



## Correlates of mobile phone use in HIV care: Results from a cross-sectional study in South Africa<sup>☆</sup>

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### ABSTRACT

**Objective.** Human Immunodeficiency Virus (HIV) is a major disease burden worldwide. Challenges include retaining patients in care and optimizing adherence to Antiretroviral Therapy (ART). One possible solution is using mobile phones as reminder tools. The main aim of our study was to identify patient demographic groups least likely to use mobile phones as reminder tools in HIV care.

**Design.** The data came from a cross-sectional study at the Chris Hani Baragwanath Hospital, Soweto Township, South Africa.

**Methods.** A comprehensive questionnaire was used to interview 883 HIV infected patients receiving ART. Logistic regression analysis was performed to identify the influence of age, gender, education level, marital status, number of sexual partners in the last three months, income level, and employment status on the use of mobile phone as reminders for clinic appointments and taking medication.

**Results.** Patient groups significantly associated with being less likely to use mobile phones as clinic appointment reminders were: a) patients 45 years or older, b) women, and c) patients with only primary or no schooling level. Patient groups significantly associated with being less likely to use mobile phones as medication reminders were: a) patients 35 years or older and b) patients with a lower monthly income.

**Conclusions.** In this setting being a woman, of older age, lower education, and socio-economic level were risk factors for the low usage of mobile phones as reminder aids. Future studies should assimilate reasons for this, such that patient-specific barriers to implementation are identified and interventions can be tailored.

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### Introduction

By 2012, 34 million people were living with Human Immunodeficiency Virus (HIV) worldwide (Anon., 2012). Reassuringly the number of new cases of HIV is declining, with eight million people receiving Antiretroviral Therapy (ART) globally, a large improvement on previous years (Anon., 2012). South Africa, however, has the highest reported number of absolute HIV cases worldwide at 5.6 million people (World AIDS Day Report, 2012 Results, 2012). Furthermore during 2010 approximately 55% of HIV patients in South Africa were enrolled in ART programs, which is considered as one of the highest ART coverage levels

in low- and middle-income countries (Anon., 2011a). The treatment success requires adherence to treatment, as well as to clinic and drug-refill appointments (Patel et al., 2010). Both missing appointments and failing to adhere to treatment are associated with adverse health outcomes (Lucas et al., 1999; Rastegar et al., 2003; Park et al., 2007; Paterson et al., 2000). Even with an increasing number of ART recipients, many are lost to follow up and in recent years this problem appears to have deteriorated (Cornell et al., 2010). Forgetfulness is repeatedly cited as being a common or significant reason for failing to attend clinic appointments and non-adherence to ART, in both high and low-income settings (Person et al., 2011; Kunutsor et al., 2010; Mills et al., 2006; El-Khatib et al., 2011; Rodrigues et al., 2012). According to the World Health Organization (WHO) (mHealth, 2011), mobile and wireless technologies have “the potential to transform the face of health service delivery across the globe” (mHealth, 2011). Latest 2013 figures from the International Telecommunication Union (The World in 2013 ICT Facts and Figures, 2013) suggest that there are approximately 6.8 billion mobile phone subscriptions worldwide, equating to a global penetration of 96% (89% in developing countries) (The World in 2013 ICT Facts and

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Figures, 2013). Mobile health technologies (mHealth) are being implemented across the globe as tools in various fields such as health education and disease surveillance (Catalani et al., 2013). The use of mobile phone devices has the potential to support HIV patients and reduce loss to follow up; importantly mobile phone use in South Africa, relative to other electronic devices is high (Nielsen, 2011).

A number of studies have looked at the impact of mobile phones as appointment reminders (Kunutsor et al., 2010; Mills et al., 2006; El-Khatib et al., 2011; Rodrigues et al., 2012; mHealth, 2011; The World in 2013 ICT Facts and Figures, 2013; Catalani et al., 2013; Perron et al., 2010). A study conducted by Kunutsor et al. (2010) in rural Uganda reports that mobile phones have a potential for use in resource-limited settings to improve the clinical management of HIV, whilst Perron et al. (2010) showed a significant increased patient attendance at an urban primary care clinic in Switzerland.

