Socio-economic impact of mHealth
An assessment report for Brazil and Mexico

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Executive summary

Capturing the socio-economic potential of mHealth requires immediate action from regulators and payers

As their populations age, both Brazil and Mexico are experiencing a need to shift the relative balance of healthcare intervention from acute care to continuous care. However, while the shift to continuous care is happening, there still remains a significant challenge in these populous emerging markets to provide and sustain universal healthcare. Amidst their infrastructural, human and financial limitations, healthcare systems in Brazil and Mexico are struggling to cope.

mHealth provides significant advantages that could help these healthcare systems achieve greater impact with the same access to human and financial resources. According to PwC's analysis, by 2017 the potential of mHealth will be significant:

- mHealth could enable an additional 28.4 million people access to the healthcare system in Brazil, and an additional 15.5 million to the same in Mexico, without having to add a doctor.

- Total healthcare spend (public and private) could be reduced by 14 billion USD in Brazil and 3.8 billion USD in Mexico while providing the same care impact.

- These savings would be enough to treat an additional 4.3 million patients in Brazil, and an additional 2.3 million in Mexico.

- Enhanced productivity could add 4.6 billion USD and 8.4 billion USD to the GDP of Brazil and Mexico respectively through increased wages and taxes.
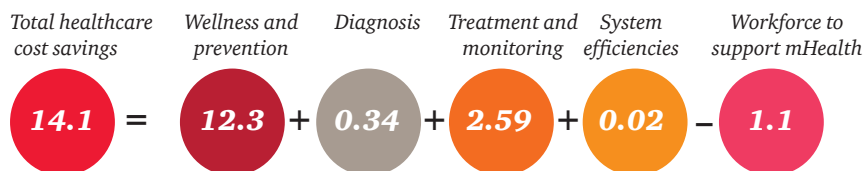
The table below shows how the impact of mHealth on care costs can add up:

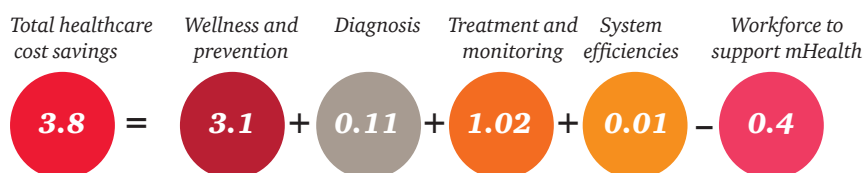| Range of mHealth benefits in 2017	Unit	Brazil		Mexico	
		100% adoption (full potential)	10% adoption (if no action taken)	100% adoption (full potential)	10% adoption (if no action taken)
Estimated population in 2017	mn	216.6		121.1	
Additional patients reached	mn	28.4	3	15.5	1.7
Total care cost saved	bn USD	14.1	1.5	3.8	0.4
Public care cost saved	bn USD	6.9	0.7	1.9	0.2
Additional patients accommodated within cost savings	mn	4.3	0.7	2.3	0.3
Additional economic output generated by healthier patients	bn USD	4.6	0.5	8.4	0.9

Source: PwC analysis

Brazil

Total healthcare cost savings		Wellness and prevention		Diagnosis		Treatment and monitoring		System efficiencies		Workforce to support mHealth
14.1	=	**12.3**	+	**0.34**	+	**2.59**	+	**0.02**	–	**1.1**

All figures are in bn USD
2017 data has been reported

Mexico

Total healthcare cost savings		Wellness and prevention		Diagnosis		Treatment and monitoring		System efficiencies		Workforce to support mHealth
3.8	=	**3.1**	+	**0.11**	+	**1.02**	+	**0.01**	–	**0.4**

All figures are in bn USD
2017 data has been reported

However, even though mHealth concepts have been proven to work in numerous pilots around the world and have been trialled in Brazil and Mexico as well, mHealth led benefits outlined above are still to be achieved.

