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**mHealth – Friend or Foe in Reducing Inequality? A
Systematic Literature Review**

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mHealth – Friend or Foe in Reducing Inequality? A Systematic Literature Review

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mHealth – Friend or Foe in Reducing Inequality? A Systematic Literature Review

The rising availability of mHealth interventions—such as apps or text-based support—is seen as an unprecedented opportunity to enhance social equality in health matters. Results from various isolated studies support these assumptions, but no attempt has been made to aggregate and synthesise available evidence. This systematic review finds that while some disadvantaged groups can benefit from mHealth, the technology may also increase inequality in certain areas. Especially a low level of education and lower socioeconomic status appear to be barriers to benefit from mHealth. More coordinated research approaches focussing on specific topics and populations within the field of mHealth are needed to create evidence for informing the development of interventions that foster equality instead of expanding the social gap.

Keywords: mhealth; equity; equality; systematic review

Introduction

The rising number of smartphone users and the wide range of opportunities associated with them has influenced nearly all aspects of life to some extent. Millions of applications (*apps*) are easily available. Recently, big companies such as Alphabet, Apple, and Amazon have announced major investments into sophisticated applications in the field of health (mobile Health: mHealth), filing patents for apps using Big Data to deliver personalised medicine and health promotion (Paavola, 2018).

The World Health Organization (WHO, 2011) summarises mHealth broadly as any “medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants (PDAs), and other wireless devices” (p. 6). MHealth can be heterogenous in nature, with some apps merely containing health information, and others being interactive, or even using built-in smartphone sensors or remotely connected devices to track activity and behaviours of the user, providing personalised feedback and advice. Text-message based support

using traditional SMS (short message service) is also common (e.g. Hall, Cole-Lewis, & Bernhardt, 2015). A large body of evidence suggests the effectiveness of such interventions for health behaviours such as medicine management and treatment adherence (Hamine, Gerth-Guyette, Faulx, Green, & Ginsburg, 2015), smoking cessation (Whittaker, McRobbie, Bullen, Rogers, & Gu, 2016), general fitness and weight loss (Higgins, 2016), and more.

With mobile phone availability spreading through all socio-economic classes, many have praised the potential of mHealth in reducing inequities and inequalities in areas such as healthcare access or health behaviour. This may happen through improving health literacy (Kumar & Arya, 2015), or providing more and better access to information (Littman-Quinn, Luberti, & Kovarik, 2013), and treatment choices (Rahimi, Menear, Robitaille, & Légaré, 2017) in socially or economically disadvantaged groups. They can also support people in receiving professional help for health issues that are stigmatised within their society (Mao, Buchanan, Wong, & Persson, 2018), like sexual health or abortion.

While eHealth in general has brought similar promises earlier, it has also been found that it has a potential to not just decrease but also foster certain (especially social) inequalities (Latulippe, Hamel, & Giroux, 2017). Recent discourses have explored the possibility of mHealth enhancing inequalities and inequities. Kangovi and Ash (2018) argue that while, for example, it seems rational of employers to encourage employees to monitor their health with apps, human reactions to the results might not be equally rational. Failure to lose weight might result in discouragement rather than encouragement to continue and put stress on the person. Depending on their personality and situational factors, some people are more likely to avoid monitoring or reject information which can help them reach beneficial goals, a phenomenon fittingly

referred to as the *Ostrich Problem* (Webb, Chang, & Benn, 2013). Behaviour is by far not the only concern in this regard. People with low socio-economic status (SES) generally appear much more reluctant in adopting mHealth interventions (Régnier & Chaufel, 2018). Although elderly people are rather diverse when it comes to adopting technology in health, they may be initially hesitant to make use of phone- or tablet-based support due to low technical literacy (Chesser, Burke, Reyes, & Rohrberg, 2016). Further, while smartphones are widely accessible and used in western societies, coverage in poor countries and rural areas remains considerably lower in comparison, ostracising people in these areas (Abaza & Marschollek, 2017). Even gender distribution among mobile phone ownership can vary systematically (GSMA, 2015). These concerns are reinforced by findings from the Netherlands, showing that “mobile health app users were generally younger, higher educated, and had higher levels of e-health literacy skills than non-users” (Bol, Helberger, & Weert, 2018, p. 183). It therefore remains questionable whether all groups benefit equally from mHealth, or if some may not benefit at all. While isolated intervention- and area-specific research exists into this matter, there has so far been no attempt at aggregating the evidence to establish an overview of affected groups. If mHealth interventions are to be used on a larger scale it is imperative to know which populations are disadvantaged and whether these disadvantages follow systematic patterns, or whether different groups are affected in various ways and inequalities need to be addressed in multiple ways. Therefore, the aim of this systematic review is to investigate in which groups the introduction of mHealth effectively reduces social inequality for disadvantaged groups and in which it may facilitate the divide. Possible reasons for both are explored in the process. Three questions are the focus:

- 1) Which disadvantaged groups benefit from mHealth interventions and which do not?
- 2) What are the barriers to equal gains?
- 3) Are these barriers specific to groups, or is there a systematic bias towards disadvantaged populations?

Method

A systematic literature review following the PRISMA statement and methodology (Moher, Liberati, Tetzlaff, Altman, & The PRISMA Group, 2009) was conducted to investigate this issue. An accompanying online repository to this article is openly available at <https://osf.io/g6cxk/> for optimal transparency. The repository contains the PRISMA checklist, and identifies all articles which were found, but excluded. *PubMed* and *PsycINFO* were used as databases for identifying relevant articles. The exact search phrase used for both databases was:

“(mhealth AND inequality) OR (mhealth AND inequalities) OR (mhealth AND equality) OR (mhealth AND inequity) OR (mhealth AND inequities) OR (mhealth AND equity)”

Considering that mHealth has only been in use for less than ten years by now, no constraints were set regarding the publication date. The databases were searched on the 17.05.2018, no studies added later were therefore considered for this review. Only publications in English, or German were considered.

Study selection criteria are based on the PICO scheme (O’Connor, Green, & Higgins, 2011) to adequately fit the research question. Criteria are listed in Table 1. Studies included focused on one or more specific groups within a population, such as

people with low SES, or ethnic minorities. No restrictions were made as to how these groups were defined by the respective authors. Interventions had to be strictly mHealth: be delivered via a mobile phone, tablet, PDA, or similar wireless device. Interventions which could be accessed by, but were not limited to, mobile devices—such as programmes accessible simply via web browser—were not included.

Table 1.
Inclusion criteria for studies.

Pico scheme area	Criteria used in review
Participants (P)	Any possibly vulnerable group
Interventions (I)	Any mHealth intervention / status of mHealth intervention
Comparisons (C)	The general reference population to the participants or baseline to intervention
Outcomes (O)	Any that measures equity and/or equality, or improvement/worsening for a disadvantaged group

As this study aims to identify both beneficial and harmful cases of mHealth in terms of equality, results containing positive, negative, and neutral or no outcomes were included. While literature reviews, communications, protocols, or other publications without own novel data were not used for this review, no restrictions have been put on surveys and trials. The type of study has been accounted for in a risk of bias assessment (Higgins, Altman, & Sterne, 2011, see table 2). This includes complete evaluations for randomised controlled trials (RCT) regarding selection bias, performance bias, detection bias, attrition bias, reporting bias, and other sources of bias. Other types of investigations were evaluated for applicable biases only. The full risk of bias assessment can be found in the Appendix. Data reported for each study include year of publication, sample size and distribution, mean age of participants, sample description/population,

country, name and type of the intervention/instrument or the topic, the device used or investigated, the (outcome) measures, and results. Only outcomes relevant to the research questions at hand are reported. Conclusions from identified qualitative studies and mixed-method designs predominantly focused on qualitative aspects are reported in the Appendix Table A1 but are not part of the synthesis of results.