In the case of ART adherence results are inconsistent. Whilst many show that mobile phone interventions help improve adherence (Rodrigues et al., 2012; da Costa et al., 2012; Hardy et al., 2011; Lester et al., 2010; Pop-Eleches et al., 2011; Uzma et al., 2011), the effects appear to depend on the type of mobile phone intervention (Pop-Eleches et al., 2011; Sidney et al., 2012), the time period of the intervention (Puccio et al., 2006), and the adherence measurement used (da Costa et al., 2012). Studies have shown that patients who fail to attend appointments differ in characteristics including age, education level, employment, marital status (Kunutsor et al., 2010), and mobile phone ownership (Person et al., 2011). The 2010 WelTel Kenya1 multisite Randomized Controlled Trial (RCT) (Lester et al., 2010) found that being a man, owning a mobile phone, and living in an urban area all improved adherence more so in the intervention group which received SMS reminders. In Karnataka, India (Shet et al., 2010), 74% of study participants interviewed felt that an automated call would be useful in sustaining adherence.

The aim of our study was to identify patient demographic groups least likely to use mobile phones as reminders for i) attending clinic appointments on time and ii) adherence to ART, in Soweto, South Africa. The goal was to improve our understanding of the type of barriers faced by HIV patients for not using their mobile phones.

## Methods

### Study design

The original study was a cross-sectional study carried out at the Chris Hani Baragwanath Hospital, Soweto, South Africa. The South African Evaluation (SAVE) study was conducted during March to September 2008, details of the study are described elsewhere (El-Khatib et al., 2010). After obtaining written informed consent information on socio-demographic characteristics, reminders used for attending clinic appointments, failing to attend appointments, reminders for taking medication, and failing to take medication was collected through a structured questionnaire from 998 participants. Analysis was performed on 883 first-line therapy recipients.

### Statistical analysis

We first described the study population and obtained frequencies for appointment reminders and medication reminders.

Outcomes mobile phone reminder for clinic appointment and mobile phone reminder for taking medication, were defined as answering “You use your mobile phone” to the questions “How did you remember to come to your appointment today” and “Now we will ask you how you used to remember to take your pills on time during the past 4 weeks”. For exposure, we included variables that could potentially influence the impact of mobile phone technology: age, gender, education level, marital status, number of sexual partners in the last three

months, income level, and employment status (Person et al., 2011; Kunutsor et al., 2010; Lester et al., 2010; Shet et al., 2010).

We performed Fisher's exact test to identify any association of two different exposure and outcome variables: a) appointment reminders and missed appointment in the last 6 months ( $n = 883/883$ ); and b) medication reminders and missed pill during the previous weekend ( $n = 875/883$ ).

Bivariate analyses to identify risk factors for i) attending clinic appointments (retention in care) and ii) taking medication on time (adherence to ART) were performed using Chi-square tests, Fisher's exact tests (when the frequency of any cell was less than or equal to five) and bivariate logistic regression (Armitage et al., 2002). In addition, multivariate logistic regression analysis (Kleinbaum and Klein, 2002) was performed. Full models for both outcomes were constructed adjusting for the variables highlighted previously. Backward stepwise algorithms (Hosmer and Lemeshow, 2004) (inclusion criteria  $P$ -value  $\leq 0.1$ ) and Akaike Information Criteria were used to identify the set of significant risk factors associated with the two outcomes and measure the quality of the statistical models. Variables with  $P$ -value  $\leq 0.05$ , from the stepwise model, contributed towards the final model for each outcome. Interactions between age, sex, and education level and employment status were further tested on the outcome mobile phone reminder for clinic appointments, as well as interactions between age and income on the outcome mobile phone reminder for taking medication. Statistical analysis was performed using Stata version 12.1 (College Station, TX: StataCorp) (Anon., 2011b).

### Ethical considerations

Ethical approval for the original study was obtained from the regional Medical Ethics Board, Stockholm, Sweden (Protocol 2008/3:7) and the Research Ethics Committee, University of Witwatersrand, Johannesburg, South Africa (M070721) (El-Khatib et al., 2011; El-Khatib, 2011).

**Table 1**

Demographic characteristics of study participants ( $n = 883$ ).