Multiple adoption barriers – regulatory, economic, structural and technological – stand in the way. For this reason the initial focus for driving adoption rests on policy makers, regulators and payers. The lack of a regulatory framework that establishes accountability of various stakeholders, the absence of clearly defined business models and the fragmented and performance-agnostic nature of healthcare systems are some of the barriers that aggravate the reluctance to adopt mHealth created by a lack of clear evidence.

Since the barriers are systemic, the immediate onus lies on policy makers, regulators and payers to drive and adopt change.

Some of the changes that need to be brought about include:

- Policy makers in Brazil and Mexico need to formally integrate mHealth into nationwide healthcare strategy, establishing a regulatory framework that harmonises the regulations between healthcare and mobile services, and removes policy barriers that are currently preventing remote diagnosis and monitoring of patients.

- Payers must introduce incentives for patients and healthcare providers to adopt mHealth. The regulators and payers should work with the governments and healthcare providers to mandate greater cohesion across the various healthcare providers and reward performance gains from mHealth.

- Further, policy makers need to support the development and use of mHealth by educating the doctors and patients on the benefits of these solutions and training healthcare providers on these solutions.

Without these interventions, this report estimates that Brazil and Mexico would only see around 10% of the potential benefits from mHealth. Based on several months of analysis, research and expert interviews, for the first time this report sets out an authoritative view on the socio-economic potential of mHealth. Throughout the report, we point out in year impacts in 2017 in order to illustrate the step-change impact mHealth can have on society.

Although the development of mHealth will be gradual, we do not expect significant increases in uptake in the coming years until there is intervention by policy makers and service providers. The purpose of the report is to articulate how the impacts will be created by mHealth, so that governments, regulators, payers and other important stakeholders can take forward specific initiatives and policy interventions that will enable us collectively to capture the real potential of mHealth.

Socio-economic impact of mHealth

> *"A lack of infrastructure, the need for improved facilities for nurses and doctors, and a need to improve the effectiveness of doctors so that diseases can be treated with minimum doctor consultations across a fragmented healthcare system are a few challenges Mexico's healthcare sector faces."*
>
> *Guadalupe Aparicio, IMSS*

2.1. Current healthcare challenges in Brazil and Mexico

While the economies of Brazil and Mexico progress, the healthcare challenges these countries face are becoming more comparable to those of developed countries. The healthcare systems in Brazil and Mexico, which are undergoing a transition to providing universal healthcare, need to add capabilities that can help them address current and emerging challenges while also more efficiently using limited resources. Mobile technologies that support the delivery of healthcare offer benefits that could be highly relevant to the current needs of these healthcare systems.
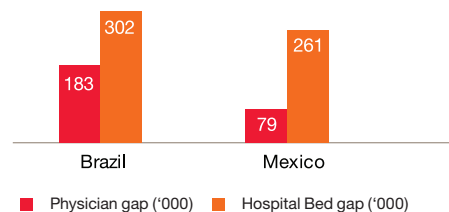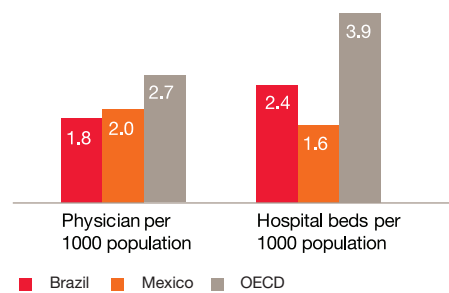
Universal healthcare systems

The healthcare systems in Brazil and Mexico are different in their own right, but face comparable challenges. While private healthcare has significant presence in Brazil and Mexico, both countries aim to provide universal healthcare through public institutions - Sistema Unicare Saude (SUS) in Brazil and Seguro Popular in Mexico. SUS is leading the transition to universal healthcare in Brazil since 1988, while Seguro Popular was formed in Mexico in 2003 in order to provide universal healthcare to its population. These institutions aim to provide equitable and affordable access to healthcare funded by public resources and which have a specific focus on the population that is usually not covered by any public or private insurance.