Results

A total of 756 papers were found using the outlined search strategy. Out of these, 20 papers were subsequently selected for inclusion, all in English. Figure 1 contains further details of the selection process. Table 2 shows the risk of bias, Table 3 summarises results from quantitative research, and Table A2 (Appendix) shows indications for equality. Out of the selected studies, 11 can be described as a trial for an intervention, whereas nine are surveys assessing mHealth status, (motivation for) usage, and attitudes towards it. Diabetes Type-2 was the most covered topic (five studies) and six papers could be summarised as investigating general mobile phone ownership and openness to mHealth. Childbirth services and physical activities are investigated in two papers each. Further covered areas are dietary behaviour, health literacy, HIV, general sexual health, and vaccination (one each). Out of the included studies, seven were conducted in the USA, three in Bangladesh, two in Peru, and one each in France, Nigeria, Bolivia, Australia, Ghana, Kenya, Canada, and the Seychelles. Strong and problematic biases are described in-text, an overview can be found in Table 2. Results are presented by study type (surveys, followed by trials), whereas each of these are split by topic.

Figure 1. Flowchart of identified and included studies based on the PRISMA approach

Table 2. Risk of bias assessment.

+ = Low risk of bias, - = high risk of bias, ? = unclear risk of bias, n/a = not applicable to study design

	Random Sequence Allocation	Allocation concealment	Blinding of participants and personnel	Blinding of outcome assessment	Incomplete outcome data	Selective reporting	Other bias
Bain et al., 2014	n/a	n/a	n/a	n/a	-	-	+
Bishwajit et al., 2017	n/a	n/a	n/a	n/a	+	+	?
Calderón et al., 2015	+	n/a	+	n/a	+	+	+
Fortmann et al., 2017	+	+	+	n/a	?	+	+
Griffin et al., 2018	+	n/a	n/a	n/a	-	-	+
Hermesen et al., 2017	-	n/a	n/a	n/a	-	-	-
Hinami et al., 2017	n/a	n/a	n/a	n/a	+	+	?

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Jennings et al., 2015	n/a	n/a	n/a	n/a	+	+	+
Kamis et al., 2015	n/a	n/a	n/a	n/a	+	+	+
Khatun et al., 2017	n/a	n/a	n/a	n/a	+	+	+
Krishnan et al., 2015	n/a	n/a	n/a	n/a	+	+	+
Mao et al., 2018	+	+	n/a	+	-	+	-
Mayberry et al., 2017	n/a	n/a	n/a	n/a	+	+	-
Nelson et al., 2016	n/a	n/a	n/a	n/a	?	-	+
Rokicki et al., 2017	+	?	+	+	+	+	?
Thomas et al., 2017	n/a	n/a	n/a	n/a	+	+	+
Uddin et al., 2016	-	n/a	n/a	n/a	+	+	+

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Van der Kop et al., 2016	n/a	n/a	n/a	n/a	+	+	+
Wayne et al., 2014	n/a	n/a	n/a	n/a	+	-	+
Yepes et al., 2016	n/a	n/a	n/a	n/a	+	+	+

Insights from surveys

Socioeconomic status, gender, and literacy appear to be dominant influences.

General mHealth use

Patients with limited language proficiency in the US were found to be five times less likely to be interested in using mHealth apps (Hinami et al., 2017), although the exact number may be debatable due to a large CI. Kamis et al. (2015) also found lower education to be connected to less use of texting services for health, as well as younger age, male gender, higher health literacy, and more years of education to be related with general mobile phone ownership in Bolivia. While younger age and higher SES were found to be related to mobile phone ownership in the general population of the Seychelles, more females owned a mobile phone than men, and a majority of 84.51% was open to receiving health related SMS (Yepes et al., 2016). This was especially high in women, younger people, and those with high SES. Contrary, a large survey in Bangladesh found that more men than women generally owned a cell-phone across all investigated groups (including SES), and those who did had to share their phone more often with another person (Khatun et al., 2017). Women were generally less aware of healthcare options available via phone.

Reproductive, child, and sexual health in low SES countries

Odds for seeking childbirth services via mobile phones are higher for women from non-slum areas, but lower for women who never attended school (Bishwajit et al., 2017). The poorest households were less likely to seek assistance across all groups. Those who did not use mobile phones for seeking childbirth services also were less likely to receive postnatal care. A large-scale survey from Nigeria (Jennings et al., 2015) showed that

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women without access to a mobile phone were less likely to make use of antenatal care, skilled delivery, and contraceptive use. They also exhibited lower knowledge of its pregnancy-related complications, and care benefits. No differences were found in the utilisation of obstetric care, postnatal services, and breastfeeding. In Peru, 85% of mothers were interested in receiving general health advice for their children via text message, but the ability to use these was strongly associated with educational level and age (Calderón et al., 2015). Therefore, some women were not able to benefit from the intervention simply because they did not understand how to use SMS. A study with HIV-positive women showed that they had to share their phones more often than men, but nearly no concern was recorded about receiving related healthcare advice from physicians via text messages (Van der Kop et al., 2016). Of HIV infected people living in Lima, the majority had access to a mobile phone and expressed interest in using mHealth for medication reminders and health advice from professionals with no differences across measured groups (Krishnan et al., 2015).

Insights from trials

Evidence from trials showed some success of mHealth for disadvantaged groups.

Diabetes Type-2

A Tele-DSME study run in Chicago showed that while less patients completed a programme compared to a classroom setting of the same intervention, participants were largely satisfied (Bain et al., 2014). However, the authors did not count the extremely high number of dropouts in the latter results. A text message-based intervention called “Dulce Digital” successfully supported low-income Hispanics in the USA to significantly reduce hemoglobin more compared to usual care, with 96% of participants

stating the intervention helped them “a lot” in their diabetes management (Fortmann et al., 2017). Another SMS based intervention (MED) in the US helped reduce barriers to medication adherence (Mayberry et al., 2017), but a different investigation using the same intervention showed decreased odds for non-whites, people with lower health literacy, those of older age, and people with more depressive symptoms to actively participate (Nelson et al., 2016). In Canada, an app by the name of CHWP showed clinically significant hemoglobin reductions, and mild weight reduction in people from low SES background but was only tested on a very small convenience sample (Wayne et al., 2014).

Overweight

Some overweight, and obese women with low-income background in the US improved their diet and physical activity through the SMS based intervention “MyQuest”, resulting in reduced body weight (Griffin et al., 2018). However, nearly half the participants dropped out of the trial. Using the physical activity tracker “FitBit” in France on a general sample, Hermsen et al. (2017) found that the most influential determinants for successfully improving fitness were age, user experience–related factors, mobile phone type, household type, perceived effect of the Fitbit tracker, and goal-related factors, but could not find any effect of SES, gender, or psychological traits. During a needs assessment among low SES women in the US, the “Dynamo Activity Tracker” was shown to be able to effectively identify health needs in disadvantaged groups (Thomas et al., 2016).

Other

A large-scale Bangladeshi intervention using text reminders and providing general

Table 3.

Extraction table for quantitative studies.

