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Acceptability of a mHealth intervention for hypertension management in a resource-limited setting: A formative qualitative study among patients and health care providers

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4 **Acceptability of a mHealth intervention for hypertension management in a resource-limited setting:**

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6 **A formative qualitative study among patients and health care providers**

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9 **Short title:** Acceptability of mHealth intervention: A formative qualitative study

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ABSTRACT

Objectives: This formative study aimed to explore the perspectives of patients and providers on the acceptability of mHealth (text message) and elicit their preferences for the models of delivery of a mHealth intervention for hypertension management in Nepal.

Design: A qualitative study was conducted using in-depth interviews (IDIs) and focus group discussions (FGDs) methods.

Setting: The study was conducted at primary health care facilities and at a tertiary level referral hospital in Kathmandu, Nepal to represent perspectives of people at different levels of health care.

Participants: A total of 61 participants, patients with hypertension (n=41), their family members (n=5), healthcare providers (n=11) and key informants (n=4) were included. We purposively recruited patients with hypertension aged 30 to 70 who attended the selected health care facilities to obtain maximum variation based on their age, sex, education, occupation, and duration of disease.

Results: The study found that respondents perceived the mobile phone text message interventions as an acceptable and cost-effective intervention that can reinforce behaviour changes. Participants also identified it could provide trustworthy information and protect patient's privacy. However, digital illiteracy and technical constraints were identified as implementation challenges, and solutions were proposed. The study also elicited the preferred characteristics of mHealth intervention in the setting to require a trusted provider, comprehensive content, reasonable frequency, and timing in the morning and evenings to deliver the intervention.

Conclusions: We found that a simplified mHealth intervention such as text messaging was of value for hypertension management in a resource-poor setting such as in Nepal. However, meticulous planning must address the needs of a diverse range of participants to ensure the intervention is acceptable to those who are illiterate or elderly. Our findings will inform the design and implementation of a mHealth intervention by considering the challenges in the setting.

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3 **Keywords:** Text messaging, SMS, High blood pressure, Mobile health, Adherence
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9 **STRENGTHS AND LIMITATIONS OF THE STUDY**
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- 11
12 - This is the first study to explore the potential of mHealth (mobile phone text messages)
13 intervention to manage hypertension in Nepal.
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17 - The strength of the study is the inclusion of diverse stakeholders such as patients, providers,
18 family members and policymakers at different levels of the health system in the setting.
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22 - This study was conducted in urban and semi-urban parts of the country, limiting the
23 transferability of findings to rural and disadvantaged areas.
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Introduction

Hypertension, a major cardiovascular disease risk factor, is an emerging public health challenge particularly affecting low and middle-income countries (LMICs).^{1,2} Although highly effective and affordable medications are widely available, a major challenge in LMICs remains abysmal hypertension management and control.³ Nepal is no exception to this, with hypertension remaining a challenge due to its asymptomatic nature⁴ and poor control of blood pressure that is more than 50% among diagnosed patients with hypertension,^{5,6} leading to high mortality and morbidity.⁷

The Global Burden of Disease Study 2019 recommended that countries invest in cost-effective public health interventions to improve blood pressure control and prevent premature deaths from hypertension and consequent CVD.⁸ Globally, a wide range of non-pharmacological interventions are implemented to improve blood pressure control, such as self-monitoring of blood pressure,⁹ educational interventions focused on patients,¹⁰ health professional-led care (nurse, pharmacist, community health workers);¹¹ as well as appointment reminders.¹² However, delivery of these interventions is hindered by inadequate communication between patients and providers,¹³ primarily due to a poor clinician-to-patient ratio in low resource settings.¹⁴

Mobile health or mHealth uses mobile devices such as mobile phones, patient monitoring devices, personal digital assistants (PDAs), and other wireless devices to support medical or public health interventions.¹⁵ In low resource settings, the mobile phone is a promising tool to improve healthcare access coverage.^{16, 17} It offers a simple and effective mode of communication, enabling the patient to self-manage hypertension through tailored feedback.^{18,19} Included in self-management, a text message is an appropriate mode to guide behaviour interventions²⁰, and although simple, it has many advantages than mobile applications and computer interventions, especially in low resource settings or remote areas with limited internet access.^{20, 21}

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3 In Nepal, there were 140 mobile subscriptions registered for every 100 people in 2019.²² Despite this
4 penetration of mobile services to the population, only a few pilot projects have used it for nutrition
5 counselling and maternal and child health services^{23, 24} but none for Non Communicable diseases
6 (NCDs) management. There is immense potential to use mobile services to bridge the communication
7 gap between the providers and patients for hypertension management in Nepal. However, it is
8 essential to understand its acceptability by the target populations, and country-specific needs to
9 develop a mHealth intervention to get its desired outcome.²⁵ This formative study aimed to explore
10 stakeholder's perceptions on the use of mHealth (text messages) and to elicit their preferences for
11 the models of delivery of the mHealth intervention for hypertension management in Nepal.
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23 **Methods**

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27 Qualitative research was conducted to explore the perspectives of the study participants on the use
28 of mHealth (text message) intervention. This study was conducted at primary health care facilities
29 (one Primary Health care centre and five Health Posts) of Kageswori Manahara municipality and at a
30 Tertiary Level Referral Hospital in Kathmandu, Nepal (Kathmandu Medical College and Teaching
31 Hospital), to explore the perspective of people of different health care levels.
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39 **Study populations and recruitment**

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41 We included patients with hypertension aged 30 to 70 who attended the selected health care facilities
42 from March to July 2018. We excluded patients with complicated hypertension and severe
43 multimorbidity requiring care at tertiary level hospitals, which would limit their ability to participate
44 in the study. Participants with severe mental and physical disability and pregnant/postpartum women
45 were excluded from the study. We also included family members of the patients, health care providers
46 from both levels of care, and key informants to obtain diverse perspectives. The details of the study
47 participants and the recruitment process has been described previously.¹³
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Data Collection Methods

In-depth interviews (IDIs) were conducted using a semi-structured interview guide (*Supplementary file:S1*). Details about the objectives of the study and interviewer were explained to participants while taking the consent. The first author BB (female, PhD fellow), a native language speaker, trained in qualitative research methods, conducted all the IDIs in the Nepali language in a comfortable private place for the participant (private room at OPD of health facilities-no presence of additional person). Interview observation notes for non-verbal cues and audio recordings captured the interview data, which lasted for about 35 to 60 minutes. A total of 25 IDIs among hypertensive patients, five IDIs among family members, 11 IDIs among health care providers, and four IDIs among key informants was conducted. Two Focus Group Discussions (FGD) were also conducted using the FGDs guides among 16 (8 participants in each FGD) diverse hypertensive patients at the tertiary level. The FGDs was facilitated by the first author in the Nepali language, and each FGD lasted for 60 to 90 minutes (*Table 1*).

Table 1: Total number of study participants included for the In-depth Interviews and Focus Group Discussion

| Participant group | Methods of data collection | Primary health care facilities | Tertiary health care facilities | Total |
|---|----------------------------|--------------------------------|---------------------------------|-----------|
| Hypertensive patients | In-depth Interview | 13 | 12 | 25 |
| Hypertensive patients | Focus group discussion | - | 2 (8 in each) * | 16 |
| Health care provider | In-depth Interview | 5 | 6 | 11 |
| Family members of hypertensive patients | In-depth interview | 3 | 2 | 5 |
| Key informants | In-depth interview | | | 4 |
| | | | Total | 61 |

*Due to low patient flow at Primary health care level, FGDs could only be conducted at the Tertiary level.

Data Analysis

All audio recorded FGDs and IDIs with the research participants were transcribed in the local language (Nepali) by the first author and a qualified transcriber. The transcripts were checked against the audio recordings for ensuring accuracy, and pseudonyms were applied. The transcripts and observation notes were translated into English by the researcher and a qualified translator. Translation reliability and accuracy was checked in a random sample of transcripts by back-translation of the transcripts to compare with the original script in local language by the first author (BB). NVivo 12 software²⁶ was used for data management. The first author coded all the transcripts inductively. The thematic analysis was used and followed the steps proposed by Braun and Clarke.²⁷ It includes familiarising with the transcribed data by reading and re-reading, generating the codes, searching and reviewing the theme, defining and naming the theme and finalising the analysis. The codes and themes were discussed with the co-author (PN) and agreed upon between investigators (BB and PN). We followed the Consolidated Criteria for Reporting Qualitative Studies (COREQ) 32-item checklist²⁸ to ensure reporting consistency. (Supplementary file S2).

Patient and public involvement

This research was conducted without patient or public involvement. Participants were not invited to comment on the study design or contribute to the research results and dissemination.

Ethics Approval: Ethical approval for the study was obtained from the Human Research Ethics Committee of the University of New South Wales, Australia (Ref no: HC17753) and Nepal Health Research Council (Reg no 21/2018). Informed consent was taken from all the study participants.

RESULTS

Most of the hypertensive participants (29%) were between the age of 50-60 years with mean age of 48 years, female (51%), educated (65%) and employed (70%). Of them, 88% had been diagnosed more than a year with 34% more than 5 years. (Table:2)

Table 2: Sociodemographic profile of the study participants of IDIs and FGDs (hypertensive patients)

| Characteristics | Categories | Hypertensive patients (N=41) | |
|---------------------------------------|----------------------|------------------------------|------------|
| | | Frequency | Percentage |
| Age (years) | 30-40 | 10 | 24.4 |
| | 40-50 | 11 | 26.8 |
| | 50-60 | 12 | 29.3 |
| | 60-70 | 8 | 19.5 |
| | Mean age \pm SD | 48.17 \pm 10.78 | |
| Gender | Female | 21 | 51.2 |
| | Male | 20 | 48.8 |
| Education | Literate | 27 | 65.8 |
| | Illiterate | 14 | 34.2 |
| Occupation | Employed | 29 | 70.7 |
| | Unemployed | 12 | 29.3 |
| Duration of diagnosis of hypertension | Less than a year | 5 | 12.2 |
| | 1-5 years | 22 | 53.6 |
| | More than five years | 14 | 34.2 |

Note: details of the study other participants (family members, HCWs and KI) are presented previously.¹³

Our study revealed four broad themes, the benefits of a mHealth intervention, challenges to its implementation, suggested solutions, and preferred features of the mHealth intervention. The subthemes are used to organise this section and illustrate some of the key findings. The themes and subthemes generated from the study are presented in **Table 3**.

Table 3: Themes and subthemes generated on the perception of using a mHealth (Text message) intervention.

| Themes | Subthemes |
|---|---|
| Perceived benefits of a mHealth intervention | Acceptable and cost-effective intervention |
| | Reinforce behaviour change |
| | Trustworthy information |
| | Protect Privacy |
| Perceived challenges for implementation of mHealth intervention | Mobile phone illiteracy |
| | Resource and technical challenges |
| Perceived solutions for overcoming the challenges | System-level preparedness |
| | Alternatives strategies for illiterate |
| Preferred features of the mHealth intervention | Comprehensive contents |
| | Reasonable frequency and timing of messages |

I. Perceived benefits

The main subthemes under perceived benefits are as follows:

Acceptable and cost-effective intervention: Study participants reported that a simple text message would be acceptable in the study settings due ubiquity of mobile phone.

These days, mobile(phone) is widely available and easy to use for many people. If anything comes in the mobile from a reliable source, it might have some good effect. (P021)

Participants expressed that mobile phones are popular, and they expressed their interest and readiness to participate in such a program. *"If you send us SMS, we are ready to use this."*

Health care workers (HCWs) also confirmed that mobile phones are widely accessible, even in rural areas. Some stated that getting messages on their mobile phone would be very handy and save time to travel to the health centre in getting information about the disease and its treatment. The key

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3 informants examined it from a program perspective. They identified such an intervention as cost-
4
5 effective as it can be sent to many people at the same time (bulk SMS) with limited investment.
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7

8 *It is also a cost-effective program. We can send one SMS to millions of people in a short period.*

9
10 *It will increase coverage among the patients and will be more effective. (K1102)*

11
12 **Reinforce behaviour change:** HCWs expressed that text messages could acts as a reminder to take
13
14 medication on time and reinforce recommended behaviour changes.

15
16 *"The patients should at least be notified on their mobile phones to take their medicine on time.*

17
18 *Then, the patient would realise and be motivated to follow that." (HCW 02)*

19
20 Participants stated that such an intervention might meet their unmet need to receive specific
21
22 information to reinforce behaviour change such as how much salt is recommended for blood pressure
23
24 control.
25
26

27
28 *"If specific information (such as this much salt is allowed) will be sent for us, definitely it would
29
30 help for changing our habits." (P09, FGD 02)*

31
32 **Trustworthy information:** Some participants reported that they can search for unlimited information
33
34 from the internet on their mobile by themselves. However, the authenticity and relevance of those
35
36 messages could not be determined. They requested information from a *"reliable and trustworthy"*
37
38 provider, referring to HCWs.
39
40

41
42 *"If messages are sent by you and others like you (health professional), I will happily accept it
43
44 thinking that doctor with whom I meet at the hospital sent this message." (P013)*

45
46 HCWs reinforced this request and stated that it should be adequately linked with the health system
47
48 to ensure that messages will be accepted and trusted by participants, that may motivate the intended
49
50 behaviour change.
51

52
53 **Protect privacy:** Participants perceived text message has advantaged of protecting their privacy as it
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55 will deliver personalised information on their mobile. They valued personal text messages sent on
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57 their mobile as others cannot know their condition. This was the case with younger patients, who did
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3 not want their illness divulged to people they associate with.
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5 *"If I get information on my mobile, then it might help to improve my blood pressure. If I go to*
6 *the health centre, there would be lots of people ... I feel shame to say myself ill in front of other*
7 *people. I have not shared with friends, as well." (P014)*
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10 11 12 **II. Perceived challenges** 13

14 Many participants identified obstacles to implement mHealth interventions in the study settings.

15
16 **Mobile phone illiteracy:** Participants raised concerns about general literacy and digital literacy of
17 patients in reading the SMS even though it is sent in the local (Nepali) language. They reported that it
18 could be difficult for those who have low digital literacy skills, for example, who do not know how to
19 open, read, or send a text message.
20
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22
23 *We cannot read, so how can we know what is being sent in mobile; we will not understand*
24 *whatever things come into our mobile....is not it? (FGD: P018)*
25
26

27
28 Further, an elderly participant expressed that *" No, I only know how to call. I have a simple mobile. I*
29 *do not know how to open and read the messages."* HCWs added that such a program could be more
30 effective in urban areas and most accessible to the young generation.
31
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33
34 **Resource and technical constraints:** HCWs were cautious, highlighting the need for resources to
35 implement such a program in Nepal. They expressed concern about resources such as the healthcare
36 workforce, funding, and commitment from the authorised body. Some HCWs also raised the issue of
37 health system preparedness to implement such programs due to cost and shortage of technical
38 workforce.
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41
42 *"No. No. How can we manage those mobile services? It will be challenging to implement. It*
43 *needs a considerable amount of budget, though the concept is excellent." (HCW 03)*
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46
47 Many HCWs identified challenges, such as not having an appropriate recording system of hypertensive
48 patients in the hospitals to locate/ trace them. They expressed that such intervention would be almost
49 impossible in public hospitals where doctors have a high workload, limiting their ability to record the
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3 patients' details, such as their phone number. One HCW expressed that *“There is not even a good*
4 *record-keeping system here in our hospital, and no one is going to record as we don’t have time.”*
5
6

7 8 **III. Perceived solutions** 9

10 In the context of resource constraints, participants recommended some solutions to have the desired
11
12 outcome:

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14 **System-level preparedness:** HCWs emphasised a proper record-keeping system, which would help
15
16 trace the hypertensive patients and send SMSs.

17
18
19 *The hospital must also have a record of the detailed list of OPD patients diagnosed with*
20 *hypertension. Proper record-keeping is essential. (HCW 09)*
21
22

23 However, they emphasised on the need for government commitments for such programs, such as
24
25 establishing a separate department to monitor the program.

26
27
28 *“For such project, we need some mobile centres/department, or some technical manpower*
29 *then only we can implement it.” (KII 03)*
30
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32
33 The key informants highlighted the need for system-level preparedness by extensive planning,
34
35 budgeting, and establishing the mobile phone text messaging software development centre. They
36
37 expressed that multi-sectoral collaboration and commitments are needed to implement the mHealth
38
39 program effectively.
40

41 42 **Alternative strategies for illiterate groups** 43

44 Participants suggested including a family member of the illiterate patients when sending messages.
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46 They highlighted every household should have at least one literate person.

47
48
49 *“These days though mother/father is illiterate, there will be son, daughter and grandchildren*
50 *who are educated. If we could send the message to the family member of the illiterate*
51 *patients, they will get the information. (HCW 07)*
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55 Even the family members were ready to support their parents. They expressed *“For illiterate people*
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57 *like my mother, it has to be sent to the member of the family like me. As a son, I have to take care of*
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3 *her" (FM 02). Furthermore, video/voice messages, symbolic pictures or cartoons were recommended*
4
5 by HCWs for the illiterate groups.
6

7 *I think the video is more effective than a text message as it has both audio/visual features.*

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9
10 (P014)

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12 However, some participants raised concern about the family member's relationship with patients and
13 their availability and the feasibility of using video message in a resource constraint setting like Nepal,
14 especially where smartphones, internet and MMS facilities are not available to support video
15 messages.
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20 21 22 **IV. Preferred features of the mHealth intervention**

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24 In each IDI and FGD, answers to the questions on the need and preference of participants to inform
25 the delivery of mHealth design were analysed.
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28 **Comprehensive contextual contents of the text messages:** participants preferred to get
29 comprehensive culturally appropriate, content in the text messages delivered in a clear, concise, and
30 personalised manner. Content preferences included information about hypertension and its
31 treatment, dietary factors (local foods), medication, physical activities.
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38 *If we talk about the SMS contents, we should first know if the patient is aware of his/her blood*
39 *pressure status. If the patient is aware of the risk factor or not. If he/she smokes*
40 *cigarettes/tobacco or not. We also need to talk about physical activity, obesity, or another*
41 *factor. On the treatment phase, if they are visiting the health post or not, whether they are*
42 *taking their medication regularly or not. (KII 01)*
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49 For lifestyle modification, some of the patients expressed that it would be good to receive information
50 about physical activity and culturally appropriate dietary factors. "*What kinds of exercise should be*
51 *done, how much.... amount.... duration.... time."* Key informants also added that patients should get
52 all the messages on pharmacological and non-pharmacological measures for controlling their blood
53 pressure.
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3 **Reasonable frequency and timing of text messages:** They also stated that the text messages should
4 be delivered with reasonable frequency and timing. Study participants preferred to have 2-3
5 reminders messages per week for taking medication or about specific behaviours. Overall,
6 participants agreed that daily messages would be too often and monthly be insufficient.
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12 *"I feel like if it can be sent once or twice a week, then it will be kept in touch also. If we send*
13 *them daily, then they might delete it. (laughs)." (HCW 05, Tertiary level)*
14

15
16 Most of them preferred the messages to be delivered in the morning or evening. Participants
17 mentioned that if the timing of the message matched the timing of taking their medicine, then it would
18 be more effective *"Usually people take medicine in the morning so, that would be a good time."* And
19 other participants also added, *"Mostly, morning would be good."*
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26 27 28 **DISCUSSION**

29
30 This is the first formative qualitative study that explored the perspectives of patients and providers on
31 the acceptability of mHealth (mobile phone text messages) interventions to manage hypertension in
32 Nepal to inform the design of a mhealth intervention. Overall, participants were receptive towards
33 such intervention with some contextual recommendation. This study found that a simple mHealth
34 intervention, such as the mobile phone text messages, could be useful in Nepal due to the ubiquitous
35 use of mobile phones in the study setting. Studies from the primary level²⁵ and rural part of India²⁹
36 have also reported mHealth as a ubiquitous and acceptable tool for managing cardiovascular diseases
37 and supporting healthcare. Key informants involved in implementing the national NCDs program and
38 policy in Nepal identified cost-effectiveness as a potential benefit of such intervention. The WHO's
39 Global Observatory for eHealth (GOe) also stated SMS an easy method to send a brief message at a
40 low cost.¹⁵ Text messages can be sent in bulk to multiple users simultaneously, are cheap, and do not
41 require advanced skills.¹⁶
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57 Our study found behaviour reinforcement as another potential benefit. In chronic diseases such as
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3 hypertension, where medication should be taken daily, SMS reminders can increase medication
4 adherence.^{30,31} Additionally, WHO GOe stated that SMS was the preferred method for treatment
5 compliance measures worldwide.¹⁵ Non-disclosure issues due to the stigma attached to hypertension
6 was reported, especially by the young people in Nepal in our previous study.¹³ The importance of
7 privacy of information stressed by our respondents has not been reported for NCD previously, but
8 mostly in the case of HIV/AIDS.³² Overall, there was a consensus of the value of text messaging in
9 preserving the privacy of hypertensive patients by all the stakeholder groups.

