 persons enrolled from the community which accounted for 89.4% of total population, of them 13784 (61.6%) were adults. The system had 13190 (59%) records of persons, who had registered their mobile number with the system and out of these 4064 (18.2%) registered mobile numbers

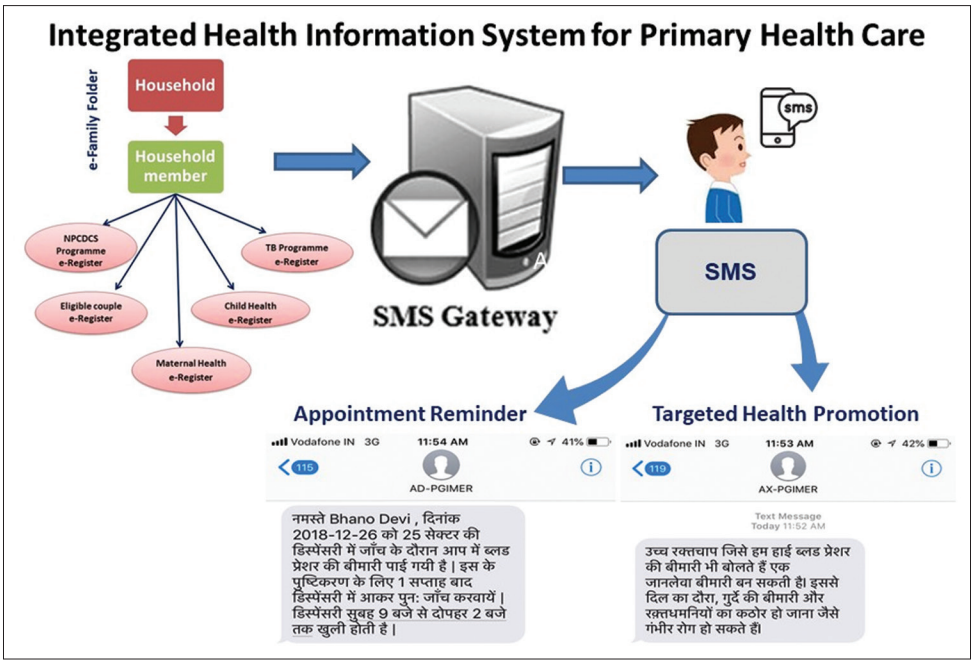

Figure 1: Automated SMS in local language sent through IHIS4PHC

Table 1: SMS schedule in IHIS4PHC

To whom	Type of Message	Frequency
Hypertension cases	Adherence message	once a week
	Promotional message	once a week
Anemia in pregnancy	Adherence message	once a week
	Promotional message	once a week
Mother with children under 5 years of age	Promotional message for use of ORS & Zinc in diarrhoea	once in two week
	Promotional message on vaccination in children	once in two week
Antenatal case	Promotional message	once in a two week
Tobacco users	Promotional message	once in a week
Presumptive TB	Reminder for testing	once in a 2 week
Automated appointment SMS	Reminder for visit (antenatal & postnatal care, anemia in pregnancy, immunization, follow-up for hypertension, diabetes etc.)	one day prior to scheduled visit

were unique. Every month SMSs were sent to approximately 750 persons enrolled under various health modules of IHIS4PHC, i.e. maternal health, child health, non-communicable disease, and presumptive tuberculosis cases.

The readiness, reach and adherence to SMS advice was studied by conducting a cross-sectional survey among the person who were on follow-up from the government primary health care facility.

Sample size: Assuming adherence for SMS-based health advice to be 75 percent in the population,[15] the minimum sample size at 95% level of confidence, 3% margin of error and finite correction (N = 750) was calculated as 388 persons. Considering that a person will be able to recall SMS sent over the last 2 months, it was decided to include all persons in the population who were sent a system-generated SMS for either schedule appointment or for health promotion in the last 2 months (November–December 2018) prior to the survey.

Inclusion criteria: Person residing in area which falls under the health cover of government primary health care facility for at least last 6 months and to whom an SMS has been sent through IHIS4PHC in the month of November and December 2018.

Exclusion criteria: Persons to whom failure of delivery of SMS is reported through IHIS4PHC.