AOR = Adjusted Odds ratio, ART = Antiretroviral therapy, AUD = Alcohol use disorders, BMI = Body Mass Index, CI = Confidence Interval, DSME = diabetes self-management education, HC = healthcare, MP = mobile phone, MSM = Men having sex with men, NCD = non-communicable disease, OR = Odds ratio, SMS = Short message service, SP = smartphone, TGW = transgender women

	Sample size and distribution	Age (years)	Sample description / Target population	Country	Name of intervention / Instrument / Topic	Device used or concerned	Measures	Outcomes
Bain et al., 2014	n=47 49% male 51% female	M=49.6 SD=11	Adults with Type-2 diabetes, no participants with Type-1 diabetes or under 18	USA (Chicago)	Tele-DSME (Live video education)	Smartphone (Motorola Atrix 4G)	User Satisfaction	49% completed the intervention compared to 65% in classroom settings, of these, 82% were satisfied with the intervention, underserved minority population appears receptive to receive Tele-DSME
Bishwajit et al., 2017	n=9014 females	M=25.92 SD=5.6	Married women living in slums (45.1%), non-slums (23%), or other urban areas (31.9%)	Bangladesh (urban areas)	Seeking childbirth services via mp's	Mp's (any)	Total number of women seeking childbirth services	Odds of using mp's for seeking childbirth services 28% higher in non-slum areas, 36% lower for women who never attended school, odds were higher for all groups compared to poorest households, women using mp's for childbirth service were also more likely to receive postnatal care
Calderón et al., 2015	n=220 females	M=27.8 SD=6.4 Range: 18-46	Mothers with at least one child under the age of 5	Peru (Cono Norte)	mp ownership and feasibility of	None used, concerned: mp's	mp ownership, Interest in utilising mp's	Mp ownership associated with educational level; educational level, and age, are each correlated with the ability to use text messages;

					and interest in mHealth across sociodemogr aphic categories		for health- related purposes	over 85% of mothers interested in receiving health advice for their child during illness; ability to use mp positively associated with intention to participate in mHealth programme
Fortmann et al., 2017	n=126 75% female 25% male	M=48.43 SD=9.8	Low-income, Hispanic people with poorly controlled type 2 diabetes	USA (Southern California)	Dulce Digital (DSME through text messaging)	Any mp	HbA _{1c} , fasting blood glucose, total cholesterol, high-density lipoprotein, low-density lipoprotein, triglycerides, systolic blood pressure, diastolic blood pressure, BMI, weight	Dulce Digital group achieved a significantly greater reduction in HbA _{1c} over time compared with usual care (M=8.5 % [SD=1.2] compared to 9.4% [SD=2.0] after 6 months); 96% of the treatment group stated that the text messages helped them “a lot” in managing their diabetes
Griffin et al., 2018	n=104 females	M=36.1 SD=8.1 Range: 19-49	Low-income, overweight to obese women, low risk for medical complications	USA (Alabama)	MyQuest (text messaging providing health tips, reminders, goal-setting prompts)	Any mp	Weight, Social Cognitive Theory Constructs; both self- reported	Participants significantly improved dietary and physical activity behaviours; higher dietary and physical activity goal setting; and reduced body weight: 204.3 lb vs 199.6 lb; t[55] = 3.047; reduced mean BMI: 34.7 vs 33.9; t[55] = 3.254, from pre- to post-assessment

in 56 participants (rest dropped out)								
Hermesen et al., 2017	n=711 46.4% female 53.6% male	<25: 133, 26-35: 444, 36- 45: 182, 46-55: 124, 56- 65: 49, >65: 4	People responding to newspaper advertisement, over 18 years old	France (Montpelli er, Lyon, Lille, Bordeaux)	Fitbit Zip (physical activity tracker)	sp combined with FitBit	Web based questionnaire , activity data measured via Fitbit Zip	Most influential determinants: age, user experience–related factors, mobile phone type, household type, perceived effect of the Fitbit tracker, goal-related factors; no effect of SES, gender, psychological traits
Hinami et al., 2017	n=302, with 100 inpatient: 37% female 63% male; 202 outpatient: 66% female 34% male	18-30: 47, 31- 50: 87, 51-65: 124, >65: 44	Low income In- and outpatients at urban clinics, 18 years or older	USA (Northeast ern Illinois)	Unnamend survey to assess health literacy and English proficiency	None used, concerns mp's	18-item questionnaire developed by the Pew Research Center	Less patients with limited language proficiency were interested in using mobile apps (OR = 0.2, 95% CI: 0.09-0.46)
Jennings et al., 2015	n=3,390 females	M=28.3 Range: 15-49	Mothers with a child of 23 months or younger, living in the selected areas	Nigeria (Enugu, Jigawa, Kaduna, Kano, Lagos)	PATHS2 household survey	None used, concerns mp's	Antenatal care, labor and delivery, postnatal care, by mp access	Women without mp access had lower odds of antenatal care utilisation (OR = 0.48, 95% CI: 0.36–0.64), skilled delivery (OR = 0.56, 95% CI: 0.45–0.70), and modern contraceptive use (OR = 0.50, 95% CI: 0.33–0.76); lower knowledge of maternal danger signs (OR = 0.69, 95% CI: 0.53– 0.90) and knowledge of antenatal (OR = 0.46, 95% CI: 0.36–0.59) and skilled delivery care benefits (OR = 0.62, 95% CI: 0.47–0.82),

								compared to women with mp's; no difference found in uptake of emergency obstetric care, postnatal services, or breastfeeding
Kamis et al., 2015	n=559 64% female 36% male	18-29: 53, 30-49: 179, 50-64: 202, >65: 125	Outclinic patients with NCD's	Bolivia (La Paz)	Unnamed questionnaire on mp usage	None used, concerns mp's	Mobile phone usage, sociodemographical characteristics, health status, access to care (self-report)	“Younger age, male gender, high health literacy, more years of education, and having fewer previously diagnosed NCDs were positively related to mobile phone ownership. Among mobile phone users, respondents with lower education and other indicators of vulnerability were less likely than their counterparts to report frequent usage of texting services” (p. 1)
Khatun et al., 2017	n=4915 (4909) 60% female 40% male	18-29: 1788, 30-39: 1343, 40-49: 794, >50: 984	General population	Bangladesh (Chakaria)	Health and Demographic Surveillance System survey	None used, concerns mp's	mp ownership, mp sharing, knowledge about available mHealth options, education, SES	Higher proportion of men owned mp's compared to women in all age groups and independent of SES, women share their phone significantly more often with another person (19.7% compared to 11.6%), more men aware of hc options via mp than women (38.5% vs 26.5%)
Krishnan et al., 2015	n=359 males, including 48 transgender	M=34.0 SD=8.11 Range: 18-65	HIV infected MSM and TGW	Peru (Lima)	Survey and standardised assessment tools	Concerns mp's and sp's	AUD, risky sexual behaviour, ART adherence,	86% had daily access to a mp (30% to a sp), expressed interest in using mHealth for medication reminders and “engaging in anonymous online interactions with health

							communicati on technology access, mHealth acceptance	professionals to discuss HIV- related issues” (p. 273), no differences in communication technology use and mHealth acceptance among participants with AUDs, depression, and suboptimal ART adherence
Mao et al., 2018	n=98 (87 completed campaign), 62 valid survey responses	M=51.5 Range= 26-65	HIV infected on ART, 18 years or older	Australia (New South Wales)	SMS reminders for ART adherence	Any mp	ART adherence, intervention grouping, age, year of HIV diagnosis, start of ART regimen, better HIV care, major life stressors, stigma and discriminatio n	82% had consistently adhered to ART in the previous week at end of intervention, but no significant intervention effect, less stigma associated with better ART adherence, campaign was well received in 11 following qualitative interviews
Mayberry et al., 2017	n=80 68% female 32% male	M=50.0 SD=10.5	Adults with type 2 diabetes	USA (Nashville)	MED (MEssaging for Diabetes, SMS reminders)	Any mp	Medication adherence, Glycemic control (HbA1c)	Most commonly reported barriers for medication adherence include: cost of medications (76%), believing medications are harmful (58%), lack of information about medications (53%), “barrier scores improved each month and barrier improvement predicted adherence