Lack of resources and access

Brazil and Mexico have a considerable gap in physical and human healthcare resources compared, for example, to OECD countries. This shortage of resources restricts the availability of universal healthcare to only around 50% of the population, leaving 85 million Brazilians[1] and 52 million Mexicans[2] outside the coverage of universal healthcare. Most hospitals are clustered in urban centres, and improving access to healthcare in rural areas is a challenge. The lack of healthcare facilities in rural or low income areas also creates an inequality in access to healthcare. In Brazil, 80% of patients covered by SUS can be assigned to hospitals within their home area[1]. But since low income areas have fewer hospitals, residents in these areas are either not assigned to hospitals or experience high waiting times compared to those residents of wealthier areas.

Brazil and Mexico lag behind OECD countries in terms of availability of hospitals and physicians
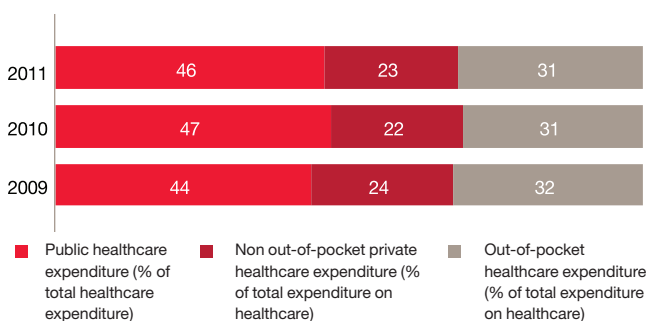

Physician per 1000 population — Brazil 1.8, Mexico 2.0, OECD 2.7
Hospital beds per 1000 population — Brazil 2.4, Mexico 1.6, OECD 3.9

Brazil · Mexico · OECD

Physician gap
Brazil : 0.89
Mexico : 0.69

Hospital beds gap
Brazil : 1.47
Mexico : 2.27

Brazil — Physician gap 183, Hospital Bed gap 302
Mexico — Physician gap 79, Hospital Bed gap 261

Physician gap ('000) · Hospital Bed gap ('000)

Source: The World Bank, PwC analysis

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1. Source: www.thelancet.com, The Brazilian health system: history, advances, and challenges
2. Source: www.thelancet.com, The quest for universal health coverage: achieving social protection for all in Mexico
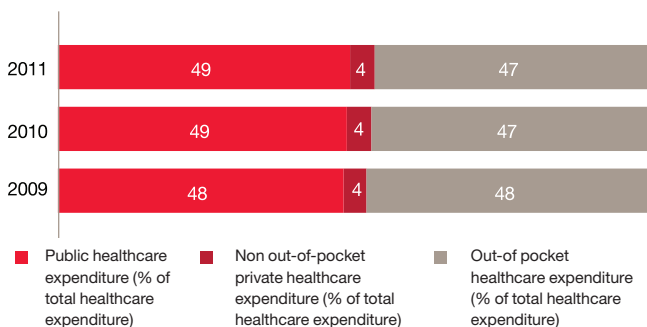
High private spending

Lack of adequate access and quality in public healthcare have forced people, especially amongst low income or rural population, to seek care from private healthcare facilities. This has resulted in high and persistent out-of-pocket spending on healthcare. Even though both these countries have been making efforts to increase their public spending, its share is still relatively low compared to other countries, such as in the EU, that have similar universal healthcare systems. The lack of public funding has also been contributing to the high private spending.