A structured questionnaire validated for face and content validity by public health experts was used for the conduct of the study. This questionnaire was pilot tested in a different area having similar population characteristics. Three field investigators were trained over a period of 3 days at the health centre by the researcher for questionnaire-based interviewing of the participants in the community after taking their informed consent. The data was collected on tablets using kobotoolbox field data collection application and the study was completed over a period of 2 weeks. The data was analysed using descriptive statistics and Chi-square method for test of significance using

statistical software STATA version 14. The study was approved by the Institutional Ethics Committee of PGIMER, Chandigarh vide their letter no. INT/IEC/2017/195 dated 23/08/2017.

Result

Among various categories of persons on follow-up through SMS-based system it was observed that high percentage of clients enrolled under RCH programme had their mobile numbers registered (92%–100%) in comparison to person enrolled under other programs (74.6%–88.2%). In total 7895 SMS were sent to 1361 patients/clients during the study period of which SMSs delivery to 1072 (78.7%) patients/clients got confirmed through SMS gateway report of IHIS4PHC. SMS delivery confirmation varied from 78.3% to 92.9% among clients enrolled under RCH programme while it varied from 56.5% to 78% among clients enrolled under other programmes such as National Programme for Prevention and Control of Cancer, Diabetes, Cardiovascular Diseases and Stroke (NPCDCS) or Revised National TB Control Program (RNTCP) [Table 2].

Characteristics of SMS survey respondents: The report of confirmed SMS delivery sent through the system was obtained from the IHIS4PHC over the last 2 months prior to the start of survey. On removing the duplicates due to enrolment of same person in different health programmes 921 persons were identified for inclusion in survey. During the conduct of survey, out of the identified 921 persons, 36 (3.9%) persons were found to have shifted from the area, and 197 (17.9%) person could not be contacted even after three visits were made to their houses on different occasions. The remaining 720 (78.2%) persons could be interviewed using a pretested structured questionnaire.

The socio-demographic characteristic of surveyed population revealed that majority (59.8%) were young (18–30 years), females (79.3%), Hindu (94%) and belonged to Scheduled caste (77.8%); a significant percentage of them were illiterates (30%) and majority were homemakers (78%) [Table 3].

Readiness and reach of SMS in population: In the study survey it was observed that 87% of the individuals had their own personal mobile phones, and 54.3% had been using smartphones. A very high percentage of surveyed population (98.3%) was willing to receive SMS on their mobile phones but only 59.5% of individuals confirmed the receipt of SMS [Table 4].

Among those who confirmed receipt of SMS, 38.5% read the SMS by themselves, while it was read out to them by other family members in 60.2% of the cases. About the frequency of SMS, 62% informed that they received SMS once a month while 26% confirmed receipt of SMS more than once in a month. Among those who had received the SMS, 71.9% remembered the contents of SMS, and 69.6% confirmed that they followed the health advice given in the SMS [Table 5].

Factors associated with adherence to SMS messages: It was found that age, literacy and personal mobile possession had no significant association with adherence to health education messages sent through SMS; while female gender, self-reading of SMS, and receipt of more than one SMS per month has significant association with adherence to health education messages [Table 6].

Among the recipients of health-related SMS, 355 (83%) participants reported that receiving health-related SMS had benefitted them. Out of them, 106 (29.7%) reported that it added to their health knowledge, 114 (32.1%) informed about increase in specific health-related knowledge, i.e. care of child and hypertensive diet, 78 (22%) informed that it motivated them to follow the advice, 57 (16.2%) told that now they are more careful about their health.

Discussion

The healthcare transformation with the help of technology is empowering patients to take better care of their health. Individual studies on mHealth have shown improvement in childhood vaccination, timely uptake of tests, health care practices, utilization of facility-based health services,[16-18] but the readiness, reach and acceptability of mHealth especially in resource constraint setting has not been adequately studied. The study assumes importance as improving access to health care and bringing health care behaviour change in underprivileged population require constant communication between the primary care physician and those in need of health care using innovative methods and tools, and mHealth seems to have that potential.[9]

This study explored the usefulness of mHealth in reaching out to underprivileged population and its acceptability in such population. It was observed in the study that all the women clients enrolled in the Reproductive child health programme had their

Table 2: SMS delivered to various categories of person on follow up during study period (2 months)

Programme	Category	Follow-ups	Mobile number registered *n* (%)	SMS delivery confirmation *n* (%)
RCH Programme	ANC cases	332	332 (100)	308 (92.9)
	PNC cases	74	74 (100)	68 (91.8)
	Child Immunization & diarrhoeal disease	383	358 (92.1)	280 (78.3)
NPCDCS Programme	Hypertension	254	210 (82.6)	164 (78.0)
	Diabetics	145	128 (88.2)	103 (80.4)
	Tobacco users	327	244 (74.6)	138 (56.5)
RNTCP Programme	Presumptive TB cases	15	15 (100)	11 (73.3)