								[...]. Among participants who completed assessments each month, barrier improvement in months 2 and 3 predicted HbA1c improvement” (p. 92)
Nelson et al., 2016	n=80 67.5% female 32.5% male	M=50.1 SD=10.5	Adults with type 2 diabetes	USA (Nashville)	MED (MEssaging for Diabetes, SMS reminders)	Any mp	Glycemic control (HbA1c), Health Literacy, Depressive Symptoms	Non-white people had a 63% decreased relative odds (AOR=0.37, 95% CI: 0.19-0.73) of participating in calls compared to whites, lower health literacy associated with decreased odds of participating in calls (AOR=0.67, 95% CI: 0.46-0.99), older age and more depressive symptoms (AOR=0.62, 95% CI: 0.38-1.02) had decreased odds of responding to texts
Rokicki et al., 2017	n=205 females	≤16: 90, 17-18: 288, ≥19: 120 Range: 14-24	Young women and girls living in the area	Ghana (Greater Accra)	Unnamed interactive mobile phone quiz	Any mp	Total number of replies, self-reported message exposure, reproductive health knowledge (deficit), self-reported pregnancy, SES, sexual activity, parental	81% of participants engaged with quiz, intervention did not disproportionately reach groups with higher SES, Sexual and reproductive health increase across all groups through intervention

							education	
Thomas et al., 2017	n=78 Females	M=59.1 SD=12.1	African-American women in resource-limited communities	USA (Washington, DC)	Washington, D.C. CV Health and Needs Assessment	Dynamo Activity Tracker (wireless physical activity monitoring system)	BMI, fasting blood glucose and cholesterol, blood pressure, fruit/vegetable intake, physical activity, smoking	Physical activity decreased, self-reported time of sedentary behaviour increased, diastolic blood pressure and glucose increased across weight classes, cholesterol, glucose, and blood pressure were near intermediate cardiovascular health goals: dynamic activity tracker appears to have successfully measured the outcomes in question
Uddin et al., 2016	n=4508 (n=3429 in rural intervention area, n=1079 in urban intervention area) female (mothers)	-	Mothers and their children living in urban and rural areas	Bangladesh	mTika (Android app)	Sp's (health workers) and mp's (mothers)	Vaccination rates pre/post-intervention per area, drop out, validity of dosage	Full vaccination coverage decreased in control areas (rural baseline: 65.9%, second measurement: 55.2%; urban baseline: 44.5% second measurement: 33.9%); Coverage increased intervention areas (rural baseline 58.9%, second measurement: 76.8%; urban baseline: 40.7%, second measurement: 57.1%); Difference-in-difference estimates were +29.5% for rural intervention versus control areas and +27.1% for urban areas for full vaccination; logistic regression adjusting for maternal education, mobile phone ownership, and sex of child showed

								OR of 3.8 (95% CI: 1.5–9.2) in rural areas and 3.0 (95% CI: 1.4–6.4) in urban areas; intervention was well-accepted (qualitative evaluation)
Van der Kop et al., 2016	n=700 59.9 % female 40.1% male	Female: M=31.23 SD=8.79 Male: M=37.44 SD=9.71	HIV-positive adults at two clinics in urban slums	Kenya (Nairobi)	WelTel Retain study	Any mp	Land line ownership, mp ownership, preferred communication, phone sharing, concerns about receiving text messages from hc provider	Of 1068 people screened for participation, no difference was found in the proportion of men (n=39/378, 10.3%) and women (n=71/690, 10.3%) excluded because of phone-related criteria; within people sharing their phone, women (n=52/108, 48.1%) were significantly more likely than men (n=6/60, 10.0%) to share with other non-household and household members; only an extremely small number had concerns about receiving text messages from their hc provider (n=6/700, all female)
Wayne et al., 2014	n=21 57% female 43% male	M=55.6 SD=12.3	Type 2 diabetes patients, over 18 years of age	Canada (Toronto)	CHWP (Connected Health and Wellness Platform, app)	Blackberry Curve 8900 (sp) with full data access (on loan during trial)	Hemoglobin (HbA1c), weight, BMI, waist circumference	2 of 21 results could not be used, within the 12 participants with a glycosylated haemoglobin level over 7.0%, a (statistically) significant reduction of 0.43% (from 8.26 to 7.83) was observed, also mild weight reduction, participants with less than 7% HbA1c (n=7) gained an average

								waist circumference of 3.8 cm
Yepes et al., 2016	n=1240 49.98% female 50.11 % male	25-34: 356, 35-44: 362, 45-54: 327, 55-64: 197 Range: 25-64	General national population (NCD risk factors)	Seychelles	Population survey	Concerns mp's	BMI, physical activity, alcohol consumption, smoking, hypertension, elevated blood sugar, mp/sp/tablet/PC ownership, internet access, openness to receiving SMS/email regarding NCD's, radio listening and TV watching habits (NCD)	1037 (83.62%) reported exposure to NCD-related programs on public television, 740 (59.67%), reported exposure via public radio; exposure to NCD-related programmes on TV was higher in older people and females; exposure to NCD-related programmes on radio was higher in older people and those with lower SES; 93.22% owned a mp, ownership was positively correlated with female sex, younger age, higher SES; 31.93% owned a sp with 19.67% of the full population using it for internet access; 84.51% are open to receiving health-related SMS, especially females, younger people, and those with higher SES; “Controlling for SES, exposure to NCD-related programs on public television or radio and willingness to receive health-related SMS were not independently associated with a person’s NCD risk” (p. 1)

health information (mTika) in rural and urban hard-to-reach areas aimed at mothers led to a large increase in vaccination throughout these areas (Uddin et al., 2016). Rokicki and Fink (2017) found that 81% of young Ghanaian women engaged with an interactive SMS quiz which increased their knowledge about sexual and reproductive health. The intervention reached women across all groups equally, including when comparing for SES. In Australia, SMS reminders for ART adherence had no significant interventional effect but might help reduce stigma and was well received in qualitative interviews held with a selection of participants (Mao et al., 2018).

Discussion

A variety of social determinants appear to influence the extent to which certain groups are benefiting—or not benefiting—from mHealth. Results from surveys investigated in this review are in line with the assumptions showed in the introduction: The mere availability of a mobile phone already poses a problem in some countries. This is mostly—but not exclusively—an issue for women. While most groups seem interested in using mHealth, a gap in education, or even basic literacy, creates a barrier. Should it continue to be predominantly higher educated people with a higher SES who engage with mHealth, the gap in benefits will surely widen and cause even further disadvantages – especially considering that technology develops and will possibly take over many classic health promoting strategies or population-based interventions in the near future. While some interventions aimed at helping disadvantaged populations show success, others still find discrepancies – again, foremost in SES and education. No factors besides these two systematically influenced results in the same way, suggesting that social determinants may influence outcomes differently, depending on both region and the goal of a certain mHealth intervention.