	N (%)
Age	883 (100)
$\leq 34$ years	256 (29.0)
35–44 years	417 (47.2)
$\geq 45$ years	210 (23.8)
Sex	883 (100)
Man	237 (26.8)
Woman	646 (73.2)
Education level	883 (100)
Tertiary	48 (5.4)
Secondary school	689 (78.0)
Primary school or never been to school	146 (16.5)
Marital status	881 (99.8)
Single	349 (39.6)
Divorced/separated/widowed	83 (9.4)
Married	127 (14.4)
Sexual relationship	210 (23.8)
Co-habitation	112 (12.7)
Sexual partners last three months	879 (99.5)
$\leq 1$	855 (97.3)
$\geq 2$	24 (2.7)
Income level (median = 940 R, equivalent to 88 USD)	883 (100)
$\geq 1351R$	213 (24.1)
941–1350R	122 (13.8)
421–940R	312 (35.3)
$\leq 420R$	236 (26.7)
Employment status	883 (100)
Employed	233 (26.4)
Work on daily basis	61 (6.9)
Retired or not employed	589 (66.7)

## Results

### Demographic characteristics of patients interviewed

Data was analyzed from 883 first line regimen patients. Table 1 shows the distribution of demographic characteristics of these patients. Most individuals were 35–44 years old (47.2%), women (73.2%), had completed secondary schooling (78.0%), were single (39.6%), with no or only one sexual partner in the last three months (97.3%), and retired/not employed (66.7%). With regard to income, the median level of the month prior to study enrolment was equal to 940 South African Rands (R) (approximately equivalent to 88 United States Dollars (USD)) (XE Currency Converter – Live Rates, 2013).

### Frequency distribution of reminders

#### Outcome 1: mobile phone as an appointment reminder

The majority of patients reported using a clinic register card with the appointment date written on it (N = 543; 61.5%), diary/appointment book (N = 192; 21.7%), or no physical record and relying on their memory only (N = 183; 20.7%). A relatively small percentage reported using a mobile phone (N = 93; 10.5%) and a similar percentage said they relied on a close friend/relative to remind them (N = 86; 9.7%). Few patients reported using a partner (N = 36; 4.1%), friend at work (N = 2; 0.2%) or other reminder device (N = 14; 1.6%).

#### Outcome 2: mobile phone as a medication reminder

The most popular medication reminder device was the mobile phone (N = 431; 48.8%). A similar percentage of patients reported relying on their memory (N = 429; 48.6%). Approximately one fifth of patients used a close friend/relative (N = 173; 19.6%) or other reminder device (N = 176; 19.9%). A relatively small number of participants used their partner to remember to take medication (N = 68; 7.7%). Less than one percent of patients reported using a pill box (N = 7; 0.8%), a diary/appointment book (N = 5; 0.6%) or a friend at work (N = 6; 0.7%).

### Number of reminders

#### Outcome 1: mobile phone as an appointment reminder

The majority of patients used one type of reminder only (73.2%). However, 24.1% of patients reported using two reminders and a small percentage used three or more types of reminders (2.7%).

Next we determined whether there was any association between the total number of reminders and missing an appointment based on the last six months. As the number of reminders increased the proportion of patients that said yes to missing an appointment in the last six months decreased, but the association was not significant (P-value = 0.056).

#### Outcome 2: mobile phone as a medication reminder

The majority of patients used one type of reminder only (57.9%). However 37.9% of patients reported using two reminders and a small minority used three or more types of reminders (4.1%).

No significant association was found between increasing number of reminders and the proportion of patients that said yes to missing a pill during the previous weekend (P-value = 0.654).

### Significant associations between demographic variables and mobile phone reminders

Significant associations were found between the following exposure variables: age, sex, education level, and employment status and the outcome mobile phone used as an appointment reminder. These results are presented in Tables 2 and 3.

Similarly, significant associations were found between the following exposure variables: age, education level, income, and employment

status and the outcome mobile phone used as a medication reminder. These results are presented in Table 3.

### Bivariate and multivariate logistic regression analyses

Using bivariate logistic regression analysis, we identified specific categories within each demographic variable associated with being less likely to use a mobile phone as an appointment reminder (Table 2). The final model included those categories that remained significant following multivariate backward stepwise logistic regression analysis. These categories were: a) patients 45 years or older, b) women, and c) completed primary schooling/never having been to school. Table 2 shows the significant variables from the bivariate and multivariate logistic regression analyses for the outcome mobile phone used as an appointment reminder.