10
11 This study was able to identify implementation barriers that were similar to other resource limited
12 setting as well as unique to the setting. Difficulty in reading text messages (even in the local language),
13 a language and literacy barrier in reading the text messages were identified, similar to south Indian
14 studies.^{25, 32} Solutions identified by stakeholders included family members of illiterate/ elderly groups
15 and sending video or symbolic messages.

16
17 While there was enthusiasm to use mHealth, HCWs and Key informants expressed concerns about the
18 lack of resources and technical issues that could be an impediment. The immaturity of health
19 information systems in hospitals and gaps in recording essential information was identified. Similar
20 issues have been reported from rural India as a barrier to the continuity of care and follow up with
21 hypertensive patients.³³ These findings were corroborated in other studies of Kenya³⁴ and
22 Bangladesh.³⁵ The WHO has also stated that unclear mHealth policy and underdeveloped
23 infrastructure are the most common barriers in adopting mHealth in LMICs settings.¹⁵ In our study, it
24 was explicitly stated that a trusted source is required as there is too much information on the internet.
25 An SMS originating from a public or private health centre will be trusted as that would be considered
26 as authentic. The trustworthiness of the information was preferred by users for the desired behaviour
27 modification.³⁶ The key recommendation was to have government commitment and multisectoral
28 collaboration and coordination with the health system to address the structural barriers to use

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3 advanced technology. These aspects should be carefully considered while designing the mHealth
4 intervention for its sustainability.
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7 **Strength and limitations of the study**

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9 One of the strengths of the study is that efforts were taken to ensure the trustworthiness³⁷ of data by
10 ensuring credibility by adopting appropriate and different methods for data collection (IDIs and FGDs);
11 by including a different cadre of participants (patients, their family, health workers, key informants)
12 from different sites (primary and tertiary level). The researcher (BB) obtained participant validation
13 at the end of the interview by summarising the main points to ensure the respondent's
14 perspective.^{38,39} We have presented the steps in the analysis and showed that we generated the
15 themes and subthemes with discussion. However, some limitations were that we had analysed data
16 from different sources and methods together, which might not fulfil all the criteria of triangulation
17 and used purposive sampling, which may have created selection bias. However, we tried to ensure
18 the diversity of participants. Furthermore, the transferability of the findings is limited as this study
19 was conducted in urban and semi-urban part of the country, which may not represent the view of
20 people from the geographically disadvantaged remote areas.
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36 **Implications for mhealth design and future research**

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38 This study found that text message intervention could be acceptable if designed to fit the context of
39 illiteracy and old age in a resource-poor setting. This study supported the evidence that mHealth could
40 bring sustainable and effective outcomes in LMIC settings if it is designed based on the local context
41 and needs.^{40, 41} Such intervention can address the gap of human resources in the LMIC setting. Our
42 formative research informed the design of TEXT4BP intervention.⁴² Information on the contents of
43 the intervention, frequency, and timing of the intervention may be of value to a similar resource-
44 limited setting. Our findings also offer guidance to authorities about programs that could improve
45 hypertension management by mHealth interventions. Future research should explore the potential of
46 alternatives methods such as image and voice messages for the illiterate group as suggested by the
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3 participants and how best to implement culturally developed mhealth intervention into the regular
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5 health care system.
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7 **CONCLUSIONS**

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10 This study found that participants were receptive towards a simple mHealth intervention such as SMS
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12 notifications. Overall, there was a consensus of the value of a text messaging solution to hypertension
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14 management by all the stakeholder groups. However, meticulous planning must include a diverse
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16 range of participants to ensure the intervention is acceptable to a wide range of participants, including
17
18 illiterate or elderly. Our findings can be used as a reference to inform similar interventions in other
19
20 resource-limited settings.
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22

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36
37 recordings of IDIs.
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41 **Author contributions**

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43
44 All authors contributed to the conception of research design, acquisition, and data interpretation. BB
45
46 conducted the fieldwork and wrote the first version of this manuscript. BB and PN participated in the
47
48 analysis of the data. All the authors BB, AES, RJ, AV, MS and PN were involved in the manuscript
49
50 drafting, revision, and finalisation. All authors read and approved the final version of the manuscript.
51
52
53

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55
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57

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5
6

7 **Patient consent for publication:** Obtained
8
9

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11 interview transcripts. The researchers have access to these data. All data are stored securely on
12 password-protected and encrypted computers. Participants have not given their permission for data
13 sharing outside the research group. Thus, no additional data are available.
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Supplementary file: S1**I. In-depth Interview guides**

1. Icebreaker
 - a. How are you doing?
 - b. What kinds of work are you doing these days?
2. Could you please share your experience of using mobile phone? *Probe: How, when, for what purpose etc*
3. What do you know about use of mobile health in management of high blood pressure?
4. Could you please share your opinion on using mobile phone for management of high blood pressure? *Probe: what, how*
5. Have you heard, or have you been told that you can get health messages through mobile phone?
6. What is your opinion about it? What is your perspective on potential of mobile health service in management of hypertension in Nepal? *Probe: what, how, example*
7. What could the potential advantages of using mobile health in Nepal?
8. What could be the challenges in using mHealth in Nepal for the management of hypertension?
9. What can be done to overcome the challenges for successful outcome?
10. What kinds of mobile health services you would like to get/use?
11. What should be the contents, timing, and frequency of such mHealth services?
12. Do you want to share anything which I missed to discuss?
13. Let's summarise some of the key points from our discussion. Is there anything else?

III. FGD guides

Let's start by going around the circle and having each person introduce her/himself.

(Members of the research team should also introduce themselves and describe each of their roles.)

1. Icebreaker
 - a. How are you doing?
 - b. What kinds of work are you doing these days?
2. Could you please share your experience of using mobile phone? *Probe: How, when, for what purpose etc*
3. What do you know about use of mobile health in management of high blood pressure?
4. Could you please share your opinion on using mobile phone for management of high blood pressure? *Probe: what, how*
5. Have you heard, or have you been told that you can get health messages through mobile phone?
6. What is your opinion about it? What is your perspective on potential of mobile health service in management of hypertension in Nepal? *Probe: what, how, example*
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12. Do you want to share anything which I missed to discuss?
13. Let us summarise some of the key points from our discussion. Is there anything else?

COREQ (CONsolidated criteria for REporting Qualitative research) Checklist

A checklist of items that should be included in reports of qualitative research. You must report the page number in your manuscript where you consider each of the items listed in this checklist. If you have not included this information, either revise your manuscript accordingly before submitting or note N/A.

| Topic | Item No. | Guide Questions/Description | Reported on Page No. |
|--|----------|--|----------------------|
| Domain 1: Research team and reflexivity | | | |
| <i>Personal characteristics</i> | | | |
| Interviewer/facilitator | 1 | Which author/s conducted the interview or focus group? | |
| Credentials | 2 | What were the researcher's credentials? E.g. PhD, MD | |
| Occupation | 3 | What was their occupation at the time of the study? | |
| Gender | 4 | Was the researcher male or female? | |
| Experience and training | 5 | What experience or training did the researcher have? | |
| <i>Relationship with participants</i> | | | |
| Relationship established | 6 | Was a relationship established prior to study commencement? | |
| Participant knowledge of the interviewer | 7 | What did the participants know about the researcher? e.g. personal goals, reasons for doing the research | |
| Interviewer characteristics | 8 | What characteristics were reported about the interviewer/facilitator? e.g. Bias, assumptions, reasons and interests in the research topic | |
| Domain 2: Study design | | | |
| <i>Theoretical framework</i> | | | |
| Methodological orientation and Theory | 9 | What methodological orientation was stated to underpin the study? e.g. grounded theory, discourse analysis, ethnography, phenomenology, content analysis | |
| <i>Participant selection</i> | | | |
| Sampling | 10 | How were participants selected? e.g. purposive, convenience, consecutive, snowball | |
| Method of approach | 11 | How were participants approached? e.g. face-to-face, telephone, mail, email | |
| Sample size | 12 | How many participants were in the study? | |
| Non-participation | 13 | How many people refused to participate or dropped out? Reasons? | |
| <i>Setting</i> | | | |
| Setting of data collection | 14 | Where was the data collected? e.g. home, clinic, workplace | |
| Presence of non-participants | 15 | Was anyone else present besides the participants and researchers? | |
| Description of sample | 16 | What are the important characteristics of the sample? e.g. demographic data, date | |
| <i>Data collection</i> | | | |
| Interview guide | 17 | Were questions, prompts, guides provided by the authors? Was it pilot tested? | |
| Repeat interviews | 18 | Were repeat interviews carried out? If yes, how many? | |
| Audio/visual recording | 19 | Did the research use audio or visual recording to collect the data? | |
| Field notes | 20 | Were field notes made during and/or after the interview or focus group? | |
| Duration | 21 | What was the duration of the interviews or focus group? | |
| Data saturation | 22 | Was data saturation discussed? | |
| Transcripts returned | 23 | Were transcripts returned to participants for comment and/or | |

| Topic | Item No. | Guide Questions/Description | Reported on Page No. |
|--|----------|--|----------------------|
| | | correction? | |
| Domain 3: analysis and findings | | | |
| <i>Data analysis</i> | | | |
| Number of data coders | 24 | How many data coders coded the data? | |
| Description of the coding tree | 25 | Did authors provide a description of the coding tree? | |
| Derivation of themes | 26 | Were themes identified in advance or derived from the data? | |
| Software | 27 | What software, if applicable, was used to manage the data? | |
| Participant checking | 28 | Did participants provide feedback on the findings? | |
| <i>Reporting</i> | | | |
| Quotations presented | 29 | Were participant quotations presented to illustrate the themes/findings? Was each quotation identified? e.g. participant number | |
| Data and findings consistent | 30 | Was there consistency between the data presented and the findings? | |
| Clarity of major themes | 31 | Were major themes clearly presented in the findings? | |
| Clarity of minor themes | 32 | Is there a description of diverse cases or discussion of minor themes? | |

Developed from: Tong A, Sainsbury P, Craig J. Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups. *International Journal for Quality in Health Care*. 2007. Volume 19, Number 6: pp. 349 – 357

BMJ Open

Acceptability of a mHealth intervention for hypertension management in a Low- and Middle-Income Country setting: A formative qualitative study among patients and health care providers

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4 **1 Acceptability of a mHealth intervention for hypertension management in a Low and Middle-**
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6 **2 Income Country setting: A formative qualitative study among patients and health care providers**

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9 **3 Short title:** Acceptability of mHealth intervention: A formative qualitative study

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2
3 1 **ABSTRACT**
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6 2 **Background:** Understanding the contextual need and preference is important for a successful design
7
8 3 and effective outcome of an mHealth intervention.
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10 4 **Objectives:** This formative study aimed to explore the perspectives of patients and providers on the
11
12 5 acceptability of mHealth (text message) and elicit preferred features of mHealth intervention for
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14 6 hypertension management in Nepal.
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16
17 7 **Design:** A qualitative study was conducted using in-depth interviews (IDIs) and focus group discussions
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19 8 (FGDs) methods guided by the Technology Acceptance Model (TAM).
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22 9 **Setting:** The study was conducted at primary health care facilities and at a tertiary level referral hospital
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24 10 in Kathmandu, Nepal to represent perspectives of people at different levels of health care.
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27 11 **Participants:** A total of 61 participants, patients with hypertension (n=41), their family members (n=5),
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29 12 healthcare providers (n=11) and key informants (n=4) were included. We purposively recruited patients
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31 13 with hypertension aged 30 to 70 who attended the selected health care facilities to obtain maximum
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33 14 variation based on their age, sex, and literacy.
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36 15 **Results:** The study found that respondents perceived usefulness of the mobile phone text message
37
38 16 interventions as an acceptable platform that can reinforce behaviour changes. Participants also
39
40 17 identified that it could provide reliable information from the health centre and can be delivered in-
41
42 18 confidence. User friendliness and delivery of content in local language were identified as advantages
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44 19 under perceived ease of use. Implementation challenges were expressed as digital illiteracy and
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46 20 contextual technical constraints, and solutions were proposed. They preferred text messages containing
47
48 21 comprehensive contextual content in a reasonable frequency and timing.
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51 22 **Conclusions:** We found that a simple mHealth intervention such as text messaging was of value for
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53 23 hypertension management in this LMIC setting. However, meticulous planning must address the needs
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55 24 of a diverse range of participants to ensure the intervention is acceptable to illiterate and older groups
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57 25 as well.
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3 1 **Keywords:** Text messaging, SMS, High blood pressure, Mobile health, Adherence, TAM Model
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9 3 **STRENGTHS AND LIMITATIONS OF THE STUDY**

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11 4 - This is a novel formative study conducted in Nepal that explored the acceptability of mobile
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13 phone text messages intervention targeted to the patients with hypertension guided by TAM
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15 model.
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17
18 7 - The strength of the study was the inclusion of diverse stakeholders such as patients, providers,
19
20 family members and policymakers at different levels of the health care.
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22
23 9 - This study was conducted in urban and semi-urban parts of the country, limiting the
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25 transferability of findings to rural and disadvantaged areas.
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1 Introduction

2 Hypertension, a major Cardiovascular Disease (CVD) risk factor, is an emerging public health
3 challenge particularly affecting low and middle-income countries (LMICs).^{1,2} Although highly effective
4 and affordable medications are widely available, a major challenge in LMICs remains abysmal
5 hypertension control of less than 50%.³ Nepal is no exception to this, with 57% patients remained
6 undiagnosed in community due to asymptomatic nature of the hypertension.⁴ In addition, among those
7 who are diagnosed, only 35-45% of the hypertensive patients have controlled blood pressure,^{5, 6} leading
8 to high mortality and morbidity.⁷

9 The Global Burden of Disease Study 2019 has recommended that countries invest in cost-effective
10 public health interventions to improve blood pressure control and prevent premature deaths from
11 hypertension and consequent CVD.⁸ Globally, a wide range of non-pharmacological interventions are
12 implemented to improve blood pressure control, such as self-monitoring of blood pressure,⁹ educational
13 interventions focused on patients,¹⁰ health professional-led care (nurse, pharmacist, community health
14 workers);¹¹ as well as appointment reminders.¹² However, delivery of these interventions is hindered by
15 inadequate communication between patients and providers,¹³ primarily due to a poor clinician-to-patient
16 ratio in low resource settings.¹⁴

17 Mobile health or mHealth uses mobile devices such as mobile phones, patient monitoring devices,
18 personal digital assistants, and other wireless devices to support medical or public health interventions.¹⁵

19 In low resource settings, mobile phone is a promising tool to improve healthcare access and
20 coverage.^{16,17} It offers a simple and effective mode of communication, enabling the patient to self-
21 manage hypertension through tailored feedback.^{18,19} Included in self-management, a text message is an
22 appropriate mode to guide behaviour interventions,²⁰ and although simple, it has many advantages than
23 mobile applications and computer interventions, especially in low resource settings or remote areas with
24 limited internet access.^{20,21}

25 Nepal Telecom Authority (NTA) has reported an estimated 38.21 million mobile services users in
26 Nepal.²² Despite this penetration of mobile services to the population, only a few pilot projects have

1 used it for nutrition counselling and maternal and child health services^{23,24} and only handful initiatives
2 for Non Communicable diseases (NCDs) management targeting community health workers.²⁵ There is
3 immense potential to use mobile services to bridge the communication gap between the providers and
4 patients for hypertension management in Nepal. However, it is essential to understand its acceptability
5 by the target populations, and country-specific needs to develop a mHealth intervention to get its desired
6 outcome.²⁶ This formative study aimed to explore different stakeholder's perceptions on the use of
7 mHealth (text messages) to capture multiple level perspectives guided by TAM model²⁷ and elicit their
8 preferred features of mHealth intervention (text messages) for hypertension management in Nepal.

9 **Methods**

10 Qualitative research was conducted to explore the perspectives of the study participants on the potential
11 use of mHealth (text message) intervention for patients with hypertension. This study was conducted at
12 primary health care facilities (one Primary Health care centre and five Health Posts) of Kageswori
13 Manahara municipality and at a Tertiary level referral Hospital in Kathmandu, Nepal (Kathmandu
14 Medical College and Teaching Hospital), to explore the perspective of people of different health care
15 levels.

16 **Theoretical model informing the study:** Our study used the TAM model developed by Davis²⁷ as an
17 overarching model to guide the analysis to assess the acceptability of the proposed mHealth intervention
18 (Figure 1). This model considered the two main beliefs: perceived usefulness and perceived ease of use
19 as the main factors for an individual's acceptance of the technology. Perceived usefulness is when users
20 believe that using a technology will enhance their job performance and perceived ease of use is a user's
21 belief that a technology is free of effort which is influenced by external factors. ²⁷ We explored mainly
22 these factors in our study. The TAM model considers that there is a strong relationship between a
23 person's intention to use and actual use of technology.²⁸ This model is valid, robust and has been widely
24 used in understanding human behaviour in acceptance of technology.²⁸⁻³² We have used this model for
25 informing our analysis considering its applicability based on our objectives .

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3 1 **Fig 1 here**
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6 2 **Study populations and recruitment**
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8 3 We included patients with hypertension aged 30 to 70 who attended the selected health care facilities
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10 4 from March to July 2018. We excluded patients with complicated hypertension with severe
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12 5 multimorbidity requiring immediate care at tertiary level hospitals, which would limit their ability to
13
14 6 participate in the study. Participants with severe mental and physical disability and pregnant/postpartum
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16 7 women were excluded from the study. However, we included participants with comorbidities who were
17
18 8 not serious. We have included the different groups of patients (based on age, sex, literacy), their family
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20 9 members, health care providers (HCWs) from both levels of care, and key informants (KI) to capture
21
22 10 the multiple perspectives for validating the data through data source triangulation.³³ Perspectives from
23
24 11 patients and family members helped in understanding patient-community level perspectives whereas
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26 12 KI and HCWs perspectives provided an opportunity to understand the system level factors for the
27
28 13 contextual design of the mHealth intervention. The details of the study participants and the recruitment
29
30 14 process has been described previously¹³ and presented briefly in *Supplementary file 1*.
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32

33 15 **Data Collection Methods**
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35 16 We collected data using In-depth interviews (IDIs) and Focus Group Discussions (FGD) methods to
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37 17 ensure rigor through methodological triangulation.³³ IDIs provides an opportunity to explore rich
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39 18 personal experiences and perspectives on the topic.³⁴ However, FGD elicits the data from the group of
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41 19 participants where they could hear each other perspectives and comments additionally which they may
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43 20 not have expressed in the IDIs.³⁵ IDIs and FGDs were conducted using a semi-structured interview
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45 21 guide. The interview guide contained the questions mainly on perspectives on using the mHealth, its
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47 22 advantages, challenges and their preference on the contents, frequency of the intervention.
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49 23 (*Supplementary file:2*). While taking the consent, participants were explained about details about the
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51 24 objectives of the study, conceptual mHealth intervention (TEXT4BP), and about interviewer. The first
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53 25 author BB (female, PhD fellow), a native language speaker trained in qualitative research methods,
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55 26 conducted all the IDIs in the Nepali language in a suitable private place (OPD of health facilities or
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57 27 privately at the home of the participants without the presence of family members). Interview
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1 observation notes for non-verbal cues and audio recordings captured the interview data, which lasted
 2 for about 35 to 60 minutes. A total of 25 IDIs among hypertensive patients, five IDIs among family
 3 members, 11 IDIs among health care providers, and four IDIs among key informants were conducted.
 4 Two Focus Group Discussions (FGD) were also conducted using the FGDs guides among 16 (8
 5 participants in each FGD) diverse hypertensive patients at a private OPD room with no additional person
 6 present at the tertiary level. The FGDs were facilitated by the first author in the Nepali language, audio
 7 recorded and each FGD lasted for 60 to 90 minutes. We decided the number of participants for FGDs
 8 based on the standard recommendations for FGDs and patient-availability.³⁶ The number of IDIs was
 9 decided based on the number of diverse group representation (by age, sex, literacy) till the saturation of
 10 information achieved at both levels of healthcare. To decide on the saturation of information, the
 11 interviewer prepared the summary after each interview to look for any new information coming from
 12 IDIs. (Table 1).