The aggregation of evidence confirms what has been suggested by literature described in the introduction: while mHealth provides numerous opportunities to overcome inequalities—especially those due to social determinants—some groups still do not benefit or benefit equally from it. The evidence remains somewhat inconsistent, especially due to high drop-out in some studies. A major problem in the investigation of this issue is that while all included studies looked at mHealth and equity or equality, they measure very different concepts on various populations, using a variety of interventions. To better understand who can benefit from mHealth interventions, it would be helpful to coordinate multiple studies with large sample sizes, measuring social determinants and their relation to efficiency right from the beginning, using standardised definitions. This may even include the involvement of policy-makers (Barkmann & Weinehall, 2017). As mHealth interventions are becoming available in more and more areas, it may soon not be useful anymore to compare them in general, but topic specific. This goes in line with findings by Bol et al. (2018) stating that usage patterns vary between groups depending on the type of app. In addition, country comparisons will be useful. Especially European countries are largely underrepresented in the research. The investigation into mHealth and equality appears to be best investigated in context, and less as a global health matter. Further, as stated by Kangovi & Asch (2018), a one-size-fits-all approach does not seem to be the right way to go in the age of patient-centered medicine, including prevention. Future research should account for this and aim for a more coordinated approach to the topic, including an investigation into the role of trust and how it may differ across groups.

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Appendix

Studies included in Literature Review

Bain, T. M., Jones, M. L., O'Brian, C. A., & Lipman, R. (2015). Feasibility of smartphone-delivered diabetes self-management education and training in an underserved urban population of adults. *Journal of Telemedicine and Telecare*, 21(1), 58–60. <http://doi.org/10.1177/1357633X14545426>

Bishwajit, G., Hoque, M. R., & Yaya, S. (2017). Disparities in the use of mobile phone for seeking childbirth services among women in the urban areas: Bangladesh Urban Health Survey. *BMC Medical Informatics and Decision Making*, 17(1), 1–9. <http://doi.org/10.1186/s12911-017-0578-2>

Calderon, T. A., Martin, H., Volpicelli, K., Diaz, C., & Gozzer, E. (2015). Formative evaluation of a proposed mHealth program for childhood illness management in a resource-limited setting in Peru. *Revista Panamericana de Salud Pública*, 38(2), 144–151. <http://doi.org/S1020-49892015000700007>

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Risk of bias assessments (online repository)

Bain et al., 2014

Domain	Support for judgement	Review authors' judgement
<u>Selection bias</u>		
Random sequence generation.	n/a, convenience sample, no control group	n/a
Allocation concealment.	n/a, aim of the study was not supposed to be concealed	n/a
<u>Performance bias</u>		
Blinding of participants and personnel	n/a (see allocation concealment)	n/a
<u>Detection bias</u>		
Blinding of outcome assessment	n/a	n/a
<u>Attrition bias</u>		
Incomplete outcome data).	49% of participants completed the programme, only n=26 reported back	High bias. Authors conclude that “an underserved minority population was receptive to using smart-phones to receive DSME, and had a high satisfaction rate with the technique”, but this only applies to less than half the participants
<u>Reporting bias</u>		
Selective reporting.	The study does not include the dropped out participants as negative satisfaction.	High reporting bias due to amount, nature or handling of incomplete outcome data.
<u>Other bias</u>		
Other sources of bias.	None.	No bias.

Bishwajit et al., 2017

Domain	Support for judgement	Review authors' judgement
<i>Selection bias</i> Random sequence generation.	n/a	n/a
Allocation concealment.	n/a	n/a
<i>Performance bias</i> Blinding of participants and personnel	n/a	n/a
<i>Detection bias</i> Blinding of outcome assessment	n/a	n/a
<i>Attrition bias</i> Incomplete outcome data	Data is reported completely.	No bias.
<i>Reporting bias</i> Selective reporting.	No selective reporting can be assumed based on the article and provided data.	No bias.
<i>Other bias</i> Other sources of bias.	Some odds ratios used to provide key evidence have wide confidence intervals, putting in question the reliability of the outcomes.	Possible bias through measurement issues.

Calderón et al., 2015

Domain	Support for judgement	Review authors' judgement
<i>Selection bias</i> Random sequence generation.	“Using a random number generator and interval sampling, 124 of the 507 [living] blocks in the sampling frame were randomly selected for door-to-door recruitment.” (p. 145)	No bias.
Allocation concealment.	n/a	n/a
<i>Performance bias</i> Blinding of participants and personnel	n/a – Blinding not necessary or possible	No bias.
<i>Detection bias</i> Blinding of outcome assessment	n/a	n/a
<i>Attrition bias</i> Incomplete outcome data	Paper appears to include complete data.	No bias.
<i>Reporting bias</i> Selective reporting.	Data from the complete sample on all measures is reported.	No bias.
<i>Other bias</i> Other sources of bias.	While the survey was supervised by a researcher in person, using an iPad may have biased the results of those people who already report problems with SMS.	Small to medium bias in subgroups not confident with SMS.

Fortmann et al., 2017

Domain	Support for judgement	Review authors' judgement
<i>Selection bias</i>		
Random sequence generation.	“Blocked random assignment with equal allocation was used to assign participants to Dulce Digital or usual care (UC), using a randomly generated numbers sequence.” (p. 1351)	No bias.
Allocation concealment.	“Participants were informed of group assignment after the baseline assessment.” (p. 1351)	Small bias.
<i>Performance bias</i>		
Blinding of participants and personnel	No blinding, participants were informed of their group and measurements.	Small bias. No problem assumed due to study design.
<i>Detection bias</i>		
Blinding of outcome assessment	n/a	n/a
<i>Attrition bias</i>		
Incomplete outcome data	All measured data was reported. Out of 63 participants per group, 13 dropped out of the treatment group and 6 of the usual care group after 3 months. After 6 months, the number of the treatment group remained the same, whereas two people seemingly re-joined the usual care group. No explanation can be found in the article.	Small bias because of dropout.
<i>Reporting bias</i>		
Selective reporting.	No selective reporting appears to be present.	No bias.
<i>Other bias</i>		

Other sources of bias.	None.	No bias.
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Griffin et al., 2018

Domain	Support for judgement	Review authors' judgement
<i>Selection bias</i>		
Random sequence generation.	None, convenience sample, 1-group pre-post-test design	Low to medium bias due to convenience sample
Allocation concealment.	n/a	n/a
<i>Performance bias</i>		
Blinding of participants and personnel	n/a	n/a
<i>Detection bias</i>		
Blinding of outcome assessment	n/a	n/a
<i>Attrition bias</i>		
Incomplete outcome data	High dropout (36%). Dropped out participants are not taken into account for results. Otherwise all data is reported per remaining person.	High bias
<i>Reporting bias</i>		
Selective reporting.	See incomplete outcome data.	High bias
<i>Other bias</i>		
Other sources of bias.	None	None

Hermesen et al., 2017

Domain	Support for judgement	Review authors' judgement
<i>Selection bias</i>		
Random sequence generation.	One group baseline comparison with two follow-up measurements	Small bias, but comparison missing
Allocation concealment.	n/a	n/a
<i>Performance bias</i>		
Blinding of participants and personnel	No blinding	n/a
<i>Detection bias</i>		
Blinding of outcome assessment	n/a	n/a
<i>Attrition bias</i>		
Incomplete outcome data	All data is reported. Out of 711 participants, 639 completed Questionnaire 2, and 601 completed Q3, culminating in a final dropout of 110 participants 15.5 %	Small bias.
<i>Reporting bias</i>		
Selective reporting.	No selective reporting appears to be present.	No bias.
<i>Other bias</i>		
Other sources of bias.	<p>“The quality of the questionnaires would have benefited from early involvement of social scientists with relevant experience in questionnaire construction, which would have led to a more hypothesis-based selection of questions, and more informative response scales.” (p. 19)</p> <p>“The psychological predictors of use such as the Big Five and user experience-related predictors were not included in Q1 but made a first appearance in Q3.” (p. 19)</p>	Small bias.