Bivariate logistic regression analysis was also performed for the outcome mobile phone as a medication reminder. This analysis identified specific demographic categories associated with being less likely to use a mobile phone as a medication reminder. The groups identified are shown in Table 3. The final model included those categories that remained significant following multivariate backward stepwise logistic regression analysis. These categories were: a) patients 35–44 years, b) patients 45 years or older, and c) earning less than or equal to 420R per month. Table 3 shows the significant variables from the bivariate and multivariate logistic regression analyses for the outcome mobile phone used as a medication reminder.

### Variable interactions (data not shown)

Interactions between age, sex, education level and employment status were tested to identify the presence of effect modification on the outcome mobile phone reminder for clinic appointments. Similarly, interactions were tested between age and income on the outcome mobile phone reminder for taking medication. These interactions appeared to have no effect on the outcome.

## Discussion

Our study showed that HIV infected patients in Soweto, South Africa use various tools as appointment reminders and medication reminders. For appointment reminders, patients most often used a clinic register card. In contrast, for medication reminders patients most often used a mobile phone. Using an increasing number of clinic appointment reminders might be associated with being less likely to miss an appointment, but the association was not significant. No association was seen for medication reminders.

These results suggest that patients choose different types of tools for different aspects of HIV care. For clinic appointments it seems that a reminder has a more passive role – that is the patient plays the more active role in remembering to check their clinic register card – such tools do not act as active prompts. Further, patients who use multiple appointment reminders seem less likely to miss appointments. Together these results suggest that patients may use a combination of reminder tools at different time points. In our setting this often included a passive reminder such as a clinic appointment card but there may also be other tools. By using multiple aids patients may be reminded of their appointment at numerous time points prior to the appointment – for example a week, a day, or an hour in advance. Conversely, for taking medication it appears that a reminder has a more active role, prompting the patient to remember to take their medication on time. Our results also suggest that one reminder is sufficient, maybe all that is needed is a single prompt during each scheduled drug dose. However, the literature doesn't support this suggestion. Many of the mobile phone adherence studies did not provide prompts for every scheduled drug dose but instead a mobile phone reminder once every few days (Rodrigues et al., 2012; da Costa et al., 2012), weekly (Lester et al., 2010; Uzma