Split of healthcare spending in Brazil

Year	Public	Non out-of-pocket	Out-of-pocket
2011	46	23	31
2010	47	22	31
2009	44	24	32

- ■ Public healthcare expenditure (% of total healthcare expenditure)
- ■ Non out-of-pocket private healthcare expenditure (% of total expenditure on healthcare)
- ■ Out-of-pocket healthcare expenditure (% of total expenditure on healthcare)

Split of healthcare spending in Mexico

Year	Public	Non out-of-pocket	Out-of-pocket
2011	49	4	47
2010	49	4	47
2009	48	4	48

- ■ Public healthcare expenditure (% of total healthcare expenditure)
- ■ Non out-of-pocket private healthcare expenditure (% of total healthcare expenditure)
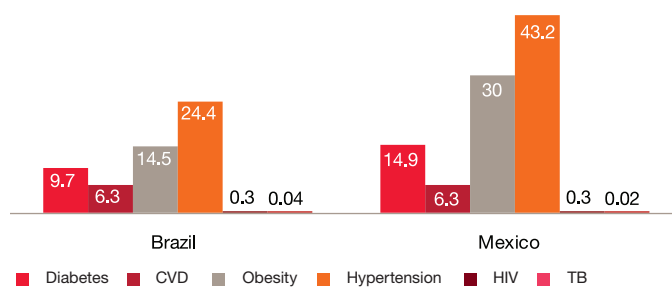- ■ Out-of pocket healthcare expenditure (% of total healthcare expenditure)

Source: The World Bank, PwC analysis

Changing disease profiles and shift in healthcare needs

The profile of diseases in Brazil and Mexico is now much more dominated by chronic diseases than by infectious diseases. Rising urbanisation, cultural diet habits and unhealthy lifestyles have resulted in lower physical activity levels, which have given rise to a growing incidence of chronic diseases. With much lower prevalence rates, infectious or communicable diseases may not pose as big a healthcare burden as the chronic diseases in the future. The healthcare systems of both these countries have historically been designed to provide the acute care needed for infectious diseases. With the rising incidence of chronic diseases, the demand on healthcare systems ill-equipped to deal with these diseases could become unmanageable. It is reasonable to expect that the quality of care will decline, while healthcare costs continue to grow.
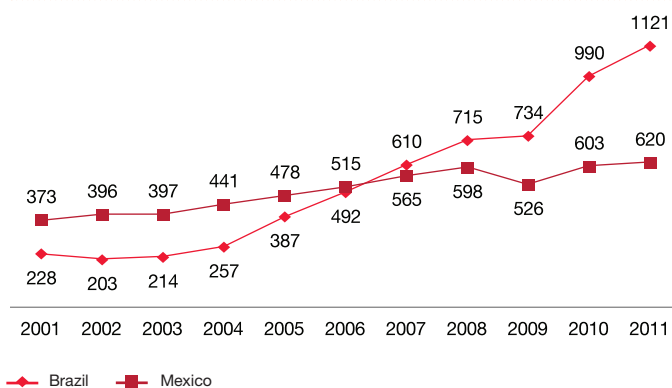
Prevalence rate* (%) of different medical conditions (2011 or latest)

	Diabetes	CVD	Obesity	Hypertension	HIV	TB
Brazil	9.7	6.3	14.5	24.4	0.3	0.04
Mexico	14.9	6.3	30	43.2	0.3	0.02

- ■ Diabetes   ■ CVD   ■ Obesity   ■ Hypertension   ■ HIV   ■ TB

*Figures reported are of 2011 or the latest data available, for TB incidence has been reported, data for COPD only available for Brazil. Assumed same rate for Mexico
Source: The World Bank, IDF, Atsjournals, Scielo, OECD 2011, WHO, PubMed, Ripsa (Brazil government), Sbpt, PwC analysis

Rising per capita healthcare costs (in USD)

Year	Brazil	Mexico
2001	228	373
2002	203	396
2003	214	397
2004	257	441
2005	387	478
2006	492	515
2007	610	565
2008	715	598
2009	734	526
2010	990	603
2011	1121	620

- ◆ Brazil   ■ Mexico

Source: The World Bank, PwC analysis

Sustaining universal healthcare

Specific capabilities need to be built within the public healthcare systems of both these countries to sustain universal healthcare. It is critical to improve the quality of care for chronic diseases and reduce disease incidence in order to efficiently utilise the limited healthcare resources in Brazil and Mexico. This will allow Mexico and Brazil to extend universal healthcare access to the population that is still not covered without having to add an inordinately high volume of healthcare resources.