Hinami et al., 2017

Domain	Support for judgement	Review authors' judgement
<i>Selection bias</i>		
Random sequence generation.	n/a, real life patients cannot just be assigned to inpatient or outpatient group	n/a
Allocation concealment.	n/a	n/a
<i>Performance bias</i>		
Blinding of participants and personnel	n/a	n/a
<i>Detection bias</i>		
Blinding of outcome assessment	n/a	n/a
<i>Attrition bias</i>		
Incomplete outcome data	All collected data appears to have been reported.	No bias.
<i>Reporting bias</i>		
Selective reporting.	No selective reporting seems to have taken place, population is described in detail	No bias.
<i>Other bias</i>		
Other sources of bias.	No limitations outlined in paper.	Unknown bias due to limitations.

Jennings et al., 2015

Domain	Support for judgement	Review authors' judgement
<i>Selection bias</i> Random sequence generation.	n/a (no intervention)	n/a
Allocation concealment.	n/a	n/a
<i>Performance bias</i> Blinding of participants and personnel	n/a	n/a
<i>Detection bias</i> Blinding of outcome assessment	n/a	n/a
<i>Attrition bias</i> Incomplete outcome data	All data described is reported.	No bias.
<i>Reporting bias</i> Selective reporting.	No selective reporting seems to have taken place, population is described in detail	No bias
<i>Other bias</i> Other sources of bias.	Data was collected by other researchers	Possible small bias

Kamis et al., 2015

Domain	Support for judgement	Review authors' judgement
<i>Selection bias</i> Random sequence generation.	n/a	n/a
Allocation concealment.	n/a	n/a
<i>Performance bias</i> Blinding of participants and personnel	n/a	n/a
<i>Detection bias</i> Blinding of outcome assessment	n/a	n/a
<i>Attrition bias</i> Incomplete outcome data	All data recorded appears to be reported.	No bias.
<i>Reporting bias</i> Selective reporting.	No selective reporting seems to have taken place.	No bias.
<i>Other bias</i> Other sources of bias.	Data relies on self-report, which may be biased because of limited memory, especially regarding mobile phone usage.	Small bias (recall bias).

Khatun et al., 2017

Domain	Support for judgement	Review authors' judgement
<i>Selection bias</i> Random sequence generation.	n/a, survey	n/a
Allocation concealment.	n/a	n/a
<i>Performance bias</i> Blinding of participants and personnel	n/a	n/a
<i>Detection bias</i> Blinding of outcome assessment	n/a	n/a
<i>Attrition bias</i> Incomplete outcome data	All data recorded appears to be presented.	No bias.
<i>Reporting bias</i> Selective reporting.	No selective reporting appears to have occurred.	No bias.
<i>Other bias</i> Other sources of bias.	Knowledge of mHealth interventions are specific to certain programmes.	Potential small bias.

Krishnan et al., 2015

Domain	Support for judgement	Review authors' judgement
<i>Selection bias</i> Random sequence generation.	n/a, survey	n/a
Allocation concealment.	n/a	n/a
<i>Performance bias</i> Blinding of participants and personnel	n/a	n/a
<i>Detection bias</i> Blinding of outcome assessment	n/a	n/a
<i>Attrition bias</i> Incomplete outcome data	All data recorded appears to be presented.	No bias.
<i>Reporting bias</i> Selective reporting.	No selective reporting appears to have occurred.	No bias.
<i>Other bias</i> Other sources of bias.	Self-reported data may be inaccurate, mHealth acceptance questions only hypothetical in nature (they did not actually get to test/use them), outcomes population specific and not necessarily generalisable	Small Bias.

Mao et al., 2018

Domain	Support for judgement	Review authors' judgement
<u>Selection bias</u> Random sequence generation.	„A total of 98 study participants were randomly assigned to three groups, using a computer generated random group allocation approach [...] Group 1 (n = 31) received two- way SMS reminders three times per week; Group 2 (n = 32) received two- way SMS reminders twice per week; whereas Group 3 (n = 35) in the control arm were sent one- way non- specific greeting messages once a week.” (p. 2)	No bias.
Allocation concealment.	Participants were not informed about which group they are in, however, text messages for intervention groups might have given away the purpose.	Small bias.
<u>Performance bias</u> Blinding of participants and personnel	n/a, see above	n/a
<u>Detection bias</u> Blinding of outcome assessment	n/a, obvious questionnaire	Small bias.
<u>Attrition bias</u> Incomplete outcome data	98 people were recruited, only 62 completed the survey, and only 11 were selected for interviews. Representativeness questionable.	Medium to high bias (amount of people not completing)
<u>Reporting bias</u> Selective reporting.	All data recorded appears to be reported.	No bias.
<u>Other bias</u> Other sources of bias.	Study is limited to people already having high awareness due to long-term sickness. The study appears to shift focus after initial hypothesis could not be confirmed,	Medium bias.

which gives input for further research, but not necessarily evidence that should be regarded as absolute. Small sample size. No causal conclusions possible due to design. Possibly non-representative sample for Australia.

Mayberry et al., 2017

Domain	Support for judgement	Review authors' judgement
<i>Selection bias</i>		
Random sequence generation.	n/a, one group pre-test-post-test-design with three follow up measurements	n/a
Allocation concealment.	n/a	n/a
<i>Performance bias</i>		
Blinding of participants and personnel	n/a	n/a
<i>Detection bias</i>		
Blinding of outcome assessment	n/a	n/a
<i>Attrition bias</i>		
Incomplete outcome data	“Assessment completion rates were 100% at baseline, 59% at 1 month, 30% at 2 months, and 65% at 3 months.” (p. 95), no systematic differences found between completers and non-completers, all recorded data appears to be reported	Small bias.
<i>Reporting bias</i>		
Selective reporting.	No selective reporting seems to have taken place.	No bias.
<i>Other bias</i>		
Other sources of bias.	“The SDSCA assesses adherence during the past 7 days only, and the average base- line adherence in our sample was more than 6 days per week, leaving little room for improvement. Others have noted the SDSCA’s lack of sensitivity, limited variability, and ceiling effects. Adherence via daily 2-way texts messages also has limitations. There is no baseline level using this measure, and this text message was an intervention component in itself—many participants said they used the message as a reminder to take their evening doses—so responses may	Medium to high bias.

have little to do with those text
messages addressing barriers.” (p. 96)

Nelson et al., 2016

Domain	Support for judgement	Review authors' judgement
<i>Selection bias</i>		
Random sequence generation.	n/a, one group pre-test-post-test-design with three follow up measurements	n/a
Allocation concealment.	n/a	n/a
<i>Performance bias</i>		
Blinding of participants and personnel	n/a	n/a
<i>Detection bias</i>		
Blinding of outcome assessment	n/a	n/a
<i>Attrition bias</i>		
Incomplete outcome data	Unclear in comparison to Mayberry study (measurement 3?)	Unknown bias.
<i>Reporting bias</i>		
Selective reporting.	Judging from Mayberry et al., 2017, more data has been collected, it is unknown why result were split, or whether more data has been collected. As opposed to the aforementioned study, no measurements from time 2 are reported	High bias.
<i>Other bias</i>		
Other sources of bias.	Sample used for multiple studies (see Mayberry et al., 2017), small sample, technical issues are reported	Small to medium bias.