**Table 2**  
Association between exposure variables and mobile phone reminder for clinic appointments (n = 883).

		Used phone			Bivariate analysis			Multivariate analysis <sup>a</sup>		
		No, N (%)	Yes, N (%)	P	OR	CI (95%)	P	OR	CI (95%)	P
<i>Age</i>	883 (100)									
≤34	256 (29.0)	217 (27.5)	39 (41.9)	<b>&lt;0.001</b>	1			1		
35–44	417 (47.2)	370 (46.8)	47 (50.5)		1.4	(0.9–2.2)	0.136	1.5	(0.9–2.4)	0.103
≥45	210 (23.8)	203 (25.7)	7 (7.5)		5.2	(2.3–11.9)	<b>&lt;0.001</b>	4.5	(1.9–10.5)	<b>0.001</b>
<i>Sex</i>	883 (100)									
Man	237 (26.8)	203 (25.7)	34 (36.6)	<b>0.025</b>	1			1		
Woman	646 (73.2)	587 (74.3)	59 (63.4)		1.7	(1.1–2.6)	<b>0.027</b>	1.8	(1.1–2.9)	<b>0.015</b>
<i>Education level</i>	883 (100)									
Tertiary	48 (5.4)	38 (4.8)	10 (10.8)	<b>0.002</b>	1			1		
Secondary school	689 (78.0)	612 (77.5)	77 (82.8)		2.1	(1.0–4.4)	<b>0.049</b>	1.6	(0.8–3.1)	0.205
Primary school or no education	146 (16.5)	140 (17.7)	6 (6.5)		6.1	(2.1–18)	<b>0.001</b>	3.4	(1.1–10.4)	<b>0.034</b>
<i>Marital status</i>	881 (99.8)									
Single	349 (39.6)	310 (39.3)	39 (41.9)	0.567	1					
Divorced/separated/widowed	83 (9.4)	77 (9.8)	6 (6.5)		1.6	(0.7–4)	0.294			
Married	127 (14.4)	110 (14.0)	17 (18.3)		0.8	(0.4–1.5)	0.508			
<i>Sexual relationship</i>	210 (23.8)	188 (23.8)	22 (23.7)		1.1	(0.6–1.9)	0.798			
Co-habitation	112 (12.7)	103 (13.1)	9 (9.7)		1.4	(0.7–3.1)	0.346			
<i>Sexual partners last three months</i>	879 (99.5)									
≤1	855 (97.3)	764 (97.2)	91 (97.9)	1	1					
≥2	24 (2.7)	22 (2.8)	2 (2.2)		1.3	(0.3–5.7)	0.718			
<i>Income</i>	883 (100)									
≥1351R	213 (24.1)	184 (23.3)	29 (31.2)	0.188	1					
941–1350R	122 (13.8)	107 (13.5)	15 (16.1)		1.1	(0.6–2.2)	0.731			
421–940R	312 (35.3)	281 (35.6)	31 (33.3)		1.4	(0.8–2.5)	0.195			
≤420R	236 (26.7)	218 (27.6)	18 (19.4)		1.9	(1–3.5)	<b>0.041</b>			
<i>Employment status</i>	883 (100)									
Employed	233 (26.4)	195 (24.7)	38 (40.9)	<b>0.004</b>	1			1		
Work on daily basis	61 (6.9)	58 (7.3)	3 (3.2)		3.8	(1.1–12.7)	<b>0.032</b>	2.9	(0.8–9.8)	0.092
Retired or not employed	589 (66.7)	537 (68.0)	52 (55.9)		2.0	(1.3–3.2)	<b>0.002</b>	1.5	(1.0–2.5)	0.072

<sup>a</sup> Multivariable logistic regression adjusted for age, sex, education level and employment status.

et al., 2011; Mbuagbaw et al., 2012) or at decreasing intervals over the study period (Puccio et al., 2006). In fact, a RCT by Pop-Eleches et al. (2011) found that short weekly messages significantly improved drug adherence whereas short daily messages did not have this effect. This

finding supports the notion that in fact patients may not require constant prompting but instead need some sort of active regular reminder possibly eliciting a red flag which reminds them of the importance of taking their medication on time every day.

**Table 3**  
Association between exposure variables and mobile phone reminder for taking medication (n = 883).

		Used phone			Bivariate analysis			Multivariate analysis <sup>a</sup>		
		No, N (%)	Yes, N (%)	P	OR	CI (95%)	P	OR	CI (95%)	P
<i>Age</i>	883 (100)									
≤34	256 (29.0)	103 (22.8)	153 (35.5)	<b>&lt;0.001</b>	1			1		
35–44	417 (47.2)	208 (46.0)	209 (48.5)		1.5	(1.1–2)	<b>0.015</b>	1.5	(1.1–2.1)	<b>0.012</b>
≥45	210 (23.8)	141 (31.2)	69 (16.0)		3.0	(2.1–4.4)	<b>&lt;0.001</b>	2.9	(2.0–4.3)	<b>&lt;0.001</b>
<i>Sex</i>	883 (100)									
Man	237 (26.8)	131 (29.0)	106 (24.6)	0.141	1					
Woman	646 (73.2)	321 (71.0)	325 (75.4)		0.8	(0.6–1.1)	0.142			
<i>Education level</i>	883 (100)									
Tertiary	48 (5.4)	18 (4.0)	30 (7.0)	<b>0.027</b>	1					
Secondary school	689 (78.0)	348 (77.0)	341 (79.1)		1.7	(0.9–3.1)	0.084			
Primary school or no education	146 (16.5)	86 (19.0)	60 (13.9)		2.4	(1.2–4.7)	<b>0.011</b>			
<i>Marital status</i>	881 (99.8)									
Single	349 (39.6)	180 (39.9)	169 (39.3)	0.716	1					
Divorced/separated/widowed	83 (9.4)	44 (9.8)	39 (9.1)		1.1	(0.7–1.7)	0.814			
Married	127 (14.4)	69 (15.3)	58 (13.5)		1.1	(0.7–1.7)	0.595			
<i>Sexual relationship</i>	210 (23.8)	99 (22.0)	111 (25.8)		0.8	(0.6–1.2)	0.31			
Co-habitation	112 (12.7)	59 (13.1)	53 (12.3)		1.0	(0.7–1.6)	0.839			
<i>Sexual partners last three months</i>	879 (99.5)									
≤1	855 (97.3)	436 (96.9)	419 (97.7)	0.478	1					
≥2	24 (2.7)	14 (3.1)	10 (2.3)		1.3	(0.6–3.1)	0.48			
<i>Income</i>	883 (100)									
≥1351R	213 (24.1)	93 (20.6)	120 (27.8)	<b>0.019</b>	1			1		
941–1350R	122 (13.8)	57 (12.6)	65 (15.1)		1.1	(0.7–1.8)	0.588	1.1	(0.7–1.8)	0.561
421–940R	312 (35.3)	167 (37.0)	145 (33.6)		1.5	(1.0–2.1)	<b>0.027</b>	1.3	(0.9–1.8)	0.182
≤420R	236 (26.7)	135 (29.9)	101 (23.4)		1.7	(1.2–2.5)	<b>0.004</b>	1.6	(1.1–2.4)	<b>0.014</b>
<i>Employment status</i>	883 (100)									
Employed	233 (26.4)	101 (22.4)	132 (30.6)	<b>0.02</b>	1					
Work on daily basis	61 (6.9)	32 (7.1)	29 (6.7)		1.4	(0.8–2.5)	0.204			
Retired or not employed	589 (66.7)	319 (70.6)	270 (62.7)		1.5	(1.1–2.1)	<b>0.005</b>			