13 **Table 1: Total number of study participants for IDIs and FGDs included from the Primary and**
 14 **Tertiary level.**

| Participant group | Primary health care level (PL) | Tertiary health care level (TL) | Total |
|--|---|---|-----------|
| Patients with hypertension | 13 - IDIs | 12-IDIs | 25 |
| Patients with hypertension | NA | 2 FGD (8 in each) * | 16 |
| Health care provider | <u>5- IDIs</u> Medical Officer- 1 Health Assistant- 1 Community Health Assistant – 1 Axillary Nurse midwife - 1 | <u>6 -IDIs</u> Cardiologist -3 Physician- 1 Medical officer- 1 Staff Nurse -1 | 11 |
| Family members of patients with hypertension | 3 -IDIs | 2- IDIs | 5 |
| Key informants | 4- IDIs NCDs policy maker -1 NCDs program focal person at DoHs, MoHP-2 NCDs researcher 1 | | 4 |
| Total | | | 61 |

15 Note: *Due to low patient flow at Primary health care level, FGDs could only be conducted at the Tertiary level. DoHs
 16 MOHP= Department of Health Services, Ministry of Health and Population

1 **Data Analysis**

2 All audio recorded FGDs and IDIs with the research participants were transcribed in the local language
3 (Nepali) by the first author and a qualified transcriber. The transcripts were checked against the audio
4 recordings for ensuring accuracy, and pseudonyms were applied. The transcripts and observation notes
5 were translated into English by the researcher and a qualified translator. Translation reliability and
6 accuracy was checked in a random sample of transcripts by back-translation of the transcripts to
7 compare with the original script in local language by the first author (BB). Transcripts were not shared
8 with the participants, however, the interviewer summarised the main information at the end of the
9 interview to obtain participant validation.³⁷ NVivo 12 software³⁸ was used for data management. The
10 first author coded all the transcripts. Data analysis was informed by the TAM model and overarching
11 aim of the study. This study utilised this model to understand the perceived usefulness, perceived ease
12 of use and perceived challenges of using the text messages intervention. We followed the thematic
13 analysis process proposed by Braun and Clarke.³⁹ It includes familiarising with the transcribed data by
14 reading and re-reading, generating the codes, searching and reviewing the theme, defining and naming
15 the theme and finalising the analysis. The codes and themes were discussed with the co-author (PN)
16 and agreed upon between investigators (BB and PN). The sub- themes generated from the transcripts
17 were mapped under the overarching theme (I-III) of the TAM model and other themes (V-VI) generated
18 based on the objectives of the study as presented in the result section. We followed the Consolidated
19 Criteria for Reporting Qualitative Studies (COREQ) 32-item checklist⁴⁰ to ensure reporting consistency.
20 (*Supplementary file 3*).

21 **Patient and public involvement**

22 This research was conducted without patient or public involvement. Participants were not invited to
23 comment on the study design or contribute to the research write up and dissemination.

24 **Ethics Approval:** Ethical approval for the study was obtained from the Human Research Ethics
25 Committee of the University of New South Wales, Australia (Ref no: HC17753) and Nepal Health
26 Research Council (Reg no 21/2018). Informed consent was taken from all the study participants.

1 RESULTS

2 Most of the hypertensive participants (29%) were between the age of 50-60 years with mean age of 48
3 years, female (51%), literate (65%) and employed (70%). Of them, 88% had been diagnosed more than
4 a year with 34% more than 5 years. (Table:2)

5 **Table 2: Sociodemographic profile of the study participants of IDIs and FGDs (hypertensive**
6 **patients)**

| Characteristics | Categories | Hypertensive patients (N=41) | |
|---------------------------------------|----------------------|------------------------------|------------|
| | | Frequency | Percentage |
| Age (years) | 30-40 | 10 | 24.4 |
| | 40-50 | 11 | 26.8 |
| | 50-60 | 12 | 29.3 |
| | 60-70 | 8 | 19.5 |
| | Mean age \pm SD | 48.17 \pm 10.78 | |
| Sex | Female | 21 | 51.2 |
| | Male | 20 | 48.8 |
| Literate | Yes | 27 | 65.8 |
| | No | 14 | 34.2 |
| Employment | Yes | 29 | 70.7 |
| | No | 12 | 29.3 |
| Duration of diagnosis of hypertension | Less than a year | 5 | 12.2 |
| | 1-5 years | 22 | 53.6 |
| | More than five years | 14 | 34.2 |

7 *Note: details of the study other participants (family members, HCWs and KI) are presented previously.¹³*

8
9 Our study revealed three broad themes (I-III) on acceptability under the TAM model and other two
10 themes (IV-V) as suggested solutions, and preferred features of the mHealth intervention. All the
11 themes, sub themes of study and supporting verbatim are presented in **Table 3**.

1 **Table 3: Themes and subthemes generated on the perception of using a mHealth (Text message) intervention.**

| Themes Based on TAM Model on acceptability | Subthemes | Supporting verbatim |
|--|---------------------------------------|--|
| Perceived usefulness | Acceptable and require less resources | <p><i>These days, mobile(phone) is widely available and easy to use for many people. If anything comes in the mobile from a reliable source, it might have some good effect. (P021: M, 40-45 Y, PL)</i></p> <p><i>It is also a cost-effective program. We can send one SMS to millions of people in a short period. It will increase coverage among the patients and will be more effective. (KII02)</i></p> |
| | Reinforce behaviour change | <p><i>"The patients should at least be notified on their mobile phones to take their medicine on time. Then, the patient would realise and be motivated to follow that." (HCW 02, PL)</i></p> |
| | Can provide reliable information | <p><i>"If messages are sent by you and others like you (health professional), I will happily accept it thinking that doctor with whom I meet at the hospital sent this message." (P013: 45-50 Y, PL)</i></p> |
| | Deliver information privately | <p><i>"If I get information on my mobile, then it might help to improve my blood pressure. If I go to the health centre, there would be lots of people ... I feel shame to say myself ill in front of other people. I have not shared with friends, as well." (P014: 35-40 Y, M, TL)</i></p> |

| | | |
|--|---------------------------|--|
| Perceived ease of use | User friendly | <i>I think it will work and be feasible because majority of the people own mobile phone, can very easily see the information in mobile without any difficulties and there is no need to have expensive smartphone for simple SMS. (P20: M, 50-55Y, PL)</i> |
| | Local language | <i>The SMS language should be simple and easy to understand for us. Nepali is the most common language out here and people can easily read that. (P015: 30-35Y, M, TL)</i> |
| Perceived challenges – external factors | Mobile phone illiteracy | <i>We cannot read, so how can we know what is being sent in mobile; we will not understand whatever things come into our mobile....is not it? (FGD01; 60-65Y, F, TL)</i> |
| | Technical constraints | <i>"No. No. How can we manage those mobile services? It will be challenging to implement. It needs a considerable amount of budget, though the concept is excellent." (HCW 03: PL)</i> |
| Themes under other objectives of study | Sub - themes | Supporting verbatim |
| Perceived solutions for overcoming the challenges | System-level preparedness | <p><i>The hospital must also have a record of the detailed list of OPD patients diagnosed with hypertension. Proper record-keeping is essential. (HCW 09: TL)</i></p> <p><i>"For such project, we need some mobile centres/department, or some technical manpower then only we can implement it." (KII 03)</i></p> |

| | | |
|---|---|--|
| | Alternatives strategies for illiterate | <p><i>"These days though mother/father is illiterate, there will be son, daughter and grandchildren who are educated. If we could send the message to the family member of the illiterate patients, they will get the information. (HCW 07: PL)</i></p> |
| Preferred features of the mHealth intervention | Comprehensive contextual contents | <p><i>Is BP controlled after taking bitter herbs (chirauto) only or should we go for acupuncture or not..some people say that there is a person who press in the hand and pressure will be fine, so should we follow that or not?– it should be send in messages. (P08: 50-60 Y F, PL)</i></p> <p><i>It should include all the information regarding what type of diet should we take and what should be avoided. Like messages regarding patient should take less salty and oily food. [P012: 45-50 Y, F, PL]</i></p> |
| | Reasonable frequency and timing of messages | <p><i>"I feel like if it can be sent once or twice a week, then it will be kept in touch also. If we send them daily, then they might delete it. (laughs)." (HCW 05, TL)</i></p> |

Themes mapped under TAM Model

I. Perceived usefulness

The main subthemes under perceived usefulness of TAM model are as follows:

Acceptable and require less resources: Study participants reported that a simple text message would be acceptable in the study settings due to ubiquity of mobile phone.

Participants expressed that mobile phone is popular. They also expressed their interest and readiness to participate in such a program. *“If you send us SMS, we are ready to use this.” (P03: 50-55 Y,F, TL)*

Health care workers (HCWs) also confirmed that mobile phones are widely accessible, even in rural areas. Some stated that getting messages on their mobile phone would be very handy and save time to travel to the health centre in getting information about the disease and its treatment. The key informants examined it from a program perspective. They identified such an intervention might require less resources as it can be sent to many people at the same time (bulk SMS) with limited investment.

Reinforce behaviour change: HCWs expressed that text messages could acts as a reminder to take medication on time and reinforce recommended behaviour changes such as physical activity.

Participants stated that such an intervention might meet their unmet need to receive specific information to reinforce behaviour change such as how much salt is recommended for blood pressure control.

“If specific information (such as this much salt is allowed) will be sent for us, definitely it would help for changing our habits.” (FGD 02: 50-55 Y, F, TL)

Can provide reliable information: Some participants reported that they can search for unlimited information from the internet on their mobile by themselves. However, the authenticity and relevance of those messages could not be determined. They requested information from a *“reliable and trustworthy”* provider, referring to HCWs.

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2
3 1 HCWs reinforced this request and stated that it should be adequately linked with the health system to
4
5 2 ensure that messages will be accepted and trusted by participants, that may motivate the intended
6
7 3 behaviour change.

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9 4 **Deliver information privately:** Participants perceived that text message has advantage of delivering
10
11 5 personalised information on their mobile privately. They valued personal text messages sent on their
12
13 6 mobile as others cannot know their hypertension status. This was the case with younger patients, who
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15 7 did not want their illness divulged to people they associate with.

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18 8 Overall, there was no reported difference in usefulness based on the gender and level of health care.
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20 9 However, the advantage of getting message privately is expressed mainly by the young participants, not
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22 10 by the older age groups.

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26 12 **II. Perceived ease of use:**

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28 13 **User friendly:** The participants expressed that the text message can be a simple and easy intervention
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30 14 as it does not require advanced technical skills to operate. Participants preferred receiving messages in
31
32 15 a simple, clear, and concise format. They further added that if SMS is designed in an understandable
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34 16 format, it can be effective in the study setting.

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38 17 *It will be effective. These days, even the lay man (naujanne), can use simple messaging. (P10: 45-50Y, F,*
39
40 18 *TL)*

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43 20 **Local language:** Study participants expressed that it would be easy to read and understand if the
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45 21 messages are sent in the Nepali language. If designed in local language, people with low literacy can
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47 22 also utilize it for behaviour modification.

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49 23 *Yes, she (patient) could read it if it is sent in Nepali. If sent in English, even I cannot read it. But*
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51 24 *we both can read in Nepali. (FM03 of 40-45Y, F, PL)*

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54 25 The ease of use was expressed mostly by the literate group of participants. The older groups and
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56 26 illiterate participants suggested to design simple text in local language.

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1 III. Perceived Challenges - External factors

2 Many participants also identified obstacles to implement mHealth interventions in the study settings.

3 **Mobile phone illiteracy:** Participants raised concerns about general literacy and digital literacy of
4 patients in reading the SMS even though it is sent in the local (Nepali) language. They reported that it
5 could be difficult for those who have low digital literacy skills, for example, who do not know how to
6 open, read, or send a text message.

7 Further, an older participant expressed that " *No, I only know how to call. I have a simple mobile. I do
8 not know how to open and read the messages.*" (P017: 65-70Y, M, PL)

9 HCWs added that such a program could be more effective in urban areas and most accessible to the young
10 generation. The participants expressed that age and illiteracy can influence the ability to read text
11 messages.

12
13 **Technical constraints:** HCWs were cautious, highlighting the need for resources to implement such
14 program in Nepal. They expressed concern about resources such as the technical workforce and funding
15 requirement for software development and SMS delivery, including commitment from the authorised
16 bodies in the hospital. Some HCWs also raised the issue of health system preparedness to implement
17 such programs due to cost and shortage of technical workforce.

18 Many HCWs identified challenges, such as not having an appropriate recording system of hypertensive
19 patient's details in the hospitals to locate/ trace them in the community. They expressed that such
20 intervention would be almost impossible in public hospitals where doctors have a high workload, limiting
21 their ability to record the patients' details, such as their phone number. One HCW expressed that "*There
22 is not even a good record-keeping system here in our hospital, and no one is going to record as we don't
23 have time.*" (HCW 08: TL)

24 The system level technical challenges were expressed by both level of health care; mostly by the HCWs
25 and KI. No such issues were reported by the hypertensive patients.

1 Themes based on other objectives of the study

2 **IV. Perceived solutions**

3 In the context of resource constraints, participants recommended some solutions to have the desired
4 outcome of text messages intervention.

5 **System-level preparedness:** HCWs emphasised a proper record-keeping system, which would help in
6 tracing the hypertensive patients to send SMSs.

7 However, they emphasised on the need for government commitments for such programs, such as
8 establishing a separate department to monitor the program.

9 The key informants highlighted the need for system-level preparedness by extensive planning,
10 budgeting, and establishing the mobile phone text messaging software development centre. They
11 expressed that multi-sectoral collaboration and commitments are needed to implement the mHealth
12 program effectively.

13 **Alternative strategies for illiterate groups**

14 Participants suggested including a family member of the illiterate patients when sending messages.
15 They highlighted every household should have at least one literate person. Even the family members
16 were ready to support their parents.

17 They expressed “*For Illiterate people like my mother, it has to be sent to the member of the family like*
18 *me. As a son, I must take care of her*” (FM 02 of 60-65 Y, F, PL). Furthermore, video/voice messages,
19 symbolic pictures or cartoons were recommended by HCWs for the illiterate groups.

20 *I think the video is more effective than a text message as it has both audio/visual features. (P014:*
21 *35-40Y, M, TL)*

22 However, some participants raised concern about the family member's relationship with patient and
23 their availability and the feasibility of using video message in a resource constraint setting like Nepal.
24 Especially these concerns were raised at primary level where smartphones, internet and MMS facilities
25 are limited to support video messages.

26

V. Preferred features of the mHealth (text message) intervention

In each IDI and FGD, answers to the questions on the need and preference of participants to inform the content and delivery of mHealth intervention were analysed.

Comprehensive contextual contents: Participants expressed various misconceptions prevalent in the study setting regarding hypertension and its' treatment. Participants preferred getting context specific messages targeting those misconception on hypertension treatment such as use of locally available herbs: aloe vera juice, bitter juice (Chirauto), barley sprout juice (JAMARA) etc. Similarly, they preferred including messages targeting the foods prepared during festivals in Nepal which are high in fat and salt content.

Patients says that "yesterday I attended a festival. After eating high salt food and meat, I am getting headache, so I came here for check-up." So, I think you should send information about diet as well. (HCW 04: TL)

For lifestyle modification, some of the patients expressed that it would be good to receive information about physical activity and culturally appropriate dietary factors. "What kinds of exercise should be done, how much.... amount.... duration.... Time." KI also added that patients should get all the messages on pharmacological and non-pharmacological measures for controlling their blood pressure.

Overall, content preferences included information about hypertension and its treatment, dietary factors (local foods), medication, side effects, physical activities, and reminder for medication.

Reasonable frequency and timing of text messages: They also stated that the text messages should be delivered with reasonable frequency and timing. Study participants preferred to receive 2-3 reminders messages per week for taking medication or about specific behaviours. Overall, participants agreed that daily messages would be too often and monthly be insufficient.

If you send in the interval of 2-3 days, then then we might see that. (P018: 40-45 Y: M, PL)

Most of them preferred the messages to be delivered in the morning or evening. Participants mentioned that if the timing of the message matched with the time of taking their medicine, then it would be more effective "Usually people take medicine in the morning so, that would be a good time." (P05:45-50, F,

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2
3 1 *PL) Another participants also added. " For women....in the evening time would be good as we will be*
4
5 2 *busy in household works during morning." (FGD 05: 30-35 Y; F, TL)*

6
7 3 Overall content preferences were not different based on the gender, age, and level of care. However,
8
9 4 female mostly expressed their preference to receive messages in the evening time.

11 5 12 13 6 **DISCUSSION**

14
15 7 This study explored the perspectives of patients and providers on the acceptability of mHealth (mobile
16
17 8 phone text messages) intervention for patients with hypertension in Nepal. Overall, participants were
18
19 9 receptive towards such text message intervention with some contextual recommendation. This study
20
21 10 found that a simple mobile phone text messages, could be useful in this setting due to the ubiquitous
22
23 11 use of mobile phones. Studies from the primary level²⁶ and rural part of India⁴⁰ have reported the similar
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25 12 findings as mHealth being ubiquitous and acceptable tool for managing cardiovascular diseases and
26
27 13 supporting healthcare. Key informants involved in implementing the national NCDs program and policy
28
29 14 in Nepal identified low resource requirement for SMS which could be a potential usefulness of such
30
31 15 intervention. The WHO's Global Observatory for eHealth (GOe) also stated SMS as an easy method to
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33 16 send a brief message at a low cost.¹⁵ Text messages can be sent in bulk to multiple users simultaneously,
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35 17 as they are cheap and do not require advanced skills.¹⁶ However, cost effectiveness analysis is an area
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37 18 for future research in this setting.

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40 19 Our study found behaviour reinforcement/modification as another potential use of mHealth. In chronic
41
42 20 diseases such as hypertension, where medication should be taken daily, SMS reminders can increase
43
44 21 medication adherence.^{42,43} Additionally, WHO GOe stated that SMS was the preferred method for
45
46 22 treatment compliance measures worldwide.¹⁵ Non-disclosure issues due to the stigma attached to
47
48 23 hypertension was reported, especially by the young people in Nepal in our previous study.¹³ The
49
50 24 importance of receiving messages privately on mobile was stressed by our respondents, it has not been
51
52 25 reported for NCD previously, but these were mostly reported in studies of HIV/AIDS.⁴⁴ Overall, there
53
54 26 was a consensus of the value of text messaging in getting information privately (in confidence) to
55
56 27 hypertensive patients by all the stakeholder groups. However, our study participants did not mention

1 about the data security, an important factor while designing a mHealth intervention.

2 Our study participants perceived text messages intervention as easy to operate that does not require
3 advanced technical skills. They preferred to have messages in the local Nepali language for the ease of
4 use for broader groups. We were also able to identify implementation challenges that were similar to
5 other resource limited setting as well as unique to the setting. Difficulty in reading text messages (even
6 in the local language), a language and literacy barrier including digital literacy in reading the text
7 messages were reported in this study, similar to South Indian studies.^{26, 44} In Nepal, though mobile
8 phone penetration is high, digital literacy is only reported as 31%.⁴⁵ In this context, alternative solutions
9 identified by stakeholders was inclusion of family members of illiterate/ older groups and sending video
10 or symbolic messages.

11 While there was enthusiasm to use mHealth, HCWs and KI expressed concerns about the lack of
12 resources and technical issues that could be an impediment. They expressed concern that implementing
13 a new mHealth (SMS) system in the hospital might require extra technical manpower for software
14 development generating a need for a separate technical department. The immaturity of health
15 information systems in hospitals and gaps in recording essential information was identified. Similar
16 issues have been reported from rural India as a barrier to the continuity of care and follow up with
17 hypertensive patients.⁴⁶ These findings were corroborated in other studies of Kenya⁴⁷ and Bangladesh.⁴⁸
18 The WHO has also stated that unclear mHealth policy and underdeveloped infrastructure are the most
19 common barriers in adopting mHealth in LMICs settings.¹⁵ In our study, it was explicitly stated that a
20 reliable and peer-reviewed source of information is required. A SMS originating from a public or private
21 health centre will be trusted by individuals as they would be considered reliable. It is therefore,
22 imperative to establish trustworthiness of the information for the desired behaviour modification.⁴⁹ The
23 key recommendation was to have government commitment and multisectoral collaboration and
24 coordination with the health system to address the structural barriers to use advanced technology. These
25 aspects should be carefully considered while designing the mHealth intervention for its sustainability.

26

27

1 **Implications for mHealth design and future research**

2 This study supported the evidence that mHealth could be acceptable in LMIC settings, if designed based
3 on the local context and needs.^{50,51} Our study participants highlighted their interest in getting messages
4 clarifying the misconceptions regarding the use of local herbs for treatment of high blood pressure and
5 targeting the cultural foods practices. The findings of this formative research informed the contextual
6 contents of our next phase TEXT4BP intervention that would be tested using the randomised controlled
7 trial design.⁵² Information on the contents of the intervention, frequency, and timing of the intervention
8 may be of value to a similar resource-limited setting. In Nepal, there are very few studies on mHealth,
9 this study could broaden the horizon for use of mHealth in the management of hypertension. In today's
10 context of the need for evidence-based use of modern technology in health service delivery, as stressed
11 in Nepal Health Sector Strategy 2015-2020,⁵³ the finding from this study are crucial in designing
12 evidence based mHealth intervention in the context of Nepal. Future research should explore how best
13 to implement culturally developed mHealth intervention in the regular health care system to increase
14 the adoption.