Domain	Support for judgement	Review authors' judgement
<i>Selection bias</i> Random sequence generation.	“We randomized 38 schools to the interactive mHealth intervention (n=12), a simplified unidirectional messaging intervention (n =12), and the control group (n =14). After randomization, we found 3 schools to be ineligible and 1 refused to participate due to time constraints. In this paper, we focus only on the interactive mHealth intervention arm and the control arm. The analytic sample consisted of 10 schools assigned to the intervention (N= 205) and 12 schools assigned to control (N=293).” (p. 2)	No bias.
Allocation concealment.	Unknown	Unknown bias.
<i>Performance bias</i> Blinding of participants and personnel	n/a, no blinding necessary	No Bias.
<i>Detection bias</i> Blinding of outcome assessment	Not necessary	No bias.
<i>Attrition bias</i> Incomplete outcome data	All outlined data has been reported, drop outs have been accounted for in statistical analysis	No bias.
<i>Reporting bias</i> Selective reporting.	No selective reporting appears to have taken place.	No bias.
<i>Other bias</i> Other sources of bias.	“there may be measurement error in some of the outcomes studied. Sexual activity and pregnancy were self-reported and thus may be subject to recall bias and social desirability bias. The bias may be differential by intervention group if, for example,	Medium bias, not measurable.

provision of sexual health information by mobile phone made participants more likely than those in the control group to respond accurately and honestly to SRH questions. It may also be differential by target subgroup” (p. 7), 20% of participants did not know parents’ level of education, participants not representative of general population (possibly higher education), “the intervention was a multi-component program that included participant interaction with quiz questions, reminder messages, and rewards; we are not able to differentiate impact as a result of individual components” (p. 7)

Thomas et al., 2017

Domain	Support for judgement	Review authors' judgement
<i>Selection bias</i> Random sequence generation.	n/a, only one group	n/a
Allocation concealment.	n/a	n/a
<i>Performance bias</i> Blinding of participants and personnel	n/a, no intervention	n/a
<i>Detection bias</i> Blinding of outcome assessment	n/a	n/a
<i>Attrition bias</i> Incomplete outcome data	All recorded data appears to have been reported.	No bias.
<i>Reporting bias</i> Selective reporting.	No selective reporting appears to have taken place.	No bias.
<i>Other bias</i> Other sources of bias.	The study investigates “resource limited communities”, yet only 40% of the participants have a household income of less than US\$ 60,000 (no further details were checked), 31% had a household income of more than \$ 60,000, but less than \$ 100,000, and 14 % more than that. It is questionable, whether this can be considered low household income	Small bias.

Uddin et al., 2016

Domain	Support for judgement	Review authors' judgement
<i>Selection bias</i> Random sequence generation.	quasi-experimental design, compares groups that may or may not overlap and it is not known to which extend, independence of observations may not be assumed	Medium bias.
Allocation concealment.	n/a	n/a
<i>Performance bias</i> Blinding of participants and personnel	n/a	n/a
<i>Detection bias</i> Blinding of outcome assessment	n/a	n/a
<i>Attrition bias</i> Incomplete outcome data	Data appears to be complete, samples at both times of measurement are nearly the same size	No bias.
<i>Reporting bias</i> Selective reporting.	No selective reporting appears to have taken place.	No bias.
<i>Other bias</i> Other sources of bias.	“we were unable to examine a large number of children eligible for full vaccination as this would have required a 12-month intervention period plus a 12-month follow-up period for children to reach appropriate age for full vaccination. While examining age-appropriate vaccination allows a comprehensive view of community-wide vaccination coverage, compliance decreases over time as children age, families move, and follow-up becomes difficult.” (p. 282), “maternal recall for vaccination history is not as accurate as EPI cards” (p. 282)	Small to medium bias.

Van der Kop et al., 2016

Domain	Support for judgement	Review authors' judgement
<i>Selection bias</i> Random sequence generation.	n/a, no intervention	n/a
Allocation concealment.	n/a	n/a
<i>Performance bias</i> Blinding of participants and personnel	n/a	n/a
<i>Detection bias</i> Blinding of outcome assessment	n/a	n/a
<i>Attrition bias</i> Incomplete outcome data	All outcome measures included, however, exclusion of people not owning a mp does not allow conclusions about their behaviour	Small to medium bias.
<i>Reporting bias</i> Selective reporting.	No selective reporting appears to have taken place.	No bias.
<i>Other bias</i> Other sources of bias.	“The barriers to health services access and phone access may be similar, and women attending the clinics may differ from women who were not able to reach the clinic. Furthermore, Kenya is one of the sub-Saharan countries with the highest mobile penetration rate: the gender digital divide may be more pronounced in other sub-Saharan African countries with lower mobile phone ownership, or in rural settings.” (pp. 5 – 6)	Small bias.

Wayne & Ritvo, 2014

Domain	Support for judgement	Review authors' judgement
<i>Selection bias</i> Random sequence generation.	n/a, no control group	n/a
Allocation concealment.	n/a	n/a
<i>Performance bias</i> Blinding of participants and personnel	n/a	n/a
<i>Detection bias</i> Blinding of outcome assessment	n/a	n/a
<i>Attrition bias</i> Incomplete outcome data	Data of two participants is missing, apparently due to failure by a healthcare professional to submit them, considering the small sample size this may cause bias	Small to medium bias.
<i>Reporting bias</i> Selective reporting.	It is stated that “analysis focused on subjects with a baseline HbA1c>7.0% (53 mmol/mol)” (p. 8), however it is unclear why people with less than 7% HbA1c—who showed a statistically significant waist circumference gain—were admitted to the trial	High bias.
<i>Other bias</i> Other sources of bias.	Small sample size, convenience sample, study reports temporary software malfunctions and updates to have resulted in service disruptions	Small to medium bias.

Yepes et al., 2016

Domain	Support for judgement	Review authors' judgement
<i>Selection bias</i> Random sequence generation.	n/a, population survey	n/a
Allocation concealment.	n/a	n/a
<i>Performance bias</i> Blinding of participants and personnel	n/a	n/a
<i>Detection bias</i> Blinding of outcome assessment	n/a	n/a
<i>Attrition bias</i> Incomplete outcome data	All recorded data appears to have been reported	No bias.
<i>Reporting bias</i> Selective reporting.	No selective reporting appears to have taken place.	No bias.
<i>Other bias</i> Other sources of bias.	Children and elderly (over 65) are excluded, “questions on willingness to receive health-related email or SMS were not designed to assess the whole range of mHealth services” and “questions on exposure to health programs on traditional media did not assess the impact of these programs on behaviors” (p. 10), results may not be generalisable to other African countries	Small to medium bias.

Conclusions from qualitative studies

Table A1.

Extraction table for studies using qualitative methodology.

