Abstract promoting ras in lmics. 1. background the

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AbstractThe usages of latest technologies in healthcare systems toimprove quality of care and to promote behavioral healthcare are prevalent inhigh-income countries. However, low and middle income countries (LMICs) are notgetting the full advantages of it due to the large population growth rates, inadequate physical resources, lack of interest among different stakeholders, and unwillingness of the public to use technologies for healthcare or healthpromotion activities.

Major behavioral risk factors of chronic diseases areincreasing in LMICs and innovative interventions are essential to address theserisk factors. Computer-based or mobile-based virtual coaches or RelationalAgents (RAs) are increasingly being explored for counselling the patients tochange their health behavior in high income countries, however, the use of RAsin LMICs is not explored. In this paper, we summarize the growing applicationof RAs in behavior change interventions in high-income countries.

Moreover, wedescribe the potential of its use in LMICs. Finally, we review the potentialbarriers and challenges in promoting RAs in

LMICs. 1.   BackgroundThe advancement of mobile phone technology hasintroduced new potentials in the field of medical informatics. Combiningtechnological advances with medical expertise has led to the use of mobilephones in health promotion intervention in high-income, and low and middleincome countries (LMICs).

High-income countries are in the leading position ofdeveloping the latest mobile technologies used in healthcare 1. According tothe World Health Organization (WHO), countries in the high-income groupreported a greater

range of mHealth initiatives compared to the low-incomegroup 2. As of 2015, 64% of American adults and 82% of those who are aged18-49 years owned an app-enabled mobile phone 3. In addition, 15% ofpopulation use a mobile-phone connected wearable device such as smart watchesand fitness bands in their daily lives 4. Mobile health (m-Health) candeliver healthcare anytime and anywhere 5. Several research topics related tohealth care have gathered important findings and contributions from m-Health, such as, cardiology 6, 7, 8, 9, diabetes 10, 11, 12, obesity 13, 14, 15, smoking cessation 16, 17, elderly care, and chronic diseases 18, 19. Mobilehealth basically used for monitoring, prevention, and detection of diseases, and in more advanced services present basic diagnosis.

The services of m-Healthare also popular in LMICs 20, 21. However, LMICs have major restrictions on their healthcare due to a lack ofinfrastructure, human and physical resources, as well as being burdened bypoverty and diseases 22. Mobile applications for healthcare systems arerapidly growing and evolving 5. There are over 40, 000 healthcare appsavailable only in the U. S. Apple iTunes store 23. In LMICs, mobile andm-Health in healthcare service are also prevalent and on the increase in theefficiency and effectiveness of under-resourced health infrastructures 24. However, the scalability of mHealth projects from pilot projects to large-scalenationwide implementation has been low 25.

Recentadvancements in mobile device technology and the development boom of mobiledevice apps (mobile applications), have opened windows of opportunities topromote technology driven healthcare programs. The apps

cover a wide range ofcommon topic areas such as anxiety, depression, smoking, alcohol use, diet, exercise, weight loss, nutrition, and relaxation 26. Smartphone apps provide useful functions in health promotionintervention 26. There are enormous number of health related appsavailable for users to download, however, these require careful review forevidence-based guidelines and reference to other available health strategies 1. Also, despitethe promising findings demonstrated by some m-Health interventions, authors 27concluded that the current evidence base is insufficient to guide decisions onpolicy and practice. It wasargued that 28, among large number of fitness and workout apps, very few areof sufficient quality to provide evidence-based exercise prescription, especially for beginners. In addition, quality of most of the free apps arevery poor and the apps did not provide an actual training plan, explaining howto choose the workouts and how to organize them in a week, although specifictraining sessions were provided 28.

Also, general public is unable toidentify the appropriate app that may be appropriate to their need. In diabetes self-management, researchers have observed that long-term engagement of app users is generallylimited 29. Chronic diseases like asthma requirelong-term self-management 30. One potential way toimprove long-term engagement, which has been successfully applied to physicalactivity, are interactions with virtual coaches 31. Thus, developers of upcoming chronic diseases apps might consider theimplementation of virtual coaches to enhance long-term engagement.

A" virtual coach" is a computer artifact design to reproduce some aspects ofhuman-delivered health coaching. The interpersonal relationship between coachand client in one such aspect, and this relationship is typically treated as akey part of a successful (human-delivered) health coaching intervention 32. Arelational agent (RA) is a computer artifact designed to reproduce some aspectsof human-human interpersonal relationships with its users 33. Motivated bythis, RAs are increasingly being explored for patient education, counseling, health behavior training and coaching, and other mHealth applications 6, 34-38. Virtual coaches or RAs can potentially be adapted to a range of health behaviortraining and coaching – both the cessation of unhealthy behavior such assmoking, overeating, substance abuse and the acquisition of healthy behaviorlike exercise, or a disease specific-diet (e.

g. for hypertension or diabetes). The promise of these mHealthtechnologies are that RAs may deliver customized interventions withsubstantially greater reach compared to human-delivered coaching, while, due totheir ability to build (some aspects of) interpersonal relationships, retainingmuch of the efficacy, and help larger populations of patients to establishlong-lasting regiments and behavioral changes 39, 40. In this paper wesummarize the growing application of RA in behavior change interventions inhigh income countries and describe the potential of its use in LMICs, as manyLMICs are moving towards using information and communication technology forhealthcare delivery. We also summarize the potential barriers and challenges inpromoting RAs in LMICs. Describing Relational Agents (RAs)? Human ComputerInteraction (HCI) research has a long history of examining

social interactionbetween computer artifacts and users, beginning with the work by Reeves andNass on the " media equation 41.

" Inthis and subsequent research, they identified numerous examples in which socialcues in a computer interface – that is, cues similar to those present inhuman-human social interaction – elicited social responses from users 42. Subsequent work hassought to apply these insights by designing computer artifacts to reproduceaspects of human social behavior in application domains – such as healthcoaching – where interpersonal relationship may be a key determinant ofoutcomes. A variety of terminology appears in the literature, reflectingdifferent and overlapping approaches to producing social behavior. The termsocial agent is used to describe computer artifacts that use humanrelationship-building techniques to build a socio-emotional relationship with auser 33. RAs are social agents that are designed to build and maintainlong-term social-emotional relationships with people 36, via processes whichare believed to serve this function in human relationship-building, including empathy, shared self-disclosure, emotionalfeedback, phatic interaction (e.

g. " small talk"), humor, and reference toshared history and background. While implementationapproaches to RAs have varied, most have been designed as embodiedconversational agents (ECA), computer interfaces designed with ananthropomorphic representation that attempt to interact via face-to-faceconversation with users43; Face-to-face conversation facilitates numerousverbal and nonverbal (e. g. hand gestures, facial expressions)

relational cues 44, and reproduction of these cues has been demonstrated to build user-reportedrapport and therapeutic alliance over time 45.

The embodiment of ECA-RAsvaries, including animated characters on client PCs, large special screens, internet sites, mobile computer screens and PDA's 6, 37, 38, as well as robotswith a humanized interface 46. Implementations have also explored a varietyof computational models of dialogue to produce realistic and effective verbaland nonverbal behavior, ranging from stage models 47 to attempts to modelingthe relationship-relevant beliefs and intentions of users 48.