15 **Strength and limitations of the study**

16 One of the strengths of the study is that efforts were taken to ensure the trustworthiness³⁷ of data by
17 ensuring credibility by adopting appropriate and different methods for data collection (IDIs and FGDs);
18 by including a different cadre of participants (patients, their family, health workers, key informants)
19 from different sites (primary and tertiary level). The researcher (BB) obtained participant validation at
20 the end of the interview by summarising the main points to ensure the respondent's perspective.⁵⁴ In
21 addition, we have used the TAM model to inform our analysis. We have presented the steps in the
22 analysis and showed that we generated the themes and subthemes with discussion. However, some
23 limitations were that we had analysed data from different sources and methods together, which might
24 not fulfil all the criteria of triangulation and used purposive sampling, which may have created selection
25 bias. However, we tried to ensure the diversity of participants. Furthermore, the transferability of the
26 findings is limited as this study was conducted in urban and semi-urban part of the country, which may
27 not represent the view of people from the geographically disadvantaged remote areas of LMICs.

CONCLUSIONS

This study found that participants were receptive towards a simple mHealth intervention such as SMS notifications. Overall, there was a consensus of the value of a text messaging solution to hypertension management by all the stakeholder groups. However, meticulous planning must include a diverse range of participants to ensure the intervention is acceptable to a wide range of participants, including illiterate and older groups. Similar formative study approach can be used to inform contextual interventions in other LMIC settings.

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Author contributions

All authors contributed to the conception of research design, acquisition, and data interpretation. BB conducted the fieldwork and wrote the first version of this manuscript. BB and PN participated in the analysis of the data. All the authors BB, AES, RJ, AV, MS and PN were involved in the manuscript drafting, revision, and finalisation. All authors read and approved the final version of the manuscript.

Competing interest

No financial or any other competing interests exist.

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1
2
3 1 **Patient consent for publication:** Obtained
4

5 2 **Data sharing statement:** The data for this research consists of audio recordings of interviews,
6
7 3 interview transcripts. The researchers have access to these data. All data are stored securely on
8
9 4 password-protected and encrypted computers. Participants have not given their permission for data
10
11 5 sharing outside the research group. Thus, no additional data are available.
12

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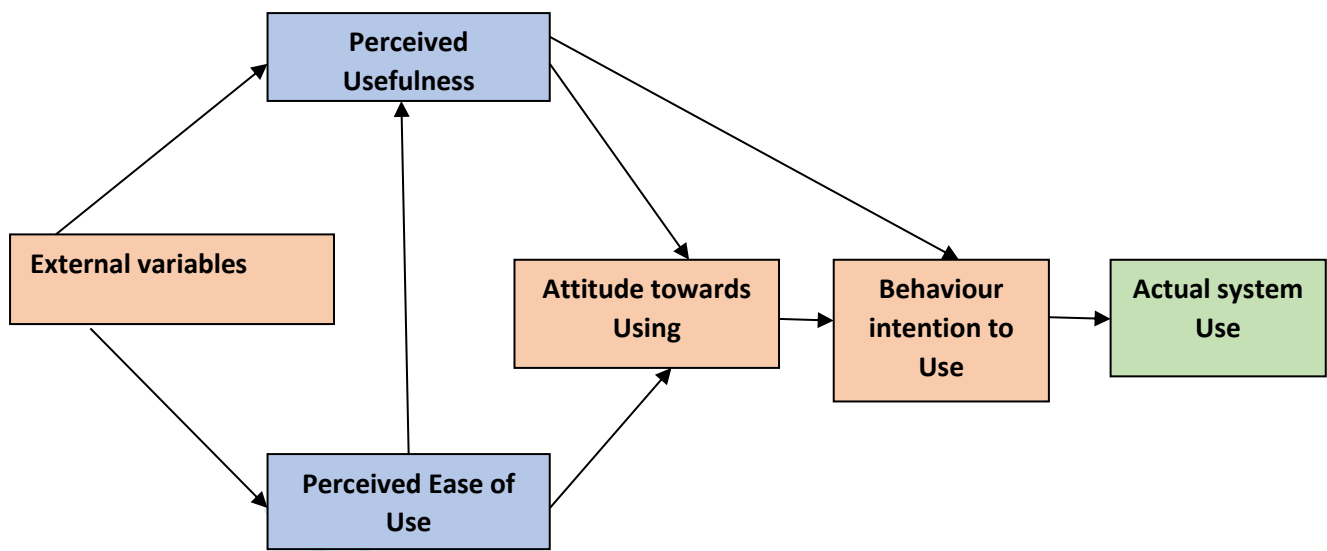


Fig 1: Technology Acceptance Model

Supplementary file 1

Process of participants recruitment

Health care providers at both levels distributed a study flyer containing information about the study to the eligible participants at OPD. When an interested participant initiated the contact, the researcher screened them for eligibility and selected purposively after informed consent based on their age, sex, literacy status to capture diverse perspectives. Similarly, study participants were asked to nominate family members after obtaining consent to be contacted by the research team. Health care workers from the selected study site were also approached for the interview by the researchers. We also invited key informants (policymakers, researchers, and program implementors) working in Non-Communicable Diseases (NCDs) management based on the recommendation from the local research team.

Definition of the variables

Acceptability: We have used the acceptability approach as defined by Schade and Schlage et.al¹ as “a prospective judgement of measures to be introduced in the future where the target group will not yet experience the new measures”.

Literacy: The ability to read and write. We have asked either they could read and write or not.

Employment: The state of having paid work. We have asked whether they were engaged in any paid income work or not.

Definition of the Health Care Providers

Cardiologist: Medical doctor who had MBBS, MD and DM cardiology degree working in public hospital/medical college at tertiary centre

Physician: Internal medicine physician who had MBBS and MD in internal medicine working in a public medical college at tertiary centre

Medical officer: Medical doctor with MBBS degree, who provides services to the hypertensive patients in both primary and tertiary level.

Health Assistant (HA) and community health assistant (CMA): Non physician health workers (HA- 3 Year certificate level formal education, CMA- diploma level 18-month formal training) who are

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3 posted in the government primary health care centre and health post and provide OPD service to
4 hypertensive patients in those centre.
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7 **Staff nurse/ANM:** Health personnel with nursing education (staff nurse- certificate level 3-year nursing
8 education, ANM- diploma level 18-month nursing training) they involve in providing counselling to
9 the hypertensive patients.
10

11 12 **Abbreviation of the verbatim of the participants**

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14 **PL: Primary level**

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16 **TL: Tertiary level**

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18 **F: female**

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20 **M: male**

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22 **Y: years**
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27 **Reference**

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Supplementary file: 2**I. In-depth Interview guides**

1. Icebreaker
 - a. How are you doing?
 - b. What kinds of work are you doing these days?
2. Could you please share your experience of using mobile phone? *Probe: How, when, for what purpose etc*
3. What do you know about use of mobile health in management of high blood pressure?
4. Could you please share your opinion on using mobile phone for management of high blood pressure? *Probe: what, how*
5. Have you heard, or have you been told that you can get health messages through mobile phone?
6. What is your opinion about it? What is your perspective on potential of mobile health service in management of hypertension in Nepal? *Probe: what, how, example*
7. What could the potential advantages of using mobile health in Nepal?
8. What could be the challenges in using mHealth in Nepal for the management of hypertension?
9. What can be done to overcome the challenges for successful outcome?
10. What kinds of mobile health services you would like to get/use?
11. What should be the contents, timing, and frequency of such mHealth services?
12. Do you want to share anything which I missed to discuss?
13. Let's summarise some of the key points from our discussion. Is there anything else?

III. FGD guides

Let's start by going around the circle and having each person introduce her/himself.

(Members of the research team should also introduce themselves and describe each of their roles.)

1. Icebreaker
 - a. How are you doing?
 - b. What kinds of work are you doing these days?
2. Could you please share your experience of using mobile phone? *Probe: How, when, for what purpose etc*
3. What do you know about use of mobile health in management of high blood pressure?
4. Could you please share your opinion on using mobile phone for management of high blood pressure? *Probe: what, how*
5. Have you heard, or have you been told that you can get health messages through mobile phone?
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12. Do you want to share anything which I missed to discuss?
13. Let us summarise some of the key points from our discussion. Is there anything else?

COREQ (CONsolidated criteria for REporting Qualitative research) Checklist

A checklist of items that should be included in reports of qualitative research. You must report the page number in your manuscript where you consider each of the items listed in this checklist. If you have not included this information, either revise your manuscript accordingly before submitting or note N/A.

| Topic | Item No. | Guide Questions/Description | Reported on Page No. |
|--|----------|--|----------------------|
| Domain 1: Research team and reflexivity | | | |
| <i>Personal characteristics</i> | | | |
| Interviewer/facilitator | 1 | Which author/s conducted the interview or focus group? | |
| Credentials | 2 | What were the researcher's credentials? E.g. PhD, MD | |
| Occupation | 3 | What was their occupation at the time of the study? | |
| Gender | 4 | Was the researcher male or female? | |
| Experience and training | 5 | What experience or training did the researcher have? | |
| <i>Relationship with participants</i> | | | |
| Relationship established | 6 | Was a relationship established prior to study commencement? | |
| Participant knowledge of the interviewer | 7 | What did the participants know about the researcher? e.g. personal goals, reasons for doing the research | |
| Interviewer characteristics | 8 | What characteristics were reported about the interviewer/facilitator? e.g. Bias, assumptions, reasons and interests in the research topic | |
| Domain 2: Study design | | | |
| <i>Theoretical framework</i> | | | |
| Methodological orientation and Theory | 9 | What methodological orientation was stated to underpin the study? e.g. grounded theory, discourse analysis, ethnography, phenomenology, content analysis | |
| <i>Participant selection</i> | | | |
| Sampling | 10 | How were participants selected? e.g. purposive, convenience, consecutive, snowball | |
| Method of approach | 11 | How were participants approached? e.g. face-to-face, telephone, mail, email | |
| Sample size | 12 | How many participants were in the study? | |
| Non-participation | 13 | How many people refused to participate or dropped out? Reasons? | |
| <i>Setting</i> | | | |
| Setting of data collection | 14 | Where was the data collected? e.g. home, clinic, workplace | |
| Presence of non-participants | 15 | Was anyone else present besides the participants and researchers? | |
| Description of sample | 16 | What are the important characteristics of the sample? e.g. demographic data, date | |
| <i>Data collection</i> | | | |
| Interview guide | 17 | Were questions, prompts, guides provided by the authors? Was it pilot tested? | |
| Repeat interviews | 18 | Were repeat interviews carried out? If yes, how many? | |
| Audio/visual recording | 19 | Did the research use audio or visual recording to collect the data? | |
| Field notes | 20 | Were field notes made during and/or after the interview or focus group? | |
| Duration | 21 | What was the duration of the interviews or focus group? | |
| Data saturation | 22 | Was data saturation discussed? | |
| Transcripts returned | 23 | Were transcripts returned to participants for comment and/or | |

| Topic | Item No. | Guide Questions/Description | Reported on Page No. |
|--|----------|--|----------------------|
| | | correction? | |
| Domain 3: analysis and findings | | | |
| <i>Data analysis</i> | | | |
| Number of data coders | 24 | How many data coders coded the data? | |
| Description of the coding tree | 25 | Did authors provide a description of the coding tree? | |
| Derivation of themes | 26 | Were themes identified in advance or derived from the data? | |
| Software | 27 | What software, if applicable, was used to manage the data? | |
| Participant checking | 28 | Did participants provide feedback on the findings? | |
| <i>Reporting</i> | | | |
| Quotations presented | 29 | Were participant quotations presented to illustrate the themes/findings? Was each quotation identified? e.g. participant number | |
| Data and findings consistent | 30 | Was there consistency between the data presented and the findings? | |
| Clarity of major themes | 31 | Were major themes clearly presented in the findings? | |
| Clarity of minor themes | 32 | Is there a description of diverse cases or discussion of minor themes? | |

Developed from: Tong A, Sainsbury P, Craig J. Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups. *International Journal for Quality in Health Care*. 2007. Volume 19, Number 6: pp. 349 – 357

BMJ Open

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1 **Acceptability of a mHealth strategy for hypertension management in a Low and Middle-Income**

2 **Country setting: A formative qualitative study among patients and healthcare providers**

3 **Short title:** Acceptability of mHealth strategy for hypertension management: A formative qualitative
4 study

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4 and references) Tables- 3, Figure-1, Supplementary files- 3

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8 3 **ABSTRACT**

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11 4 **Background:** Understanding contextual needs and preferences is important for a successful design and
12 effective outcome of a mHealth strategy.

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15 6 **Objectives:** This formative study aimed to explore the perspectives of patients and providers on the
16 acceptability of mHealth (text message) strategy and elicit preferred features of a mHealth strategy for
17 hypertension management.

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22 9 **Design:** A qualitative study was conducted using in-depth interviews (IDIs) and focus group discussions
23 (FGDs) guided by the Technology Acceptance Model (TAM).

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27 11 **Setting:** The study was conducted at primary healthcare facilities and at a tertiary level referral hospital
28 in Kathmandu, Nepal.

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32 13 **Participants:** A total of 61 participants, patients with hypertension (n=41), their family members (n=5),
33 healthcare providers (n=11) and key informants (n=4) were included. We purposively recruited patients
34 with hypertension aged 30 to 70 who attended the selected health care facilities to obtain maximum
35 variation based on their age, sex, and literacy.

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41 17 **Results:** The respondents perceived text message interventions to be useful as it can reinforce
42 medication compliance and behaviour change. Participants valued the trustworthiness of information
43 from health authorities that can be delivered privately. Some, implementation challenges were identified
44 as lack of technical manpower, resources for software development, gaps in recording patient's essential
45 information and digital illiteracy. Solutions proposed were to have system level preparedness for
46 recording the patient's details, establishing separate technical department in the hospital and involving
47 a family member of illiterate/elderly patients. In addition, participants preferred text messages in local
48 language, containing comprehensive contextual content (disease, treatment, cultural foods and
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3 1 misconceptions etc.) delivered at regular intervals (2-3 times/week) preferably in the morning or
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5 2 evening.

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8 3 **Conclusions:** We found that a simple as text messaging strategy was acceptable for hypertension
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10 4 management in this LMIC setting. However, meticulous planning must address the needs of a diverse
11
12 5 range of participants to ensure the mHealth is acceptable to wider groups.
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17 7 **Keywords:** Text messaging, SMS, High blood pressure, Mobile health, Adherence, TAM Model
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21 22 23 9 **STRENGTHS AND LIMITATIONS OF THE STUDY**

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26 10 - This formative study is the first conducted in Nepal that explored the acceptability of mobile
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28 11 phone text messages strategy targeted to the patients with hypertension guided by an accepted
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30 12 technology acceptance (TAM) model.
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33 13 - The strength of the study was the inclusion of diverse stakeholders such as patients, providers,
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35 14 family members and policymakers at different levels of the health care system.
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38 15 - This study was conducted in urban and semi-urban parts of the country, limiting the
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40 16 transferability of findings to rural and disadvantaged areas.
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1 Introduction

2 Hypertension, a major Cardiovascular Disease (CVD) risk factor, is an emerging public health
3 challenge particularly affecting low and middle-income countries (LMICs).^{1,2} Although highly effective
4 and affordable medications are widely available, a major challenge in LMICs remains abysmal
5 hypertension control of less than 50%.³ Nepal is no exception to this, with 57% patients remained
6 undiagnosed in community due to asymptomatic nature of the hypertension.⁴ In addition, among those
7 who are diagnosed, only 35-45% of the hypertensive patients have controlled blood pressure,^{5, 6} leading
8 to high mortality and morbidity.⁷

9 The Global Burden of Disease Study 2019 has recommended that countries invest in cost-effective
10 public health interventions to improve blood pressure control and prevent premature deaths from
11 hypertension and consequent CVD.⁸ Globally, a wide range of non-pharmacological interventions are
12 implemented to improve blood pressure control, such as self-monitoring of blood pressure,⁹ educational
13 interventions focused on patients,¹⁰ health professional- led care (nurse, pharmacist, community health
14 workers);¹¹ as well as appointment reminders.¹² However, delivery of these interventions is hindered by
15 inadequate communication between patients and providers,¹³ primarily due to a poor clinician to patient
16 ratio in low-resource setting.¹⁴

17 Mobile health or mHealth uses mobile devices such as mobile phones, patient monitoring devices,
18 personal digital assistants, and other wireless devices to support medical or public health practice.¹⁵ In
19 low resource settings, mobile phones are a promising tool to improve healthcare access and
20 coverage.^{16,17} It offers a simple and effective mode of communication, enabling the patient to self-
21 manage hypertension through tailored feedback.^{18,19} Included in self-management, a text message is an
22 appropriate mode to guide behaviour interventions,²⁰ and although simple, it has many advantages than
23 mobile applications and computer interventions, especially in low resource settings or remote areas with
24 limited internet access.^{20,21}

25 The Nepal Telecom Authority (NTA) has reported an estimated 38.21 million mobile services users in
26 Nepal.²² Despite this penetration of mobile services to the population, only a few pilot projects have

1 used it for nutrition counselling and maternal and child health services^{23,24} and only handful initiatives
2 for non-communicable disease (NCD) management targeting community health workers.²⁵ There is
3 immense potential to use mobile services to bridge the communication gap between providers and
4 patients for hypertension management in Nepal. However, it is essential to understand its acceptability
5 by target populations, and country-specific needs to develop a mHealth strategy to get its desired
6 outcomes.²⁶ This formative study aimed to explore different stakeholder's perceptions on the use of
7 mHealth (text messages) to capture multiple level perspectives guided by the TAM model²⁷ and elicit
8 their preferred features of mHealth (text messages) strategy for hypertension management in Nepal.

9 **Methods**

10 Qualitative research was conducted to explore the perspectives of the study participants on the potential
11 use of mHealth (text message) strategy for patients with hypertension. This study was conducted at
12 primary health care facilities (one primary healthcare centre and five health posts) of Kageswori
13 Manahara municipality and at a Tertiary level referral Hospital in Kathmandu, Nepal (Kathmandu
14 Medical College and Teaching Hospital), to explore the perspective of people of different healthcare
15 levels.

16 **Theoretical model informing the study:** Our study used the TAM model developed by Davis²⁷ as an
17 overarching model to guide the analysis to assess the acceptability of the proposed mHealth strategy
18 (Figure 1). This model considered the two main beliefs: perceived usefulness and perceived ease of use
19 as the main factors for an individual's acceptance of the technology. Perceived usefulness is when users
20 believe that using a technology will enhance their job performance and perceived ease of use is a user's
21 belief that a technology is free of effort which is influenced by external factors. ²⁷ We explored mainly
22 these factors in our study. The TAM model considers that there is a strong relationship between a
23 person's intention to use and actual use of technology.²⁸ This model is valid, robust and has been widely
24 used in understanding human behaviour in acceptance of technology.²⁸⁻³² We have used this model for
25 informing our analysis considering its applicability based on our objectives .