Table 3: Socio-demographic characteristics of the respondents

Characteristics	(*n*=720) *n* (%)
Age group (years)	
18-30	431 (59.8)
31-60	258 (35.8)
>60	31 (4.2)
Gender	
Male	149 (20.7)
Female	571 (79.3)
Religion	
Hindu	677 (94.0)
Muslim	34 (4.7)
Sikh	7 (1.0)
Other	2 (0.3)
Caste Schedule Caste	561 (77.8)
Schedule Tribe	27 (3.7)
Other Backward Class	49 (6.8)
General Caste	84 (11.6)
Education Illiterate	218 (30.0)
Primary	131 (18.1)
Middle	132 (18.3)
Higher/Secondary	191 (26.4)
Graduate/Postgraduate	49 (6.8)
OccupationHomemaker	562 (78.0)
Working	135 (18.5)
Retired	3 (0.4)
Student	1 (0.1)
Unemployed	19 (2.6)

Table 4: Status of mHealth readiness

Variables	Total *n*	*n* (%)
Personal mobile phone	720	
Mobile phone type		627 (87)
(i) Featured phone		329 (45.7)
(ii) Smart Phone*		391 (54.3)
Willing to receive SMS	720	707 (98.3)
Usage of mobile	720	
(i) Dialling and taking calls		709 (98.5)
(ii) Read, write & send SMS		391 (54.3)
(iii) Use WhatsApp on mobile		331 (46)
(iv) Use Facebook on mobile		309 (43)
(v) Use email on mobile		38 (5.3)
Confirmed Receiving SMS	720	428 (59.5)

*94% of the smartphone users had Internet connection

Table 5: Assessment of mHealth ac cess and its impact

Variables	Total *n*	*n* (%)
SMS read by		
Self	428	165 (38.5)
Family Member		258 (60.2)
Other		5 (1.3)
Frequency of SMS		
Once/Month	428	264 (62)
More Than Once/month		110 (26)
Don't remember		54 (12)
Remember SMS Content	428	308 (71.9)
Adherence to SMS message instructions	428	298 (69.6)

mobiles registered with the IHIS4PHC, possibly because many schemes have incentives linked to them and the Auxiliary Nurse Midwives/Accredited Social Health Activist providing primary health care are more oriented towards provision of these services.

Despite being underprivileged slum population possession of personal mobile phones was found to be quite high in this community. Other studies have also reported high mobile phone rates even in low socio-economic population. Studies from Delhi, Bangalore, Puducherry have found personal mobile phone possession to be 81.6%, 87% and 76%, respectively, while willingness to receive mHealth communication was 78%, 99% and 50%, respectively, in these studies.[19-21] In a study on mDiabetes 75.6% of the participants understood and tried to follow the health advice sent through text message, which was similar to this study.[15]

In this study, the receipt of SMS was found to be 59.5%, which was higher than observed in a study on use of text message service under Mother and Child Tracking System (MCTS), where receipt of SMS was confirmed by only 14% of the pregnant women. The study had cited low education, mobile phone possession and language of SMS to be a major barrier for receipt of SMS.[22] A study done in slum residents of Kenya had observed that although 94% of the study population was willing to receive SMS but only 38% actually reported receiving them.[23]

In this study, willingness and acceptability for SMS was found to be high. Adherence to SMS-based health advice was significantly higher among females, those who read messages themselves, and who received SMS more than once in a month. Majority of those who received SMS expressed that these were beneficial to them. It has been suggested that for marginalized populations with the poorest access to care SMS-based interventions can be preferred modality to provide an equitable access to health care.[23]

Mobile-based SMSs has emerged as a powerful tool for social and behavioural change communication as it is widely available, inexpensive, instant, allows access as per personal convenience and can be easily modulated to match the socio-cultural norms of the community.[24] The SMSs in this study were based on formative research related to community health needs, and were modelled in such a way that it matched the content and delivery approach to the local context.[25] The SMSs provided an effective medium that can fulfil the cross-cutting factors requirements for behavioural change at individual level as described under socio-ecological model for change [Figure 2]. The cross-cutting factors included, providing information to the individuals which is timely, accessible and relevant, keeping them motivated for change through risk perception and understanding seriousness of the issue, enhancing their ability to act through improving their self-efficacy and access to health and using approach which is sensitive to gender and socio-cultural norms.[26]