<sup>a</sup> Multivariable logistic regression adjusted for age and income.

For clinic reminders, the majority of people did not appear to use mobile phones as reminder tools. Understanding which groups don't use mobile phones may help us to study their reasons and potentially make changes in policy and practice to overcome these barriers. For medication reminders it appears that a reminder has a more active role, prompting the patient to remember to take their medication on time. Our results also suggest that one reminder is sufficient, with a single prompt during each scheduled drug dose.

Through both stages of statistical analysis and for both appointment reminders and medication reminders older age was associated with being less likely to use a mobile phone as a reminder aid. There may be various reasons for this association and the other associations noted. These reasons could be divided into: "not having" and "not wanting". That is: not having a mobile phone, not having the finances to buy and use a mobile phone, not having the knowledge to operate a mobile phone, not having any use for a phone, as well as not wanting to use a mobile phone and not wanting to change from older communication methods to newer methods. These reasons are not mutually exclusive and it is likely that in our study patients had a number of reasons for not using a mobile phone as a reminder device.

In terms of study limitations, individuals volunteered to be part of the study: patients not randomly selected from the population might present common characteristics that differ from those of the general population. For example, people that volunteer to be part of a study might have a higher educational level and be more prone to the use of technology. Also, participants were grouped in age categories, with the lowest age group consisting of people younger than 35 years. This classification might include in the same age group people with different attitude towards technology, since the technological knowledge of people younger than 25 might exceed the one of those aged 26–35. Additionally, information on exposure and outcome was self-reported and might have been subjected to recall bias and social desirability bias. Knowing that adherence to therapy is important for successful treatment outcome might have influenced the answers of study participants in the direction of over reporting treatment adherence and use of mobile phones. Finally, more information about the usage of mobile phones might have been interesting to analyze our results. Questions specifically directed at how exactly mobile phones were used as reminders (e.g. use of calendar devices or automatic reminders on the phone) might have provided interesting information and should be included in further studies on mHealth and adherence to therapy.

## Conclusion

Our study identified a number of groups that did not use mobile phones as reminder devices both for attending appointments and for taking medication on time. These groups were being a woman, of low education level, low income and age older than 35. Further studies to assimilate reason for this are needed, before incorporating mobile phone use in national strategies. Policy makers and researchers should look into further interventions to improve the uptake of mHealth.

## Contributions

NM wrote the original draft as part of her graduate thesis work. EL and BF contributed to the writing; MS contributed to the data analysis and revision of the manuscript; ZEK contributed to the conception of the study, the writing and supervision of the research project.

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