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6 **2 Study populations and recruitment**
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8 3 We included patients with hypertension aged 30 to 70 who attended the selected healthcare facilities
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10 4 from March to July 2018. We excluded patients with complicated hypertension with severe multi-
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12 5 morbidity requiring immediate care at tertiary level hospitals, which would limit their ability to
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14 6 participate in the study. Participants with severe mental and physical disabilities and
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16 7 pregnant/postpartum women were excluded from the study. However, we included participants with
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18 8 comorbidities who were not serious. We have included the different groups of patients (based on age,
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20 9 sex, literacy), their family members, healthcare providers (HCWs) from both levels of care, and key
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22 10 informants (KI) to capture the multiple perspectives for validating the data through data source
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24 11 triangulation.³³ Perspectives from patients and family members helped in understanding patient-
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26 12 community level perspectives whereas KI and HCWs perspectives provided an opportunity to
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28 13 understand the system level factors for the contextual design of the mHealth strategy. The details of the
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30 14 study participants and the recruitment process has been described previously¹³ and presented briefly in
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32 15 *Supplementary file 1.*
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36 **16 Data Collection Methods**
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38 17 We collected data using in-depth interviews (IDIs) and focus group discussions (FGD) methods to
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40 18 ensure rigor through methodological triangulation.³³ IDIs provide an opportunity to explore rich
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42 19 personal experiences and perspectives on the topic.³⁴ However, FGD elicit data from the group of
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44 20 participants where they could hear each other perspectives and comments additionally which they may
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46 21 not have expressed in the IDIs.³⁵ IDIs and FGDs were conducted using a semi-structured interview
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48 22 guide. The interview guide contained the questions mainly on perspectives on using the mHealth, its
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50 23 advantages, challenges and their preference on the contents, frequency of the text messages.
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52 24 (*Supplementary file:2*). While taking the consent, participants were explained about details objectives
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54 25 of the study, conceptual mHealth (TEXT4BP) study, and about interviewer. The first author BB
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56 26 (female, PhD fellow), a native language speaker trained in qualitative research methods, conducted all
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58 27 the IDIs in the Nepali language in a suitable private place (OPD of health facilities or privately at the
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home of the participants without the presence of family members). Interview observation notes for non-verbal cues and audio recordings captured the interview data, which lasted for about 35 to 60 minutes. A total of 25 IDIs among hypertensive patients, five IDIs among family members, 11 IDIs among healthcare providers, and four IDIs among key informants were conducted. Two Focus Group Discussions (FGD) were also conducted using the FGDs guides among 16 (8 participants in each FGD) diverse hypertensive patients at a private OPD room with no additional person present at the tertiary level. The FGDs were facilitated by the first author in the Nepali language, audio recorded and each FGD lasted for 60 to 90 minutes. We decided the number of participants for FGDs based on the standard recommendations for FGDs and patient-availability.³⁶ The number of IDIs was decided based on the number of diverse group representation (by age, sex, literacy) till the saturation of information achieved at both levels of healthcare. To decide on the saturation of information, the interviewer prepared the summary after each interview to look for any new information coming from IDIs. (Table 1).

Table 1: Total number of study participants for IDIs and FGDs included from the Primary and Tertiary level.

| Participant group | Primary health care level (PL) | Tertiary health care level (TL) | Total |
|--|--|--|-----------|
| Patients with hypertension | 13 - IDIs | 12-IDIs | 25 |
| Patients with hypertension | NA | 2 FGD (8 in each) * | 16 |
| Healthcare provider | 5- IDIs Medical Officer- 1 Health Assistant- 1 Community Health Assistant – 1 Axillary Nurse midwife - 1 | 6 -IDIs Cardiologist -3 Physician- 1 Medical officer- 1 Staff Nurse -1 | 11 |
| Family members of patients with hypertension | 3 -IDIs | 2- IDIs | 5 |
| Key informants | 4- IDIs NCDs policy maker -1 NCDs program focal person at DoHs, MoHP-2 NCDs researcher 1 | | 4 |
| Total | | | 61 |

Note: *Due to low patient flow at Primary healthcare level, FGDs could only be conducted at the Tertiary level. DoHs MOHP= Department of Health Services, Ministry of Health and Population

1 **Data Analysis**

2 All audio recorded FGDs and IDIs with the research participants were transcribed in the local language
3 (Nepali) by the first author and a qualified transcriber. The transcripts were checked against the audio
4 recordings for ensuring accuracy, and pseudonyms were applied. The transcripts and observation notes
5 were translated into English by the researcher and a qualified translator. Translation reliability and
6 accuracy was checked in a random sample of transcripts by back-translation of the transcripts to
7 compare with the original script in local language by the first author (BB). Transcripts were not shared
8 with the participants, however, the interviewer summarised the main information at the end of the
9 interview to obtain participant validation.³⁷ NVivo 12 software³⁸ was used for data management. The
10 first author coded all the transcripts. Data analysis was informed by the TAM model and overarching
11 aim of the study. This study utilised this model to understand the perceived usefulness, perceived ease
12 of use and perceived challenges of using text messages as a behaviour change strategy. We followed
13 the thematic analysis process proposed by Braun and Clarke.³⁹ It includes familiarising with the
14 transcribed data by reading and re-reading, generating the codes, searching and reviewing the theme,
15 defining and naming the theme and finalising the analysis. The codes and themes were discussed with
16 the co-author (PN) and agreed upon between investigators (BB and PN). The sub- themes generated
17 from the transcripts were mapped under the overarching theme (I-III) of the TAM model and other
18 themes (V-VI) generated based on the objectives of the study as presented in the result section. We
19 followed the Consolidated Criteria for Reporting Qualitative Studies (COREQ) 32-item checklist⁴⁰ to
20 ensure reporting consistency. (*Supplementary file 3*).

21 **Patient and public involvement**

22 This research was conducted without patient or public involvement. Participants were not invited to
23 comment on the study design or contribute to the research write up and dissemination.

24 **Ethics Approval:** Ethics approval for the study was obtained from the Human Research Ethics
25 Committee of the University of New South Wales, Australia (Ref no: HC17753) and Nepal Health
26 Research Council (Reg no 21/2018). Informed consent was taken from all the study participants.

1 RESULTS

2 Most of the hypertensive participants (29%) were between the age of 50-60 years with mean age of 48
3 years, female (51%), literate (65%) and employed (70%). Of them, 88% had been diagnosed more than
4 one year prior to study with 34% more than 5 years. (Table:2)

5 **Table 2: Sociodemographic profile of the study participants of IDIs and FGDs (hypertensive**
6 **patients)**

| Characteristics | Categories | Hypertensive patients (N=41) | |
|---------------------------------------|----------------------|------------------------------|------------|
| | | Frequency | Percentage |
| Age (years) | 30-40 | 10 | 24.4 |
| | 40-50 | 11 | 26.8 |
| | 50-60 | 12 | 29.3 |
| | 60-70 | 8 | 19.5 |
| | Mean age \pm SD | 48.17 \pm 10.78 | |
| Sex | Female | 21 | 51.2 |
| | Male | 20 | 48.8 |
| Literate | Yes | 27 | 65.8 |
| | No | 14 | 34.2 |
| Employment | Yes | 29 | 70.7 |
| | No | 12 | 29.3 |
| Duration of diagnosis of hypertension | Less than a year | 5 | 12.2 |
| | 1-5 years | 22 | 53.6 |
| | More than five years | 14 | 34.2 |

7 *Note: details of the study other participants (family members, HCWs and KI) are presented previously.¹³*

8
9 Our study revealed three broad themes (I-III) on acceptability under the TAM model and other two
10 themes (IV-V) as suggested solutions, and preferred features of the mHealth strategy. All the themes,
11 sub themes of study and supporting verbatim are presented in **Table 3**.

1 **Table 3: Themes and subthemes generated on the perception of using a mHealth (Text message) strategy.**

| Themes Based on TAM Model on acceptability | Subthemes | Supporting verbatim |
|--|---------------------------------------|--|
| Perceived usefulness | Acceptable and require less resources | <p><i>These days, mobile(phone) is widely available and easy to use for many people. If anything comes in the mobile from a reliable source, it might have some good effect. (P021: M, 40-45 Y, PL)</i></p> <p><i>It is also a cost-effective program. We can send one SMS to millions of people in a short period. It will increase coverage among the patients and will be more effective. (KII02)</i></p> |
| | Reinforce behaviour change | <p><i>"The patients should at least be notified on their mobile phones to take their medicine on time. Then, the patient would realise and be motivated to follow that." (HCW 02, PL)</i></p> |
| | Can provide reliable information | <p><i>"If messages are sent by you and others like you (health professional), I will happily accept it thinking that doctor with whom I meet at the hospital sent this message." (P013: 45-50 Y, PL)</i></p> |
| | Deliver information privately | <p><i>"If I get information on my mobile, then it might help to improve my blood pressure. If I go to the health centre, there would be lots of people ... I feel shame to say myself ill in front of other people. I have not shared with friends, as well." (P014: 35-40 Y, M, TL)</i></p> |

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|--|---------------------------|--|
| Perceived ease of use | User friendly | <i>I think it will work and be feasible because majority of the people own mobile phone, can very easily see the information in mobile without any difficulties and there is no need to have expensive smartphone for simple SMS. (P20: M, 50-55Y, PL)</i> |
| | Local language | <i>The SMS language should be simple and easy to understand for us. Nepali is the most common language out here and people can easily read that. (P015: 30-35Y, M, TL)</i> |
| Perceived challenges – external factors | Mobile phone illiteracy | <i>We cannot read, so how can we know what is being sent in mobile; we will not understand whatever things come into our mobile....is not it? (FGD01; 60-65Y, F, TL)</i> |
| | Technical constraints | <i>"No. No. How can we manage those mobile services? It will be challenging to implement. It needs a considerable amount of budget, though the concept is excellent." (HCW 03: PL)</i> |
| Themes under other objectives of study | Sub - themes | Supporting verbatim |
| Perceived solutions for overcoming the challenges | System-level preparedness | <p><i>The hospital must also have a record of the detailed list of OPD patients diagnosed with hypertension. Proper record-keeping is essential. (HCW 09: TL)</i></p> <p><i>"For such project, we need some mobile centres/department, or some technical manpower then only we can implement it." (KII 03)</i></p> |

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|---|---|--|
| | Alternatives strategies for illiterate | <p><i>"These days though mother/father is illiterate, there will be son, daughter and grandchildren who are educated. If we could send the message to the family member of the illiterate patients, they will get the information. (HCW 07: PL)</i></p> |
| Preferred features of the mHealth strategy | Comprehensive contextual contents | <p><i>Is BP controlled after taking bitter herbs (chirauto) only or should we go for acupuncture or not..some people say that there is a person who press in the hand and pressure will be fine, so should we follow that or not?– it should be send in messages. (P08: 50-60 Y F, PL)</i></p> <p><i>It should include all the information regarding what type of diet should we take and what should be avoided. Like messages regarding patient should take less salty and oily food. [P012: 45-50 Y, F, PL]</i></p> |
| | Reasonable frequency and timing of messages | <p><i>"I feel like if it can be sent once or twice a week, then it will be kept in touch also. If we send them daily, then they might delete it. (laughs)." (HCW 05, TL)</i></p> |

Themes mapped under TAM Model

I. Perceived usefulness

The main subthemes under perceived usefulness of TAM model are as follows:

Acceptable and require less resources: Study participants reported that a simple text message would be acceptable in the study settings due to the ubiquity of mobile phones.

Participants expressed that mobile phones are popular. They also expressed their interest and readiness to participate in such a program. *"If you send us SMS, we are ready to use this."* (P03: 50-55 Y,F, TL)

Healthcare workers (HCWs) also confirmed that mobile phones are widely accessible, even in rural areas. Some stated that getting messages on their mobile phone would be very handy and save time to travel to the health centre in getting information about the disease and its treatment. The key informants examined mHealth from a program perspective. They identified SMS might require less resources as it can be sent to many people at the same time (bulk SMS) with limited investment.

Reinforce behaviour change: HCWs expressed that text messages could act as a reminder to take medication on time and reinforce recommended behaviour changes such as physical activity.

Participants stated that using a text messages strategy might meet their unmet needs to receive specific information to reinforce behaviour change such as how much salt is recommended for blood pressure control.

"If specific information (such as this much salt is allowed) will be sent for us, definitely it would help for changing our habits." (FGD 02: 50-55 Y, F, TL)

Can provide reliable information: Some participants reported that they can search for unlimited information from the internet on their mobile by themselves. However, the authenticity and relevance of those messages could not be determined. They requested information from a *"reliable and trustworthy"* provider, referring to HCWs.

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3 1 HCWs reinforced this request and stated that it should be adequately linked with the health system to
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5 2 ensure that messages will be accepted and trusted by participants, that may motivate the intended
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7 3 behaviour change.

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9 4 **Deliver information privately:** Participants stated that text messages have the advantage of delivering
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11 5 personalised information on their mobile privately. They valued personal text messages sent on their
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13 6 mobile as others cannot know their hypertension status. This was the case with younger patients, who
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15 7 did not want their illness divulged to people they associate with.

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18 8 Overall, there was no reported difference in usefulness based on the gender and level of healthcare.
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20 9 However, the advantage of getting messages privately was expressed mainly by the younger
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22 10 participants, not by the older age groups.

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12 II. Perceived ease of use:

13 **User friendly:** The participants expressed that the text messages can be a simple and easy strategy as it
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15 14 does not require advanced technical skills to operate. Participants preferred receiving messages in a
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17 15 simple, clear, and concise format. They further added that if SMS is designed in an understandable
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19 16 format, it can be effective in the study setting.

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38 17 *It will be effective. These days, even the lay man (najjanne), can use simple messaging. (P10: 45-50Y, F,*
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40 18 *TL)*

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20 **Local language:** Study participants expressed that it would be easy to read and understand if the
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22 21 messages are sent in the Nepali language. If designed in local language, people with low literacy can
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24 22 also utilize it for behaviour modification.

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23 *Yes, she (patient) could read it if it is sent in Nepali. If sent in English, even I cannot read it. But*
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25 24 *we both can read in Nepali. (FM03 of 40-45Y, F, PL)*

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25 The ease of use was expressed mostly by the literate group of participants. Older and illiterate
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27 26 participants suggested to design simple text in local language.

1 III. Perceived Challenges - External factors

2 Many participants also identified obstacles to implementing a mHealth strategy in the study settings.

3 **Mobile phone illiteracy:** Participants raised concerns about general literacy and digital literacy of
4 patients in reading the SMS even though it is sent in the local (Nepali) language. They reported that it
5 could be difficult for those who have low digital literacy skills, for example, who do not know how to
6 open, read, or send a text message.

7 Further, an older participant expressed that " *No, I only know how to call. I have a simple mobile. I do
8 not know how to open and read the messages.*" (P017: 65-70Y, M, PL)

9 HCWs added that such a program could be more effective in urban areas and most accessible to the young
10 generation. The participants expressed that age and illiteracy can influence the ability to read text
11 messages.

12
13 **Technical constraints:** HCWs were cautious, highlighting the need for resources to implement such
14 program in Nepal. They expressed concern about resources such as the technical workforce and funding
15 requirement for software development and SMS delivery, including commitment from the authorised
16 bodies in the hospital. Some HCWs also raised the issue of health system preparedness to implement such
17 programs due to cost and shortage of technical workforce.

18 Many HCWs identified challenges, such as not having an appropriate recording system of hypertensive
19 patient's details in the hospitals to locate/ trace them in the community. They expressed that text
20 messaging would be almost impossible in public hospitals where doctors have a high workload, limiting
21 their ability to record the patients' details, such as their phone number. One HCW expressed that "*There
22 is not even a good record-keeping system here in our hospital, and no one is going to record as we don't
23 have time.*" (HCW 08: TL)

24 The system level technical challenges were expressed by both level of healthcare; mostly by the HCWs
25 and KI. No such issues were reported by the hypertensive patients.

1 Themes based on other objectives of the study

2 **IV. Perceived solutions**

3 In the context of resource constraints, participants recommended some solutions to have the desired
4 outcome of text messages

5 **System-level preparedness:** HCWs emphasised a proper record-keeping system, which would help in
6 tracing the hypertensive patients to send SMSs.

7 However, they emphasised the need for government commitments for such programs, such as
8 establishing a separate department to monitor the program.

9 Key informants highlighted the need for system-level preparedness by extensive planning, budgeting,
10 and mobile phone text messaging software development. They expressed that multi-sectoral
11 collaboration and commitments are needed to implement the mHealth program effectively.

12 **Alternative strategies for illiterate groups**

13 Participants suggested including a family member of the illiterate patients when sending messages.

14 They highlighted every household should have at least one literate person. Even the family members
15 were ready to support their parents.

16 They expressed “*For illiterate people like my mother, it has to be sent to the member of the family like*
17 *me. As a son, I must take care of her*” (FM 02 of 60-65 Y, F, PL). Furthermore, video/voice messages,
18 symbolic pictures or cartoons were recommended by HCWs for the illiterate groups.

19 *I think the video is more effective than a text message as it has both audio/visual features. (P014:*
20 *35-40Y, M, TL)*

21 However, some participants raised concern about the family member's relationship with patient and
22 their availability and the feasibility of using video message in a resource constraint setting like Nepal.

23 Especially these concerns were raised at primary level where smartphones, internet and MMS facilities
24 are limited and less available.

25 **V. Preferred features of the mHealth (text message) strategy**

26 In each IDI and FGD, answers to the questions on the need and preference of participants to inform the
27 content and delivery of text messages were analysed.

1
2
3 1 **Comprehensive contextual contents:** Participants expressed various misconceptions prevalent in the
4
5 2 study setting regarding hypertension and its' treatment. Participants preferred getting context specific
6
7 3 messages targeting those misconception on hypertension treatment such as use of locally available
8
9 4 herbs: aloe vera juice, bitter juice (Chirauto), barley sprout juice (Jamara) etc. Similarly, they preferred
10
11 5 including messages targeting the foods prepared during festivals in Nepal which are high in fat and salt
12
13 6 content.

14
15
16 7 *Patients says that "yesterday I attended a festival. After eating high salt food and meat, I am*
17 8 *getting headache, so I came here for check-up."* So, I think you should send information about
18 9 *diet as well. (HCW 04: TL)*

20
21
22 10 For lifestyle modification, some of the patients expressed that it would be good to receive information
23
24 11 about physical activity and culturally appropriate dietary factors. "*What kinds of exercise should be*
25
26 12 *done, how much.... amount.... duration.... Time.*" KI also added that patients should get all the messages
27
28 13 on pharmacological and non-pharmacological measures for controlling their blood pressure.

29
30 14 Overall, content preferences included information about hypertension and its treatment, dietary factors
31
32 15 (local foods), medication, side effects, physical activities, and reminder for medication.

33
34
35
36
37 17 **Reasonable frequency and timing of text messages:** They also stated that the text messages should
38
39 18 be delivered with reasonable frequency and timing. Study participants preferred t receiving 2-3
40
41 19 reminders messages per week for taking medication or about specific behaviours. Overall, participants
42
43 20 agreed that daily messages would be too often and monthly would be insufficient.

44
45 21 *If you send in the interval of 2-3 days, then then we might see that. (P018: 40-45 Y: M, PL)*

46
47 22 Most of them preferred messages to be delivered in the morning or evening. Participants mentioned that
48
49 23 if the timing of the message matched with the time of taking their medicine, then it would be more
50
51 24 effective "*Usually people take medicine in the morning so, that would be a good time.*" (P05:45-50, F,
52
53 25 *PL)* Another participant also added. "*for women....in the evening time would be good as we will be busy*
54
55 26 *in household works during morning.*" (FGD 05: 30-35 Y; F, TL)

1
2
3 1 Overall content preferences were not different based on the gender, age, and level of care. However,
4
5 2 female participants expressed greater preference to receive messages in the evening time.
6
7 3

4 **DISCUSSION**

5 This study explored the perspectives of patients and providers on the acceptability of mHealth (mobile
6 phone text messages) strategy for patients with hypertension in Nepal. Overall, participants were
7 receptive towards a text messages strategy with some contextual recommendation. This study found
8 that simple mobile phone text messages could be useful in this setting due to the ubiquitous use of
9 mobile phones. Studies from the primary level²⁶ and rural parts of India⁴¹ have reported similar findings
10 as mHealth being a ubiquitous and acceptable tool for managing cardiovascular diseases and supporting
11 healthcare. Key informants involved in implementing the national NCDs program and policy in Nepal
12 identified the low-resource requirements of SMS as a potentially useful for such interventions.
13 The WHO's Global Observatory for eHealth (GOe) also stated SMS as an easy method to send a brief
14 message at a low cost.¹⁵ Text messages can be sent in bulk to multiple users simultaneously, are cheap,
15 and do not require advanced skills.¹⁶ However, cost effectiveness analysis is an area for future research
16 in this setting.

17 Our study found behaviour reinforcement/modification as another potential use of mHealth. In chronic
18 diseases such as hypertension, where medication should be taken daily, SMS reminders can increase
19 medication adherence.^{42,43} Additionally, WHO GOe stated that SMS was the preferred method for
20 treatment compliance measures worldwide.¹⁵ Non-disclosure issues due to the stigma attached to
21 hypertension was reported, especially by young people in Nepal in earlier study.¹³ The importance of
22 receiving messages privately on mobile was stressed by our respondents, it has not been reported for
23 NCD previously, but these were mostly reported in studies of HIV/AIDS.⁴⁴ Overall, there was a
24 consensus of the value of text messaging in getting information privately (in confidence) to
25 hypertensive patients by all the stakeholder groups. However, our study participants did not mention
26 about the data security, an important factor while designing a mHealth strategy.