The quasi-experimental study which studied the impact of the IHISPHC on various health indicators in the present community had found significant improvements in many of the health behaviour-related outcomes. There was reduction

Table 6: Association of socio-demographic characteristics with SMS reach and adherence

Variables	*n*=428	Adherence to SMS Instructions *n* (%)	Adjusted Odds ratio (95% Confidence Interval), *P*
Age			
<=30 years	272	197 (72.4)	1.0 (0.9, 1.0), *P*=0.3
>30 years	156	101 (64.7)	
Gender			
Female	353	254 (71.9)	2.4 (1.2,5.1), *P*=0.01
Male	75	44 (58.7)	
Literacy			
Literate	307	228 (74.3)	1.2 (0.6, 2.2), *P*=0.5
Illiterate	121	70 (57.8)	
Mobile ownership			
Personal	395	279 (70.6)	2.5 (0.8-6.8), *P*=0.08
Others	33	19 (57.6)	
SMS Read by			
Self	165	126 (71.7)	1.9 (1.0, 3.3), *P*=0.03
Others	263	172 (65.4)	
Frequency of SMS			
>Once/month	110	92 (83.6)	2.2 (1.2, 4.2), *P*=0.01
Once/month	264	190 (71.9)	

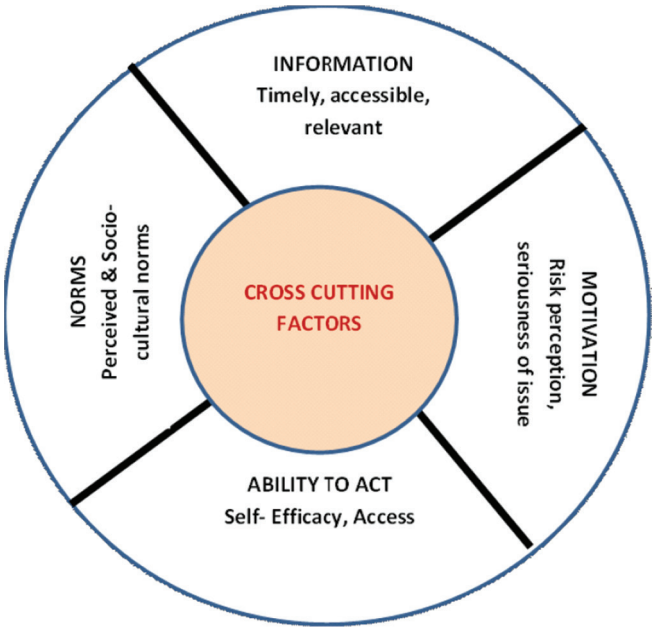

Figure 2: Cross cutting factors to generate change through Socio-Behavioural Communication Change (Adapted from socio-ecological model for change)

in additional salt intake, consumption of processed food, improved adherence to medication among hypertensive and increase in attempt to quit tobacco for more than 24 h among tobacco users in the community after just 6 months of full implementation of the system. The mHealth component of IHIS4PHC could provide the much-needed wide and instant reach in the community.[14]

The study shows that accessibility to mobile phones and acceptability for health communication through SMS was high in underprivileged population, thus mHealth can be effectively utilized as a medium for these difficult-to-reach population to improve their accessibility to primary health care and also bring about health behaviour change. In this study a large proportion of person have been using smartphone, thereby the possibility of using advance methods of communication such as WhatsApp could also be explored wherever feasible.

Most of the studies have often used mHealth interventions as standalone solutions with no health system integration strategy. However, in this study, mHealth was integrated with the IHIS4PHC for improving the healthcare services reach and bring sustainable change in health-related behaviour in the community. A systematic review of mHealth in India has concluded that to reap maximal benefits, mHealth innovations should function as integrable tool that yields positive outcomes related to access, equity, quality, and responsiveness.[27]

Conclusions

With continued spread in technology reach, communities with low-socio-economic status have shown high willingness and acceptance towards mHealth use in healthcare. Digitization is seen as a potential tool for improving the equity, quality and access to the health care and mHealth will have an important role to play in it. The study provides an evidence base for readiness, reach and acceptability of mHealth solution in the marginalized communities.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Financial support and sponsorship

Norwegian Research Council.

Conflicts of interest

There are no conflicts of interest.

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