	Sample size	Country	Conclusions
Barlott et al., 2015	n=8	Colombia (Bogota)	“The proliferation of mobile phones in this resource-limited setting provided a feasible method for reducing the exclusion of [people with disabilities] and caregivers. SMS was a useful tool for sharing information and reducing the isolation experienced by this socially excluded population.” (p. 347)
Maar et al., 2016	n=45	Canada	“The objective of this qualitative research study was to identify major factors that may impact on the effectiveness of evidence-based SMS messages designed to reduce health inequities in hypertension management in low resource settings, including Aboriginal populations in high-income countries and rural populations in low-income countries.” (p. 1) 1) “The quality of text messages impacts significantly on the effectiveness of a mobile health intervention. Our research underscores the urgent need for interventions to incorporate and evaluate the quality of SMS messages and to examine the mediators of meaning within each targeted cultural and demographic group.” (p. 2)
Messinger et al., 2017	n=58	Bangladesh (Dhaka and Sylhet districts)	“We report low utilization yet high acceptability of mHealth services among low-income MR [menstrual regulation] clients in Bangladesh. Expanding formal and informal mHealth services targeted towards MR – and increasing publicity of these services in low-income communities – may help increase timely access to accurate MR information and formal providers among women at risk for clandestine abortion.” (p. 1)

Régnier et al., 2018	n=79	France	<p>“We aimed to determine under which social, economic, and cultural conditions individuals in France were more likely to be actively invested in the use of self-tracking diet and fitness apps for better health behaviors. [...] Individuals from affluent or intermediate social milieus were most likely to use the apps and to participate in the associated online social networks. These interviewees also demonstrated a preventive approach to a healthy lifestyle. Individuals from lower milieus were more reluctant to use digital devices relating to diet and physical activity or to participate in self-quantification. The results of the study have major implications for public health: the digital self-quantification device is intrinsically less important than the way the individual uses it, in terms of adoption of successful health behaviors.” (p. 1)</p>
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Indications for inequality (online repository)

Table A2.

Indications of studies for inequality.

	Indications for inequality
Bain et al., 2014	Potential to reduce inequity by providing self-management tools for diabetes patients with low access to care
Bishwajit et al., 2017	Mp's help people seek childbirth assistance, but are limited by education
Calderón et al., 2015	mHealth can support mothers in resource-limited settings, mothers with limited education (and their children) face inequity
Fortmann et al., 2017	“These findings suggest that, if implemented on a wider scale, simple, low-cost, text message-based mHealth approaches such as Dulce Digital have the potential to achieve a significant public health benefit in diabetes, a chronic health condition that is rapidly increasing in the Hispanic and other under- served populations.” (p. 1352)
Griffin et al., 2018	“A low-cost, text messaging initiative particularly targeting women residing in rural communities with high rates of poverty and obesity can promote weight loss and improve dietary and physical activity behaviors. Future studies may include a control group and social support component such as group text messaging” (p. 11)
Hermesen et al., 2017	“The relative importance of age as a predictor of sustained tracker use (with higher age associated with longer use) is in line with previous literature (eg, [25,30,31]). More research is needed to answer the question why this is, and to determine its implications for the design of tracker-based interventions for physical activity. Is the greater efficacy for older participants problematic, or are younger participants already well-served by other possibilities to exert themselves physically? In a similar notion, is this age-effect a consequence of self-selection, in which younger people already have enough alternatives for physical activity, and it is mostly those older than 25 years that turn to tracking as viable solution? Answers to these questions also have implications for the development of tracker interventions. Do we need more age-inclusive solutions, or can we regard this type of intervention as more effective for people older than 25 years?” (p. 18)

Hinami et al., 2017	<p>“mHealth exclusions around literacy and language proficiency threaten equity, and innovative solutions are needed to realize mHealth’s potential for reducing disparities.” (p. 90)</p> <p>“Our assessment indicates that large exclusions of a safety-net population in 2015 are a legitimate concern in communication strategies that rely too heavily on mHealth.” (p. 92)</p>
Jennings et al., 2015	<p>“Women with no mobile phone access were significantly less likely to utilize skilled obstetric services and recognize their benefits as compared to mobile-connected women. In settings with unequal access to mobile phone technologies, mHealth interventions may not reach women who have the poorest maternal knowledge and care-seeking as these women often lacked access to mobile phones.” (p. 347)</p>
Kamis et al., 2015	<p>“Mobile phones have high penetration among NCD patients in La Paz, Bolivia, including among those who are older, less educated, and who have other socioeconomic risk factors. Smartphone use is still relatively uncommon, even among patients who are younger and more educated. While certain patient characteristics such as age or education impact patients’ use of text messaging, mobile phone-based mHealth interventions are feasible strategies for increasing NCD patients’ access to self-management support between face-to-face clinical encounters.” (p. 1)</p>
Khatun et al., 2017	<p>“Compared to men, women are less likely to own a mobile phone and less aware of available mHealth services, despite high intention to use mHealth among both genders. To optimise the use of mHealth services and to achieve equity of use, uptake strategies should target women, with a focus on the poorer and less educated groups.” (p. 1)</p>
Krishnan et al., 2015	<p>“Findings show support for implementing mHealth-based intervention strategies using cell phones to assess and reduce HIV-risk behaviors among HIV-infected MSM and TGW.” (p. 273)</p>
Mao et al., 2018	<p>“This study underscores the essential role of empowerment through enhancing disease self- management, increasing social support and reducing stigma, particularly for long- term HIV survivors. SMS messaging, part of mHealth, delivered by community services could have broader impacts on reducing health and social inequity.” (p. 1)</p>
Mayberry et al., 2017	<p>“Iterative, individual tailoring may overcome users’ barriers to adherence. Attrition is a challenge for mHealth interventions among low-income patients.” (p. 92)</p>
Rokicki et al., 2017	<p>“mHealth programs for adolescents have the potential to engage and increase SRH knowledge of adolescent girls across sociodemographic strata, including those who may be at higher risk of poor SRH outcomes.” (p. 1)</p>
Thomas et al., 2017	<p>“Decreased PA and increased ST are potential community intervention targets for overweight and obese African-American women in resource-limited Washington D.C. areas. mHealth technology can assist in adapting CBPR intervention resources to improve PA for African- American women in resource-limited communities.” (p. 876)</p>
Uddin et al., 2016	<p>“Our study demonstrated that a mobile phone intervention can improve vaccination coverage in rural hard-to-reach and urban street dweller communities in Bangladesh. This small-scale successful demonstration should serve as an example to other low-income</p>

	countries with high mobile phone usage.” (p. 276)
Van der Kop et al., 2016	„In this study, men and women were equally able to participate in a trial of an mHealth intervention. Equitable access in these urban slums may indicate the ‘gender digital divide’ is narrowing in some settings; however, gender-specific phone sharing patterns and concerns regarding privacy must be fully considered in the development and scale-up of mHealth programmes.“ (p. 1)
Wayne et al., 2014	“This project supported the feasibility of smartphone-based health coaching for individuals from lower SES with minimal prior smartphone experience.” (p. 1)
Yepes et al., 2016	“Broadcasting health programs through traditional mass media (national public radio and television) reached the majority of the population under study, including older adults and those in lower socioeconomic groups. With a high penetration of mobile phones and willingness to receive health-related SMS, mHealth presents an opportunity for health programs, especially when targeted SMS messages are intended for younger adults and those in higher socioeconomic groups. By contrast, due to reduced Internet access, email-based programs had a more limited reach for health promotion programs. These findings emphasize the different reach of interventions using SMS or email versus traditional mass media, according to demographic and socioeconomic categories, for health education programs in a developing country.” (pp. 1 – 2)