27 Our participants perceived a text message strategy as easy to operate and not require advanced technical

1 skills. They preferred to have messages in the local Nepali language for the ease of use for broader
2 groups. We were also able to identify implementation challenges that were similar to other resource-
3 limited settings as well as unique to the setting. Difficulty in reading text messages (even in the local
4 language), a language and literacy barrier including digital literacy in reading the text messages were
5 reported in this study, similar to South Indian studies.^{26, 44} In Nepal, though mobile phone penetration
6 is high, digital literacy is only reported as 31%.⁴⁵ In this context, alternative solutions identified by
7 stakeholders was inclusion of family members of illiterate/ older groups and sending video or symbolic
8 messages.

9 While there was enthusiasm to use mHealth, HCWs and KI expressed concerns about the lack of
10 resources and technical issues that could be an impediment. A key concern was that implementing a
11 new mHealth (SMS) system in the hospital might require extra technical manpower for software
12 development generating a need for a separate technical department. The immaturity of health
13 information systems in hospitals and gaps in recording essential information was identified. Similar
14 issues have been reported from rural India as a barrier to the continuity of care and follow up with
15 hypertensive patients.⁴⁶ These findings were corroborated in other studies in Kenya⁴⁷ and Bangladesh.⁴⁸
16 The WHO has also stated that unclear mHealth policy and underdeveloped infrastructure are the most
17 common barriers in adopting mHealth in LMICs settings.¹⁵ In our study, it was explicitly stated that a
18 reliable and peer-reviewed source of information is required. A SMS originating from a public or private
19 health centre will be trusted by individuals as they would be considered reliable. It is therefore,
20 imperative to establish trustworthiness of the information for the desired behaviour modification.⁴⁹ The
21 key recommendation was to have government commitment and multisectoral collaboration and
22 coordination with the health system to address the structural barriers to use advanced technology. These
23 aspects should be carefully considered while designing the mHealth strategy for its sustainability.

24 25 **Implications for mHealth design and future research**

26 This study supported the evidence that mHealth could be acceptable in LMIC settings, if designed based
27 on the local context and needs.^{50,51} Our study participants highlighted their interest in getting messages

1
2
3 1 clarifying the misconceptions regarding the use of local herbs for treatment of high blood pressure and
4
5 2 targeting cultural food practices. The findings of this formative research informed the contextual
6
7 3 contents of our next phase TEXT4BP study that would be tested using a randomised controlled trial
8
9 4 design.⁵² Information on the contents of the SMS, frequency, and timing of the messages may be of
10
11 5 value to a similar resource-limited setting. In Nepal, there are very few studies on mHealth, this study
12
13 6 could broaden the horizon for use of mHealth in the management of hypertension. In today's context
14
15 7 of the need for evidence-based use of modern technology in health service delivery, as stressed in Nepal
16
17 8 Health Sector Strategy 2015-2020,⁵³ the findings from this study are crucial in designing evidence based
18
19 9 mHealth strategy in the context of Nepal.

20
21
22
23 10 The COBRA-BPS study in Pakistan, Bangladesh and Sri Lanka⁵⁴ provided promising evidence in
24
25 11 improving blood pressure control. However, their main intervention was based on mobilising
26
27 12 community health care workers and training physicians. In the context of Nepal, due to the scarce
28
29 13 human resources and overburdened Female Community Health Volunteers (FCHV), it is important to
30
31 14 develop and test interventions that would not burden the health workers. The more recent
32
33 15 mWELLCARE trial⁵⁵ was a large, well-designed study in India designed to utilise a mHealth system
34
35 16 for integrated management of five chronic condition including hypertension. However, the study did
36
37 17 not find a significant reduction in blood pressure. Other studies such as the STAR trial among
38
39 18 hypertensives patients⁴³ and the Text2preventCVD study,⁵⁶ have reported promising findings with an
40
41 19 intervention that use text messages. Given this background, we undertook this formative research to
42
43 20 develop a mHealth strategy based on participant and stake holder input. We recommend that research
44
45 21 in the application of mHealth need to be undertaken in the future to align the mHealth strategy to the
46
47 22 culture and context of the existing health care system to increase the likelihood of adoption of such
48
49 23 interventions.

24 **Strength and limitations of the study**

25 One of the strengths of the study is that efforts were taken to ensure the trustworthiness³⁷ of data by
26 ensuring credibility by adopting appropriate and different methods for data collection (IDIs and FGDs);

1
2
3 1 by including a different cadre of participants (patients, their family, health workers, key informants)
4
5 2 from different sites (primary and tertiary level). The researcher (BB) obtained participant validation at
6
7 3 the end of the interview by summarising the main points to ensure the respondent's perspective.⁵⁷ In
8
9 4 addition, we have used the TAM model to inform our analysis. We have presented the steps in the
10
11 5 analysis and showed that we generated the themes and subthemes with discussion. However, some
12
13 6 limitations were that we had analysed data from different sources and methods together, which might
14
15 7 not fulfil all the criteria of triangulation and used purposive sampling, which may have created a
16
17 8 selection bias. However, all reasonable efforts were made to ensure the diversity of participants.
18
19 9 Furthermore, the transferability of the findings is limited as this study was conducted in urban and semi-
20
21 10 urban parts of the country, which may not completely represent the views of people from
22
23 11 geographically-disadvantaged and remote areas of LMICs.
24
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28

29 13 **CONCLUSIONS**

30 14 This study found that participants were receptive towards a simple mHealth strategy using SMS
31
32 15 notifications. Overall, there was a consensus of the value of a text messaging solution to hypertension
33
34 16 management by all stakeholder groups. However, meticulous planning is required to include a diverse
35
36 17 range of participants to ensure the text messaging strategy is acceptable to a wide range of participants,
37
38 18 including illiterate and older groups. Similar formative study approaches can be used to inform
39
40 19 contextual design of mHealth in other LMIC settings.
41
42
43
44

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3 **Author contributions**

4 All authors contributed to the conception of research design, acquisition, and data interpretation. BB
5 conducted the fieldwork and wrote the first version of this manuscript. BB and PN participated in the
6 analysis of the data. All the authors BB, AES, RJ, AV, MS and PN were involved in the manuscript
7 drafting, revision, and finalisation. All authors read and approved the final version of the manuscript.

8 **Competing interest**

9 No financial or any other competing interests exist.

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13 **Patient consent for publication:** Obtained

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15 interview transcripts. The researchers have access to this data. All data is stored securely on password-
16 protected and encrypted computers. Participants have not given their permission for data sharing outside
17 the research group. Thus, no additional data is available.

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For peer review only

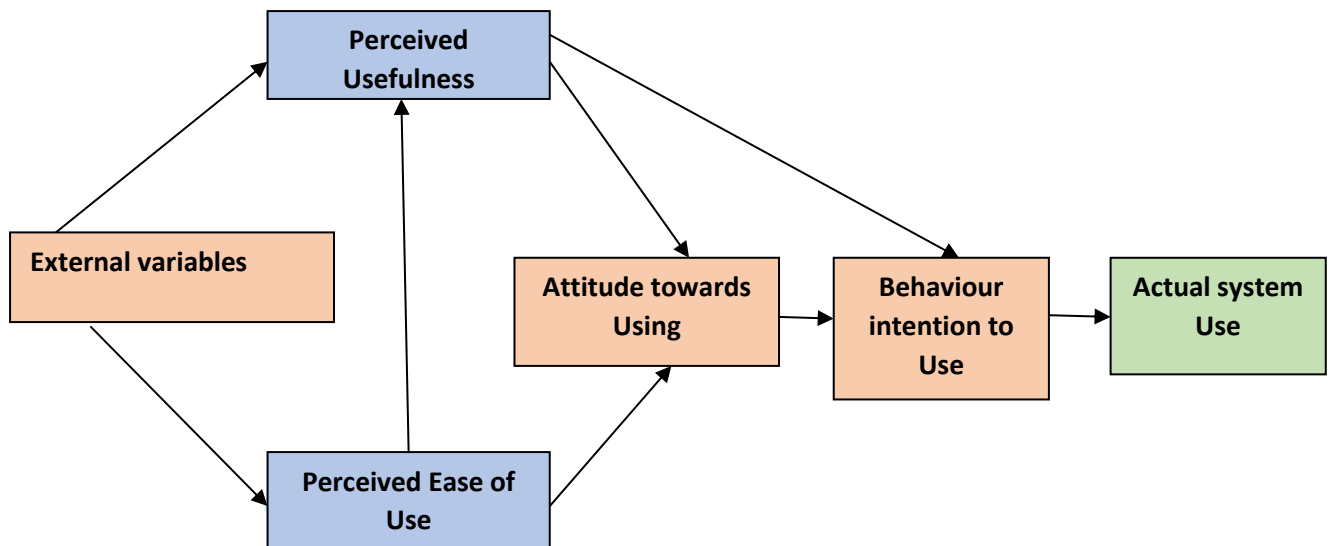


Fig 1: Technology Acceptance Model

Supplementary file 1

Process of participants recruitment

Health care providers at both levels distributed a study flyer containing information about the study to the eligible participants at OPD. When an interested participant initiated the contact, the researcher screened them for eligibility and selected purposively after informed consent based on their age, sex, literacy status to capture diverse perspectives. Similarly, study participants were asked to nominate family members after obtaining consent to be contacted by the research team. Health care workers from the selected study site were also approached for the interview by the researchers. We also invited key informants (policymakers, researchers, and program implementors) working in Non-Communicable Diseases (NCDs) management based on the recommendation from the local research team.

Definition of the variables

Acceptability: We have used the acceptability approach as defined by Schade and Schlage et.al¹ as “a prospective judgement of measures to be introduced in the future where the target group will not yet experience the new measures”.

Literacy: The ability to read and write. We have asked either they could read and write or not.

Employment: The state of having paid work. We have asked whether they were engaged in any paid income work or not.

Definition of the Health Care Providers

Cardiologist: Medical doctor who had MBBS, MD and DM cardiology degree working in public hospital/medical college at tertiary centre

Physician: Internal medicine physician who had MBBS and MD in internal medicine working in a public medical college at tertiary centre

Medical officer: Medical doctor with MBBS degree, who provides services to the hypertensive patients in both primary and tertiary level.

Health Assistant (HA) and community health assistant (CMA): Non physician health workers (HA- 3 Year certificate level formal education, CMA- diploma level 18-month formal training) who are

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2
3 posted in the government primary health care centre and health post and provide OPD service to
4 hypertensive patients in those centre.
5
6

7 **Staff nurse/ANM:** Health personnel with nursing education (staff nurse- certificate level 3-year nursing
8 education, ANM- diploma level 18-month nursing training) they involve in providing counselling to
9 the hypertensive patients.
10
11

12 **Abbreviation of the verbatim of the participants**

13
14 **PL: Primary level**

15
16 **TL: Tertiary level**

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18 **F: female**

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20 **M: male**

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22 **Y: years**
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27 **Reference**

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Supplementary file: 2**I. In-depth Interview guides**

1. Icebreaker
 - a. How are you doing?
 - b. What kinds of work are you doing these days?
2. Could you please share your experience of using mobile phone? *Probe: How, when, for what purpose etc*
3. What do you know about use of mobile health in management of high blood pressure?
4. Could you please share your opinion on using mobile phone for management of high blood pressure? *Probe: what, how*
5. Have you heard, or have you been told that you can get health messages through mobile phone?
6. What is your opinion about it? What is your perspective on potential of mobile health service in management of hypertension in Nepal? *Probe: what, how, example*
7. What could the potential advantages of using mobile health in Nepal?
8. What could be the challenges in using mHealth in Nepal for the management of hypertension?
9. What can be done to overcome the challenges for successful outcome?
10. What kinds of mobile health services you would like to get/use?
11. What should be the contents, timing, and frequency of such mHealth services?
12. Do you want to share anything which I missed to discuss?
13. Let's summarise some of the key points from our discussion. Is there anything else?

III. FGD guides

Let's start by going around the circle and having each person introduce her/himself.

(Members of the research team should also introduce themselves and describe each of their roles.)

1. Icebreaker
 - a. How are you doing?
 - b. What kinds of work are you doing these days?
2. Could you please share your experience of using mobile phone? *Probe: How, when, for what purpose etc*
3. What do you know about use of mobile health in management of high blood pressure?
4. Could you please share your opinion on using mobile phone for management of high blood pressure? *Probe: what, how*
5. Have you heard, or have you been told that you can get health messages through mobile phone?
6. What is your opinion about it? What is your perspective on potential of mobile health service in management of hypertension in Nepal? *Probe: what, how, example*
7. What could the potential advantages of using mobile health in Nepal?
8. What could be the challenges in using mHealth in Nepal for the management of hypertension?
9. What can be done to overcome the challenges for successful outcome?
10. What kinds of mobile health services you would like to get/use?
11. What should be the contents, timing, and frequency of such mHealth services?
12. Do you want to share anything which I missed to discuss?
13. Let us summarise some of the key points from our discussion. Is there anything else?

COREQ (CONsolidated criteria for REporting Qualitative research) Checklist

A checklist of items that should be included in reports of qualitative research. You must report the page number in your manuscript where you consider each of the items listed in this checklist. If you have not included this information, either revise your manuscript accordingly before submitting or note N/A.

| Topic | Item No. | Guide Questions/Description | Reported on Page No. |
|--|----------|--|----------------------|
| Domain 1: Research team and reflexivity | | | |
| <i>Personal characteristics</i> | | | |
| Interviewer/facilitator | 1 | Which author/s conducted the interview or focus group? | |
| Credentials | 2 | What were the researcher's credentials? E.g. PhD, MD | |
| Occupation | 3 | What was their occupation at the time of the study? | |
| Gender | 4 | Was the researcher male or female? | |
| Experience and training | 5 | What experience or training did the researcher have? | |
| <i>Relationship with participants</i> | | | |
| Relationship established | 6 | Was a relationship established prior to study commencement? | |
| Participant knowledge of the interviewer | 7 | What did the participants know about the researcher? e.g. personal goals, reasons for doing the research | |
| Interviewer characteristics | 8 | What characteristics were reported about the interviewer/facilitator? e.g. Bias, assumptions, reasons and interests in the research topic | |
| Domain 2: Study design | | | |
| <i>Theoretical framework</i> | | | |
| Methodological orientation and Theory | 9 | What methodological orientation was stated to underpin the study? e.g. grounded theory, discourse analysis, ethnography, phenomenology, content analysis | |
| <i>Participant selection</i> | | | |
| Sampling | 10 | How were participants selected? e.g. purposive, convenience, consecutive, snowball | |
| Method of approach | 11 | How were participants approached? e.g. face-to-face, telephone, mail, email | |
| Sample size | 12 | How many participants were in the study? | |
| Non-participation | 13 | How many people refused to participate or dropped out? Reasons? | |
| <i>Setting</i> | | | |
| Setting of data collection | 14 | Where was the data collected? e.g. home, clinic, workplace | |
| Presence of non-participants | 15 | Was anyone else present besides the participants and researchers? | |
| Description of sample | 16 | What are the important characteristics of the sample? e.g. demographic data, date | |
| <i>Data collection</i> | | | |
| Interview guide | 17 | Were questions, prompts, guides provided by the authors? Was it pilot tested? | |
| Repeat interviews | 18 | Were repeat interviews carried out? If yes, how many? | |
| Audio/visual recording | 19 | Did the research use audio or visual recording to collect the data? | |
| Field notes | 20 | Were field notes made during and/or after the interview or focus group? | |
| Duration | 21 | What was the duration of the interviews or focus group? | |
| Data saturation | 22 | Was data saturation discussed? | |
| Transcripts returned | 23 | Were transcripts returned to participants for comment and/or | |

| Topic | Item No. | Guide Questions/Description | Reported on Page No. |
|--|----------|--|----------------------|
| | | correction? | |
| Domain 3: analysis and findings | | | |
| <i>Data analysis</i> | | | |
| Number of data coders | 24 | How many data coders coded the data? | |
| Description of the coding tree | 25 | Did authors provide a description of the coding tree? | |
| Derivation of themes | 26 | Were themes identified in advance or derived from the data? | |
| Software | 27 | What software, if applicable, was used to manage the data? | |
| Participant checking | 28 | Did participants provide feedback on the findings? | |
| <i>Reporting</i> | | | |
| Quotations presented | 29 | Were participant quotations presented to illustrate the themes/findings? Was each quotation identified? e.g. participant number | |
| Data and findings consistent | 30 | Was there consistency between the data presented and the findings? | |
| Clarity of major themes | 31 | Were major themes clearly presented in the findings? | |
| Clarity of minor themes | 32 | Is there a description of diverse cases or discussion of minor themes? | |

Developed from: Tong A, Sainsbury P, Craig J. Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups. *International Journal for Quality in Health Care*. 2007. Volume 19, Number 6: pp. 349 – 357

BMJ Open

Acceptability of a mHealth strategy for hypertension management in a Low and Middle-Income Country setting: A formative qualitative study among patients and healthcare providers

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| | |

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4 **1 Acceptability of a mHealth strategy for hypertension management in a Low and Middle-Income**

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6 **2 Country setting: A formative qualitative study among patients and healthcare providers**

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8 **3 Short title:** Acceptability of mHealth strategy for hypertension management: A formative qualitative
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10 study
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58 and references) Tables- 3, Figure-1, Supplementary files- 3
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1
2
3 **1 ABSTRACT**
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6 **2 Background:** Understanding contextual needs and preferences is important for a successful design and
7
8 effective outcome of a mHealth strategy.
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10 **4 Objectives:** This formative study aimed to explore the perspectives of patients and providers on the
11
12 acceptability of a mHealth (text message) strategy and elicit preferred features of a mHealth strategy
13
14 for hypertension management.
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16

17 **7 Design:** A qualitative study was conducted using in-depth interviews and focus group discussions
18
19 guided by the Technology Acceptance Model.
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22 **9 Setting:** The study was conducted at primary healthcare facilities and at a tertiary level referral hospital
23
24 in Kathmandu, Nepal.
25
26

27 **11 Participants:** A total of 61 participants, patients with hypertension (n=41), their family members (n=5),
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29 healthcare providers (n=11) and key informants (n=4) were included. We purposively recruited patients
30
31 with hypertension aged 30 to 70 who attended the selected health care facilities to obtain maximum
32
33 variation based on their age, sex, and literacy.
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36 **15 Results:** The respondents perceived the mHealth strategy to be useful as it would reinforce medication
37
38 compliance and behaviour change. Participants valued the trustworthiness of information from health
39
40 authorities that could be delivered privately. Some implementation challenges were identified including
41
42 a lack of technical manpower, resources for software development, gaps in recording a patient's
43
44 essential information and digital illiteracy. Solutions proposed were having system-level preparedness
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46 for recording the patient's details, establishing a separate technical department in the hospital and
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48 involving a family member to assist illiterate/elderly patients. In addition, participants preferred text
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50 messages in the local language, containing comprehensive contextual content (disease, treatment,
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52 cultural foods and misconceptions) delivered at regular intervals (2-3 times/week) preferably in the
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54 morning or evening.
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3 1 **Conclusions:** We found that a simple text messaging strategy was acceptable for hypertension
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5 2 management in this LMIC setting. However, meticulous planning must address the needs of a diverse
6
7 3 range of participants to ensure the mHealth strategy is acceptable to wider groups.
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13 5 **Keywords:** Text messaging, SMS, High blood pressure, Mobile health, Adherence, TAM Model
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17 18 7 **STRENGTHS AND LIMITATIONS OF THE STUDY**

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21 8 - This formative study is the first conducted in Nepal that explored the acceptability of a mobile
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23 9 phone text messaging strategy targeting patients with hypertension guided by a technology
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25 10 acceptance (TAM) model.
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28 11 - The strength of the study was the inclusion of diverse stakeholders such as patients, providers,
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30 12 family members and policymakers at different levels of the health care system.
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33 13 - This study was conducted in urban and semi-urban parts of the country, limiting the
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35 14 transferability of findings to rural and disadvantaged areas.
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1 Introduction

2 Hypertension, a major cardiovascular disease (CVD) risk factor, is an emerging public health challenge
3 particularly affecting low and middle-income countries (LMICs).^{1,2} Although highly effective and
4 affordable medications are widely available, a major challenge in LMICs remains abysmal hypertension
5 control of less than 50%.³ Nepal is no exception to this, with 57% of patients remaining undiagnosed
6 in the community due to the often asymptomatic nature of hypertension.⁴ In addition, among those who
7 are diagnosed, only 35-45% of the hypertensive patients have controlled blood pressure,^{5, 6} leading to
8 high mortality and morbidity.⁷

9 The Global Burden of Disease Study 2019 recommends that countries invest in cost-effective public
10 health interventions to improve blood pressure control and prevent premature deaths from hypertension
11 and consequent CVD.⁸ Globally, a wide range of non-pharmacological interventions are implemented
12 to improve blood pressure control, such as self-monitoring of blood pressure,⁹ educational interventions
13 focused on patients,¹⁰ health professional- led care (nurse, pharmacist, community health workers);¹¹ as
14 well as appointment reminders.¹² However, delivery of these interventions is hindered by inadequate
15 communication between patients and providers,¹³ primarily due to poor clinician-to-patient ratios in
16 low-resource settings.¹⁴

17 Mobile health or mHealth interventions use mobile devices such as mobile phones, patient monitoring
18 devices, personal digital assistants, and other wireless devices to support medical or public health
19 practice.¹⁵ In low resource settings, mobile phones are a promising tool to improve healthcare access
20 and coverage.^{16,17} Mobile technologies offer a simple and effective mode of communication, enabling
21 the patient to self-manage hypertension through tailored feedback.^{18,19} Included in self-management, a
22 text message is an appropriate mode to guide behaviour interventions,²⁰ and although simple, has many
23 advantages over other mobile applications and computer interventions, especially in low resource
24 settings or remote areas with limited internet access.^{20,21}

25 The Nepal Telecom Authority (NTA) estimates that there are 38.21 million mobile service users in
26 Nepal.²² Despite this penetration of mobile services to the population, only a few pilot projects have

1 used mobile services for nutrition counselling and maternal and child health services^{23,24} and only a
2 handful of initiatives for non-communicable disease (NCD) management targeting community health
3 workers.²⁵ There is immense potential to use mobile services to bridge the communication gap between
4 providers and patients for hypertension management in Nepal. However, it is essential to understand its
5 acceptability among target populations and consider country-specific needs to develop an effective
6 mHealth strategy.²⁶ This formative study aimed to explore different stakeholder's perceptions on the
7 use of mHealth (text messages) to capture multiple level perspectives guided by the TAM model²⁷ and
8 elicit their preferred features of mHealth (text messages) strategies for hypertension management in
9 Nepal.

10 **Methods**

11 Qualitative research was conducted to explore the perspectives of the study participants on the potential
12 use of a mHealth (text message) strategy for patients with hypertension. This study was conducted at
13 primary health care facilities (one primary healthcare centre and five health posts) of Kageswori
14 Manahara municipality and at a tertiary level referral Hospital in Kathmandu, Nepal (Kathmandu
15 Medical College and Teaching Hospital), to explore the perspectives of people of different healthcare
16 levels.

17 **Theoretical model informing the study:** Our study used the TAM model developed by Davis²⁷ as an
18 overarching model to guide the analysis to assess the acceptability of the proposed mHealth strategy
19 (Figure 1). This model considers two main beliefs: perceived usefulness and perceived ease of use as
20 the main factors for an individual's acceptance of the technology. Perceived usefulness is when users
21 believe that using technology will enhance their job performance. Perceived ease of use is a user's belief
22 that technology is free of effort, which is influenced by external factors.²⁷ We focused on these factors
23 in our study. The TAM model assumes that there is a strong relationship between a person's intention
24 to use and a person's actual use of technology.²⁸ This model is valid, robust, and widely used to
25 understand human behaviour in acceptance of technology.²⁸⁻³² We have used this model for informing
26 our analysis considering its applicability based on our objectives .

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5 2 **Fig 1 here**

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7 3 **Study populations and recruitment**

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9 4 We included patients with hypertension aged 30 to 70 who attended the selected healthcare facilities
10 5 from March to July 2018. We excluded patients with complicated hypertension with severe multi-
11 6 morbidity requiring immediate care at tertiary level hospitals, which would limit their ability to
12 7 participate in the study. Participants with severe mental and physical disabilities and
13 8 pregnant/postpartum women were excluded from the study. However, we included participants with
14 9 comorbidities who were not serious. We have included the different groups of patients (based on age,
15 10 sex, literacy), their family members, healthcare providers (HCWs) from both levels of care, and key
16 11 informants (KI) to capture the multiple perspectives for validating the data through data source
17 12 triangulation.³³ Perspectives from patients and family members helped in understanding patient-
18 13 community level perspectives whereas KI and HCWs perspectives provided an opportunity to
19 14 understand the system level factors for the contextual design of the mHealth strategy. The details of the
20 15 study participants and the recruitment process has been described previously¹³ and presented briefly in
21 16 *Supplementary file 1*.

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37 17 **Data Collection Methods**

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39 18 We collected data using in-depth interviews (IDIs) and focus group discussions (FGD) to ensure rigor
40 19 through methodological triangulation.³³ IDIs provide an opportunity to explore rich personal
41 20 experiences and perspectives on the topic.³⁴ However, FGD elicit data from a group of participants
42 21 where they could hear each other perspectives and comments additionally which they may not have
43 22 expressed in the IDIs.³⁵ IDIs and FGDs were conducted using a semi-structured interview guide. The
44 23 interview guide contained the questions mainly on perspectives on using the mHealth intervention, its
45 24 advantages, challenges and their preference on the contents and frequency of the text messages.
46 25 (*Supplementary file:2*). Prior to giving consent to take part in the study, participants were informed of
47 26 the objectives of the study, conceptual mHealth (TEXT4BP) study, and about the interviewer. The first
48 27 author BB (female, PhD fellow), a native language speaker trained in qualitative research methods,

1 conducted all the IDIs in the Nepali language in a suitable private place (OPD of health facilities or
 2 privately at the home of the participants without the presence of family members). Interview
 3 observation notes for non-verbal cues and audio recordings captured the interview data, which lasted
 4 for about 35 to 60 minutes. A total of 25 IDIs among hypertensive patients, five IDIs among family
 5 members, 11 IDIs among healthcare providers, and four IDIs among key informants were conducted.
 6 Two Focus Group Discussions (FGD) were also conducted using the FGD guides among 16 (8
 7 participants in each FGD) diverse hypertensive patients at a private OPD room with no additional person
 8 presented at the tertiary level. The FGDs were facilitated by the first author in the Nepali language,
 9 audio recorded and each FGD lasted for 60 to 90 minutes. We decided the number of participants for
 10 FGDs based on the standard recommendations for FGDs and patient-availability.³⁶ The number of IDIs
 11 was decided based on the number of diverse group representation (by age, sex, literacy) until reaching
 12 a saturation point of information achieved at both levels of healthcare. To decide on the saturation point,
 13 the interviewer prepared the summary after each interview to look for any new information coming
 14 from IDIs. (Table 1).

15 **Table 1: Total number of study participants for IDIs and FGDs included from the Primary and**
 16 **Tertiary level.**

| Participant group | Primary health care level (PL) | Tertiary health care level (TL) | Total |
|--|--|--|-------|
| Patients with hypertension | 13 - IDIs | 12-IDIs | 25 |
| Patients with hypertension | NA | 2 FGD (8 in each) * | 16 |
| Healthcare provider | 5- IDIs Medical officer- 1 Health assistant- 1 Community health assistant – 1 Axillary nurse midwife - 1 | 6 -IDIs Cardiologist -3 Physician- 1 Medical officer- 1 Staff nurse -1 | 11 |
| Family members of patients with hypertension | 3 -IDIs | 2- IDIs | 5 |
| Key informants | 4- IDIs NCDs policy maker -1 NCDs program focal person at DoHs, MoHP-2 NCDs researcher 1 | | 4 |

Total 61

1 Note: *Due to low patient flow at Primary healthcare level, FGDs could only be conducted at the Tertiary level. DoHs
2 MoHP= Department of Health Services, Ministry of Health and Population

3 **Data Analysis**

4 All audio recorded FGDs and IDIs with the research participants were transcribed in the local language
5 (Nepali) by the first author and a qualified transcriber. The transcripts were checked against the audio
6 recordings for ensuring accuracy, and pseudonyms were applied to de-identify participants. The
7 transcripts and observation notes were translated into English by the researcher and a qualified
8 translator. Translation reliability and accuracy was checked in a random sample of transcripts by back-
9 translation of the transcripts to compare with the original script in local language by the first author
10 (BB). Transcripts were not shared with the participants, however, the interviewer summarised the main
11 information at the end of the interview to obtain participant validation.³⁷ NVivo 12 software³⁸ was used
12 for data management. The first author coded all the transcripts. Data analysis was informed by the TAM
13 model and overarching aim of the study. This study utilised this model to understand the perceived
14 usefulness, perceived ease of use and perceived challenges of using text messages as a behaviour change
15 strategy. We followed the thematic analysis process proposed by Braun and Clarke.³⁹ This method of
16 analysis involves familiarisation with the transcribed data by reading and re-reading, generating codes,
17 searching for and reviewing themes, defining and naming themes and finalising the analysis. The codes
18 and themes were discussed with the co-author (PN) and agreed upon between investigators (BB and
19 PN). The sub- themes generated from the transcripts were mapped under the overarching theme (I-III)
20 of the TAM model and other themes (V-VI) generated based on the objectives of the study as presented
21 in the result section. We followed the Consolidated Criteria for Reporting Qualitative Studies (COREQ)
22 32-item checklist⁴⁰ to ensure reporting consistency. (*Supplementary file 3*).

23 **Patient and public involvement**

24 This research was conducted without patient or public involvement. Participants were not invited to
25 comment on the study design or contribute to the research write up and dissemination.

Ethics Approval: Ethics approval for the study was obtained from the Human Research Ethics Committee of the University of New South Wales, Australia (Ref no: HC17753) and Nepal Health Research Council (Ref no 21/2018). Informed consent was taken from all the study participants.

RESULTS

Most of the hypertensive participants (29%) were between the ages of 50-60 years with a mean age of 48 years, female (51%), literate (65%) and employed (70%). Of them, 88% had been diagnosed more than one year prior to study and 34% were diagnosed more than 5 years prior to the study. (Table:2)

Table 2: Sociodemographic profile of the study participants of IDIs and FGDs (hypertensive patients)

| Characteristics | Categories | Hypertensive patients (N=41) | |
|---------------------------------------|----------------------|------------------------------|------------|
| | | Frequency | Percentage |
| Age (years) | 30-40 | 10 | 24.4 |
| | 40-50 | 11 | 26.8 |
| | 50-60 | 12 | 29.3 |
| | 60-70 | 8 | 19.5 |
| | Mean age \pm SD | 48.17 \pm 10.78 | |
| Sex | Female | 21 | 51.2 |
| | Male | 20 | 48.8 |
| Literate | Yes | 27 | 65.8 |
| | No | 14 | 34.2 |
| Employment | Yes | 29 | 70.7 |
| | No | 12 | 29.3 |
| Duration of diagnosis of hypertension | Less than a year | 5 | 12.2 |
| | 1-5 years | 22 | 53.6 |
| | More than five years | 14 | 34.2 |

Note: details of the study other participants (family members, HCWs and KI) are presented previously.¹³

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3 1 Our study revealed three broad themes (I-III) of acceptability under the TAM model and other two
4
5 2 themes (IV-V) as suggested solutions, and preferred features of the mHealth strategy. All the themes,
6
7 3 sub themes of study and supporting verbatim are presented in **Table 3**.
8
9 4

11 **Themes mapped under TAM Model**

14 **I. Perceived usefulness**

17 The main subthemes under perceived usefulness of TAM model are as follows:

19 **Acceptable and require less resources:** Study participants reported that a simple text message would
20
21 9 be acceptable in the study settings due to the ubiquity of mobile phones.

23 Participants mentioned that mobile phones are popular. They also expressed their interest and readiness
24
25 10 to participate in such a program. *“If you send us SMS, we are ready to use this.” (P03: 50-55 Y,F, TL)*

27 Healthcare workers (HCWs) also confirmed that mobile phones are widely accessible, even in rural
28
29 12 areas. Some stated that getting messages on their mobile phone would be very handy and save time
30
31 13 spent for travel to the health centre for getting information about the disease and its treatment. The key
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33 14 informants examined mHealth from a program perspective. Participants identified SMS might require
34
35 15 less resources as it can be sent to many people at the same time (bulk SMS) with limited investment.
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40 **Reinforce behaviour change:** HCWs mentioned that text messages could act as a reminder to take
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42 18 medication on time and reinforce recommended behaviour changes such as physical activity.

43
44 19 Participants stated that using a text message strategy might meet their unmet needs to receive specific
45
46 20 information to reinforce behaviour change such as how much salt is recommended for blood pressure
47
48 21 control.
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50 22

51 *“If specific information (such as this much salt is allowed) will be sent for us, definitely it would*
52
53 23 *help for changing our habits.” (FGD 02: 50-55 Y, F, TL)*
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1 **Table 3: Themes and subthemes generated on the perception of using a mHealth (Text message) strategy**

| Themes Based on | | |
|----------------------|---------------------------------------|---|
| TAM Model on | Subthemes | Supporting verbatim |
| acceptability | Acceptable and require less resources | <i>These days, mobile(phone) is widely available and easy to use for many people. If anything comes in the mobile from a reliable source, it might have some good effect. (P021: M, 40-45 Y, PL)</i> <i>It is also a cost-effective program. We can send one SMS to millions of people in a short period. It will increase coverage among the patients and will be more effective. (KII02)</i> |
| | Reinforce behaviour change | <i>"The patients should at least be notified on their mobile phones to take their medicine on time. Then, the patient would realise and be motivated to follow that." (HCW 02, PL)</i> |
| Perceived usefulness | Can provide reliable information | <i>"If messages are sent by you and others like you (health professional), I will happily accept it thinking that doctor with whom I meet at the hospital sent this message." (P013: 45-50 Y, PL)</i> |
| | Deliver information privately | <i>"If I get information on my mobile, then it might help to improve my blood pressure. If I go to the health centre, there would be lots of people ... I feel shame to say myself ill in front of other people. I have not shared with friends, as well." (P014: 35-40 Y, M, TL)</i> |

| | | |
|--|---------------------------|--|
| Perceived ease of use | User friendly | <i>I think it will work and be feasible because majority of the people own mobile phone, can very easily see the information in mobile without any difficulties and there is no need to have expensive smartphone for simple SMS. (P20: M, 50-55Y, PL)</i> |
| | Local language | <i>The SMS language should be simple and easy to understand for everyone. Nepali is the most common language out here and people can easily read that. (P015: 30-35Y, M, TL)</i> |
| Perceived challenges – external factors | Mobile phone illiteracy | <i>We cannot read, so how can we know what is being sent in mobile; we will not understand whatever things come into our mobile....is not it? (FGD01; 60-65Y, F, TL)</i> |
| | Technical constraints | <i>"No. No. How can we manage those mobile services? It will be challenging to implement. It needs a considerable amount of budget, though the concept is excellent." (HCW 03: PL)</i> |
| Themes under other objectives of study | Sub - themes | Supporting verbatim |
| Perceived solutions for overcoming the challenges | System-level preparedness | <i>The hospital must also have a record of the detailed list of OPD patients diagnosed with hypertension. Proper record-keeping is essential. (HCW 09: TL)</i> |
| | | <i>"For such project, we need some mobile centres/department, or some technical manpower then only we can implement it." (KII 03)</i> |

| | | |
|--|--|--|
| | <p>Alternatives strategies for illiterate</p> | <p><i>“These days though mother/father is illiterate, there will be son, daughter and grandchildren who are educated. If we could send the message to the family member of the illiterate patients, they will get the information. (HCW 07: PL)</i></p> |
| <p>Preferred features of the mHealth strategy</p> | <p>Comprehensive contextual contents</p> | <p><i>Is BP controlled after taking bitter herbs (chirauto) only or should we go for acupuncture or not..some people say that there is a person who press in the hand and pressure will be fine, so should we follow that or not?— it should be send in messages. (P08: 50-60 Y F, PL)</i></p> <p><i>It should include all the information regarding what type of diet should we take and what should be avoided. Like messages regarding patient should take less salty and oily food. [P012: 45-50 Y, F, PL]</i></p> |
| | <p>Reasonable frequency and timing of messages</p> | <p><i>"I feel like if it can be sent once or twice a week, then it will be kept in touch also. If we send them daily, then they might delete it. (laughs)." (HCW 05, TL)</i></p> |

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4
5 2 **Can provide reliable information:** Some participants reported that they could search for unlimited
6
7 3 information from the internet on their mobile by themselves. However, the authenticity and relevance
8
9 4 of that information could not be determined. They requested information from a "*reliable and*
10
11 5 *trustworthy*" provider, referring to HCWs.

12
13 6 HCWs reinforced this request and stated that it should be adequately linked with the health system to
14
15 7 ensure that messages will be accepted and trusted by participants, that may motivate the intended
16
17 8 behaviour change.

18
19 9 **Deliver information privately:** Participants stated that text messages have the advantage of delivering
20
21 10 personalised information on their mobile privately. They valued personal text messages sent on their
22
23 11 mobile to maintain privacy regarding their hypertension status. This was the case with younger patients,
24
25 12 who did not want their illness divulged to people they associate with.

26
27 13 Overall, there was no reported difference in usefulness based on the gender and level of healthcare.
28
29 14 However, the advantage of getting messages privately was expressed mainly by the younger
30
31 15 participants, not by the older age groups.

32 33 34 35 16 **II. Perceived ease of use:**

36
37 17 **User friendly:** Participants stated that the text messages are a simple and easy strategy as text messages
38
39 18 do not require advanced technical skills to operate. Participants preferred receiving messages in a
40
41 19 simple, clear, and concise format. They added that if SMS is designed in an understandable format, it
42
43 20 could be effective in the study setting.

44
45
46 21 *It will be effective. These days, even the lay man (najjanne), can use simple messaging. (P10: 45-*
47
48 22 *50Y, F, TL)*

49
50
51 24 **Local language:** Study participants stated that it would be easiest to read and understand if the
52
53 25 messages would be sent in the Nepali language. If designed in a local language, people with low literacy
54
55 26 could also utilize the mHealth intervention for behaviour modification.

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2
3 1 Yes, she (patient) could read it if it is sent in Nepali. If sent in English, even I cannot read it. But
4
5 2 we both can read in Nepali. (FM03 of 40-45Y, F, PL)
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7

8 3 The ease of use was expressed mostly by the literate group of participants. Older and illiterate
9
10 4 participants suggested designing simple text messages in the local language.
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12

13 5 **III. Perceived Challenges - External factors**

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15 6 Many participants also identified obstacles to implement the mHealth strategy in the study settings.

16
17 7 **Mobile phone illiteracy:** Some participants raised concerns about general literacy and digital literacy of
18
19 8 patients in reading the SMS even though messages would be sent in the local (Nepali) language. They
20
21 9 reported that it could be difficult for those who have low digital literacy skills, for example, who do not
22
23 10 know how to open, read, or send a text message.
24

25
26 11 Further, an older participant mentioned that "No, I only know how to call. I have a simple mobile. I do
27
28 12 not know how to open and read the messages." (P017: 65-70Y, M, PL)
29

30 13 HCWs added that such a program could be more effective in urban areas and are most accessible to the
31
32 14 young generation. The participants expressed that age and illiteracy may influence the ability to read text
33
34 15 messages.
35

36 16 **Technical constraints:** HCWs were cautious, highlighting the need for resources to implement such a
37
38 17 program in Nepal. They expressed concern about resources such as the technical workforce and funding
39
40 18 requirements for software development and SMS delivery, including commitment from the authorised
41
42 19 bodies in the hospital. Some HCWs also raised the issue of health system preparedness to implement such
43
44 20 programs due to costs and a limited technical workforce.
45

46
47 21 Many HCWs identified challenges, such as not having an appropriate recording system for hypertensive
48
49 22 patient's details in the hospitals to locate and trace them in the community. They argued that text
50
51 23 messaging would be almost impossible in public hospitals where doctors have a high workload, limiting
52
53 24 their ability to record the patients' details, such as their phone number. One HCW stated that "There is
54
55 25 not even a good record-keeping system here in our hospital, and no one is going to record as we don't
56
57 26 have time." (HCW 08: TL)
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59
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2
3 1 The system level technical challenges were expressed by both levels of healthcare; mostly by the HCWs
4
5 2 and KI. No such issues were reported by the hypertensive patients.

3 **Themes based on other objectives of the study**

4 **IV. Perceived solutions**

5 In the context of resource constraints, participants recommended some solutions to create the desired
6
7 outcome of mHealth strategy.

8 **System-level preparedness:** HCWs emphasised a proper record-keeping system, which would help in
9
10 tracing the hypertensive patients to send SMSs.

11 However, they emphasised the need for government commitments for such programs, such as
12
13 establishing a separate department to monitor the program.

14 Key informants highlighted the need for system-level preparedness by extensive planning, budgeting,
15
16 and mobile phone text messaging software development. They stated that multi-sectoral collaboration
17
18 and commitments will be needed to implement the mHealth program effectively.

15 **Alternative strategies for illiterate groups**

16 Participants suggested including a family member of illiterate patients when sending messages. They
17
18 mentioned that every household should have at least one literate person, and family members were
19
20 ready to support illiterate relatives and parents.

21 They stated that *“For illiterate people like my mother, it has to be sent to the member of the family like
22
23 me. As a son, I must take care of her” (FM 02 of 60-65 Y, F, PL)*. Furthermore, video/voice messages,
24
25 symbolic pictures or cartoons were recommended by HCWs for the illiterate groups.

26 *“I think the video is more effective than a text message as it has both audio/visual features” (P014: 35-
27
28 40Y, M, TL)*

29 However, some participants raised concerns about the family member's relationship with patients and
30
31 their availability and the feasibility of using video messaging in a resource-constrained setting like
32
33 Nepal. These concerns were especially prominent at the primary level where smartphones, internet and
34
35 MMS facilities are limited and less available.

V. Preferred features of the mHealth (text message) strategy

In each IDI and FGD, answers to questions regarding the need and preference of participants to inform the content and delivery of text messages were analysed.

Comprehensive contextual contents: Participants expressed various misconceptions prevalent in the study setting regarding hypertension and its treatment. Participants preferred getting context-specific messages targeting misconceptions about hypertension treatments such as use of locally available herbs: aloe vera juice, bitter juice (Chirauto), barley sprout juice (Jamara) etc. Similarly, participants suggested including messages targeting the foods prepared during festivals in Nepal which are high in fat and salt content.

Patients says that "yesterday I attended a festival. After eating high salt food and meat, I am getting headache, so I came here for check-up." So, I think you should send information about diet as well. (HCW 04: TL)

For lifestyle modification, some participants stated that it would be good to receive information about physical activity and culturally appropriate dietary factors. "*What kinds of exercise should be done, how much.... amount.... duration.... Time.*" KI also added that patients should get all the messages on pharmacological and non-pharmacological measures for controlling their blood pressure.

Overall, content preferences included information about hypertension and its treatment, dietary factors (local foods), medication, side effects, physical activities, and reminder for medication.

Reasonable frequency and timing of text messages: Participants also stated that text messages should be delivered with reasonable frequency and timing. Study participants preferred receiving 2-3 reminder messages per week for taking medications or about specific behaviours. Overall, participants agreed that daily messaging would be too often and monthly messaging would be insufficient.

If you send in the interval of 2-3 days, then then we might see that. (P018: 40-45 Y: M, PL)

Most of them preferred messages to be delivered in the morning or evening. Participants mentioned that if the timing of the message matched with the time of taking their medicine, then it would be more effective "*Usually people take medicine in the morning so, that would be a good time.*" (P05:45-50, F,

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2
3 1 *PL) Another participant also added. " for women.... evening time would be good as we will be busy in*
4
5 2 *household works during morning." (FGD 05: 30-35 Y; F, TL)*

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7 3 Overall content preferences were not different based on the gender, age, and level of care. However,
8
9 4 female participants expressed greater preference to receive messages in the evening time.
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12 5

13 6 **DISCUSSION**

14
15 7 This study explored the perspectives of patients and providers on the acceptability of mHealth (mobile
16
17 8 phone text messages) strategy for patients with hypertension in Nepal. Overall, participants were
18
19 9 receptive towards the text message-based intervention with some contextual recommendations. This
20
21 10 study found that simple mobile phone text messages could be useful in this setting due to the ubiquitous
22
23 11 use of mobile phones. Studies at the primary level²⁶ and in rural parts of India⁴¹ have reported similar
24
25 12 findings of mHealth being a ubiquitous and acceptable tool for managing cardiovascular diseases and
26
27 13 supporting healthcare. Key informants involved in implementing the national NCDs program and policy
28
29 14 in Nepal identified the low-resource requirements of SMS as potentially useful for such interventions.
30
31 15 The WHO's Global Observatory for eHealth (GOe) also argues that SMS is an easy method to
32
33 16 disseminate targeted health information at a low cost.¹⁵ Text messages can be sent in bulk to multiple
34
35 17 users simultaneously, are cheap, and do not require advanced skills on the part of the health service or
36
37 18 the patient.¹⁶ However, cost effectiveness analysis is an area for future research in this setting.

38
39 19 Our study found behaviour reinforcement/modification to be another potential use of mHealth. In
40
41 20 chronic diseases such as hypertension where medication should be taken daily, SMS reminders can
42
43 21 increase medication adherence.^{42,43} Additionally, WHO GOe stated that SMS was the preferred method
44
45 22 for treatment compliance measures worldwide.¹⁵ Non-disclosure issues due to the stigma attached to
46
47 23 hypertension were reported, especially by young people in Nepal in an earlier study.¹³ The importance
48
49 24 of receiving messages privately on mobile phones was stressed by our respondents. It has not been
50
51 25 reported for NCD previously, but these were mostly reported in studies of HIV/AIDS.⁴⁴ Overall, there
52
53 26 was a consensus on the value of text messaging in getting information privately (in confidence) to
54
55 27 hypertensive patients by all the stakeholder groups. However, our study participants did not mention
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1 concerns about data security, an increasingly important factor in designing mHealth strategies.

2 Our participants found the text message strategy easy to operate and not requiring advanced technical

3 skills. Participants preferred to have messages in the local Nepali language for the ease of use of broader

4 groups. We were able to identify implementation challenges that were similar to other resource-limited

5 settings as well as unique to Nepal. Difficulty in reading text messages (even in the local language), a

6 language and literacy barrier including digital literacy in reading the text messages were reported in this

7 study, similar to South Indian studies.^{26,44} In Nepal, though mobile phone penetration is high, digital

8 literacy is only reported as 31%.⁴⁵ In this context, alternative solutions identified by stakeholders were

9 the inclusion of family members of illiterate/older people and sending video or symbol-based messages.

10 While there was enthusiasm to use mHealth, HCWs and KI expressed concerns about the lack of

11 resources and technical issues that could be an impediment. A key concern was that implementing a

12 new mHealth (SMS) system in the hospital might require extra technical manpower for software

13 development, generating a need for a separate technical department. The immaturity of health

14 information systems in hospitals and gaps in recording essential information was also identified as a

15 potential limitation. Similar issues have been reported from rural India as a barrier to the continuity of

16 care and follow-up with hypertensive patients.⁴⁶ These findings are corroborated by other studies in

17 Kenya⁴⁷ and Bangladesh.⁴⁸ The WHO has also stated that unclear mHealth policies and underdeveloped

18 infrastructure are the most common barriers to adopting mHealth in LMICs settings.¹⁵ In our study, it

19 was explicitly stated that a reliable and peer-reviewed source of information is required. An SMS

20 originating from a public or private health centre will be trusted by individuals as they would be

21 considered reliable. It is therefore imperative to establish the trustworthiness of the information for the

22 desired behaviour modification.⁴⁹ The key recommendation was to have government commitment and

23 multi-sectoral collaboration and coordination with the health system to address the structural barriers

24 to use advanced technology. These aspects should be carefully considered while designing any mHealth

25 strategy for its sustainability.

1 **Implications for mHealth design and future research**

2 This study contributes to a small but growing body of evidence that mHealth could be an acceptable
3 strategy in LMIC settings if designed based on the local context and needs.^{50,51} Our study participants
4 highlighted their interest in getting messages clarifying the misconceptions regarding the use of local
5 herbs for treatment of high blood pressure and targeting cultural food practices. The findings of this
6 formative research informed the next phase of the TEXT4BP study, tested using a randomised
7 controlled trial design.⁵² Information on the contents of SMS texts, their frequency and timing of the
8 messages may be of value in similar resource-limited settings. In Nepal, there are very few studies on
9 mHealth. The need for the evidence-based use of modern technology in health service delivery is
10 emphasized in the Nepal Health Sector Strategy 2015-2020.⁵³ This study's findings represent a crucial
11 contribution for designing evidence-based mHealth strategies in Nepal.

12 The COBRA-BPS study in Pakistan, Bangladesh and Sri Lanka⁵⁴ provided promising evidence in
13 improving blood pressure control. However, their main intervention was based on mobilising
14 community health care workers and training physicians. In Nepal, due to the scarce human resources
15 and overburdened Female Community Health Volunteers (FCHV), it is important to develop and test
16 interventions that would not burden the health workers. The more recent mWELLCARE trial⁵⁵ was a
17 large, well-designed study in India designed to utilise a mHealth system for integrated management of
18 five chronic condition including hypertension. However, the study did not find a significant reduction
19 in blood pressure. Other studies such as the STAR trial among hypertensive patients⁴³ and the
20 Text2preventCVD study⁵⁶ have reported promising findings with an intervention that uses text
21 messages. Given this background, we undertook this formative research to develop a mHealth strategy
22 based on participant and stake holder input. We recommend that research in the application of mHealth
23 needs to be undertaken in the future to align the mHealth strategy to the culture and context of the
24 existing health care system to increase the likelihood of adoption of such interventions.

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26

1 **Strengths and limitations of the study**

2 One of the strengths of the study is that efforts were taken to ensure the trustworthiness³⁷ of data by
3 ensuring credibility, through appropriate and different methods for data collection (IDIs and FGDs); by
4 including a different cadre of participants (patients, their family, health workers, key informants) from
5 different sites (primary and tertiary level). The researcher (BB) obtained participant validation at the
6 end of the interview by summarising the main points to ensure the respondent's perspective.⁵⁷ In
7 addition, we have used the TAM model to inform our analysis. Some limitations of this study were that
8 we analysed data from different sources and methods together, which might not fulfil all the criteria of
9 triangulation. This study also used purposive sampling to identify participants, which may have created
10 a selection bias. However, all reasonable efforts were made to ensure the diversity of participants.
11 Furthermore, the transferability of the findings is limited as this study was conducted in urban and semi-
12 urban parts of the country, which may not completely represent the views of people from
13 geographically-disadvantaged and remote areas of LMICs.

15 **CONCLUSIONS**

16 This study found that participants were receptive towards a simple mHealth strategy for controlling
17 hypertension using SMS notifications. Overall, there was a consensus on the value of a text messaging
18 solution to hypertension management by all stakeholder groups. However, meticulous planning is
19 required to include a diverse range of participants to ensure the text messaging strategy is acceptable to
20 a wide range of participants, including illiterate and older groups. Similar formative study approaches
21 can be used to inform contextual design of mHealth in other LMIC settings.

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4 **Author contributions**

5 All authors contributed to the conception of research design, acquisition, and data interpretation. BB
6 conducted the fieldwork and wrote the first version of this manuscript. BB and PN participated in the
7 analysis of the data. All the authors BB, AES, RJ, AV, MS and PN were involved in the manuscript
8 drafting, revision, and finalisation. All authors read and approved the final version of the manuscript.

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17 protected and encrypted computers. Participants have not given their permission for data sharing outside
18 the research group. Thus, no additional data is available.

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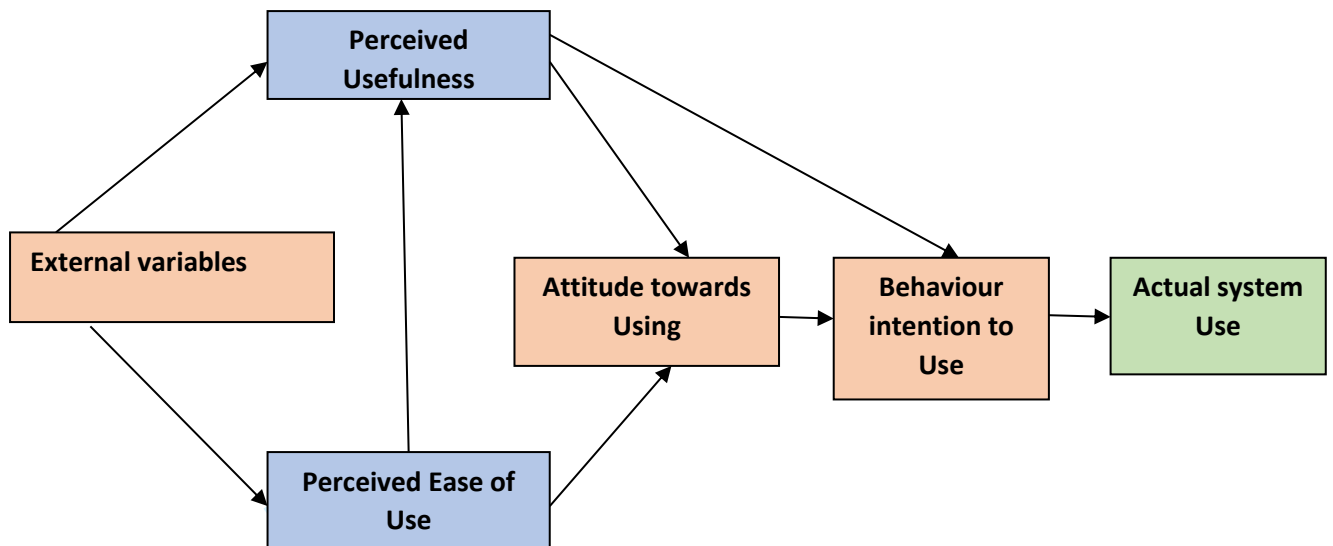


Fig 1: Technology Acceptance Model

Supplementary file 1

Process of participants recruitment

Health care providers at both levels distributed a study flyer containing information about the study to the eligible participants at OPD. When an interested participant initiated the contact, the researcher screened them for eligibility and selected purposively after informed consent based on their age, sex, literacy status to capture diverse perspectives. Similarly, study participants were asked to nominate family members after obtaining consent to be contacted by the research team. Health care workers from the selected study site were also approached for the interview by the researchers. We also invited key informants (policymakers, researchers, and program implementors) working in Non-Communicable Diseases (NCDs) management based on the recommendation from the local research team.

Definition of the variables

Acceptability: We have used the acceptability approach as defined by Schade and Schlage et.al¹ as “a prospective judgement of measures to be introduced in the future where the target group will not yet experience the new measures”.

Literacy: The ability to read and write. We have asked either they could read and write or not.

Employment: The state of having paid work. We have asked whether they were engaged in any paid income work or not.

Definition of the Health Care Providers

Cardiologist: Medical doctor who had MBBS, MD and DM cardiology degree working in public hospital/medical college at tertiary centre

Physician: Internal medicine physician who had MBBS and MD in internal medicine working in a public medical college at tertiary centre

Medical officer: Medical doctor with MBBS degree, who provides services to the hypertensive patients in both primary and tertiary level.

Health Assistant (HA) and community health assistant (CMA): Non physician health workers (HA- 3 Year certificate level formal education, CMA- diploma level 18-month formal training) who are

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3 posted in the government primary health care centre and health post and provide OPD service to
4 hypertensive patients in those centre.
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7 **Staff nurse/ANM:** Health personnel with nursing education (staff nurse- certificate level 3-year nursing
8 education, ANM- diploma level 18-month nursing training) they involve in providing counselling to
9 the hypertensive patients.
10
11

12 **Abbreviation of the verbatim of the participants**

13
14 **PL: Primary level**

15
16 **TL: Tertiary level**

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18 **F: female**

19
20 **M: male**

21
22 **Y: years**
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27 **Reference**

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Supplementary file: 2**I. In-depth Interview guides**

1. Icebreaker
 - a. How are you doing?
 - b. What kinds of work are you doing these days?
2. Could you please share your experience of using mobile phone? *Probe: How, when, for what purpose etc*
3. What do you know about use of mobile health in management of high blood pressure?
4. Could you please share your opinion on using mobile phone for management of high blood pressure? *Probe: what, how*
5. Have you heard, or have you been told that you can get health messages through mobile phone?
6. What is your opinion about it? What is your perspective on potential of mobile health service in management of hypertension in Nepal? *Probe: what, how, example*
7. What could the potential advantages of using mobile health in Nepal?
8. What could be the challenges in using mHealth in Nepal for the management of hypertension?
9. What can be done to overcome the challenges for successful outcome?
10. What kinds of mobile health services you would like to get/use?
11. What should be the contents, timing, and frequency of such mHealth services?
12. Do you want to share anything which I missed to discuss?
13. Let's summarise some of the key points from our discussion. Is there anything else?

III. FGD guides

Let's start by going around the circle and having each person introduce her/himself.

(Members of the research team should also introduce themselves and describe each of their roles.)

1. Icebreaker
 - a. How are you doing?
 - b. What kinds of work are you doing these days?
2. Could you please share your experience of using mobile phone? *Probe: How, when, for what purpose etc*
3. What do you know about use of mobile health in management of high blood pressure?
4. Could you please share your opinion on using mobile phone for management of high blood pressure? *Probe: what, how*
5. Have you heard, or have you been told that you can get health messages through mobile phone?
6. What is your opinion about it? What is your perspective on potential of mobile health service in management of hypertension in Nepal? *Probe: what, how, example*
7. What could the potential advantages of using mobile health in Nepal?
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10. What kinds of mobile health services you would like to get/use?
11. What should be the contents, timing, and frequency of such mHealth services?
12. Do you want to share anything which I missed to discuss?
13. Let us summarise some of the key points from our discussion. Is there anything else?

COREQ (CONsolidated criteria for REporting Qualitative research) Checklist

A checklist of items that should be included in reports of qualitative research. You must report the page number in your manuscript where you consider each of the items listed in this checklist. If you have not included this information, either revise your manuscript accordingly before submitting or note N/A.

| Topic | Item No. | Guide Questions/Description | Reported on Page No. |
|--|----------|--|----------------------|
| Domain 1: Research team and reflexivity | | | |
| <i>Personal characteristics</i> | | | |
| Interviewer/facilitator | 1 | Which author/s conducted the interview or focus group? | |
| Credentials | 2 | What were the researcher's credentials? E.g. PhD, MD | |
| Occupation | 3 | What was their occupation at the time of the study? | |
| Gender | 4 | Was the researcher male or female? | |
| Experience and training | 5 | What experience or training did the researcher have? | |
| <i>Relationship with participants</i> | | | |
| Relationship established | 6 | Was a relationship established prior to study commencement? | |
| Participant knowledge of the interviewer | 7 | What did the participants know about the researcher? e.g. personal goals, reasons for doing the research | |
| Interviewer characteristics | 8 | What characteristics were reported about the interviewer/facilitator? e.g. Bias, assumptions, reasons and interests in the research topic | |
| Domain 2: Study design | | | |
| <i>Theoretical framework</i> | | | |
| Methodological orientation and Theory | 9 | What methodological orientation was stated to underpin the study? e.g. grounded theory, discourse analysis, ethnography, phenomenology, content analysis | |
| <i>Participant selection</i> | | | |
| Sampling | 10 | How were participants selected? e.g. purposive, convenience, consecutive, snowball | |
| Method of approach | 11 | How were participants approached? e.g. face-to-face, telephone, mail, email | |
| Sample size | 12 | How many participants were in the study? | |
| Non-participation | 13 | How many people refused to participate or dropped out? Reasons? | |
| <i>Setting</i> | | | |
| Setting of data collection | 14 | Where was the data collected? e.g. home, clinic, workplace | |
| Presence of non-participants | 15 | Was anyone else present besides the participants and researchers? | |
| Description of sample | 16 | What are the important characteristics of the sample? e.g. demographic data, date | |
| <i>Data collection</i> | | | |
| Interview guide | 17 | Were questions, prompts, guides provided by the authors? Was it pilot tested? | |
| Repeat interviews | 18 | Were repeat interviews carried out? If yes, how many? | |
| Audio/visual recording | 19 | Did the research use audio or visual recording to collect the data? | |
| Field notes | 20 | Were field notes made during and/or after the interview or focus group? | |
| Duration | 21 | What was the duration of the interviews or focus group? | |
| Data saturation | 22 | Was data saturation discussed? | |
| Transcripts returned | 23 | Were transcripts returned to participants for comment and/or | |

| Topic | Item No. | Guide Questions/Description | Reported on Page No. |
|--|----------|--|----------------------|
| | | correction? | |
| Domain 3: analysis and findings | | | |
| <i>Data analysis</i> | | | |
| Number of data coders | 24 | How many data coders coded the data? | |
| Description of the coding tree | 25 | Did authors provide a description of the coding tree? | |
| Derivation of themes | 26 | Were themes identified in advance or derived from the data? | |
| Software | 27 | What software, if applicable, was used to manage the data? | |
| Participant checking | 28 | Did participants provide feedback on the findings? | |
| <i>Reporting</i> | | | |
| Quotations presented | 29 | Were participant quotations presented to illustrate the themes/findings? Was each quotation identified? e.g. participant number | |
| Data and findings consistent | 30 | Was there consistency between the data presented and the findings? | |
| Clarity of major themes | 31 | Were major themes clearly presented in the findings? | |
| Clarity of minor themes | 32 | Is there a description of diverse cases or discussion of minor themes? | |

Developed from: Tong A, Sainsbury P, Craig J. Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups. *International Journal for Quality in Health Care*. 2007. Volume 19, Number 6: pp. 349 – 357