2.2. Addressing the challenges through mHealth solutions

Mobile technologies can connect systems and people, irrespective of their location. Technologies such as mHealth solutions could prove to be an effective tool for the healthcare systems in Brazil and Mexico, as they can enhance the quality and reach of care. mHealth solutions could improve clinical decision-making and coordination within hospitals and across the healthcare system by analysing electronic medical records. By enabling remote treatment and monitoring, patients can now be treated, staying at home, thus bringing down the cost of care. Doctors' time could thus be better allocated and beds in hospitals can be made available for other patients. The enhanced reach provided by mHealth could even extend the access of care to rural and low income people.

Assessing socio-economic impact

mHealth could make healthcare delivery fairer by lowering the cost of care and increasing access. Fewer hospitalisations, healthier lives and a more productive healthcare delivery system could enable an improved economic output, an enhanced quality of life and an increased efficiency of healthcare spend. Therefore, mHealth has the potential to create a significant socio-economic impact by enhancing healthcare delivery across the following four dimensions:

- **Stronger healthcare systems:** Enhancing clinical decision-making and improving utilisation of physical and human healthcare resources by integrating systems, equipping staff with latest information and enabling real-time and easier to see analysis of health patterns of patients.

- **Wellness and prevention:** Supporting patients and governments in making lives healthier by improving lifestyles, reducing the incidence of disease by providing education and through using communications to influence behavioural changes.

- **Diagnosis:** Expediting quicker and more timely diagnosis of the severity of disease and lowering associated treatment costs.

- **Treatment and monitoring:** Administering continuous care more efficiently to chronic patients through mobile-based communication technologies that support patient mobility and reduce the need to regularly visit hospitals.

In this report, we have quantified the health benefits that mHealth solutions can provide across the four dimensions discussed above by using initial outputs from relevant studies and their validation by healthcare experts in relevant geographies. While we have referenced these inputs throughout the report, the methodology and assumptions for quantifying the impact have been detailed in the appendices.

2.2.1. Making healthcare systems efficient

"Providing effective emergency response through well equipped ambulances, leveraging electronic medical records better, improving in-hospital coordination, and enhancing practitioner support in aspects such as treatment checklists and prescriptions are definite areas where mHealth can play a role."

Dr. Miguel Angel, Health Advisor PwC Mexico

"mHealth would help in improved data collection and analytics for hospitals."

Guadalupe Aparicio, IMSS

Inefficient utilisation of information technology and electronic health records

The lack of an integrated health system and the insufficient use of electronic health records exposes the inefficiencies of Mexico's and Brazil's healthcare systems. The inefficiencies also hamper in-hospital administration through the lack of referrals across different levels of care and limited coordination amongst different departments within a hospital. Further, practitioners spend 25 to 30% of their time gathering and analysing medical and patient care data. Thus, the limited presence of electronic medical records also increases manual effort and administrative costs.

Healthcare IT solutions in these countries, today, do not provide many practitioners with enough information updates on the latest protocols and best practices internationally. Resulting lack of ready availability of information leads to uninformed clinical decisions such as prescription and procedural errors related to medication. The prescription of conflicting medicines or inappropriate dosage of medication can lead to adverse drug events (ADEs), prolonged hospitalisation and increase treatment costs

About 60% of 1.5 million[4] ADE events are preventable and their care costs Brazil and Mexico a combined 208 million USD every year.

3. Source: WellDoc
4. Source: http://www.rightdiagnosis.com/a/adverse_reaction/stats-country.htm, http://www.ensp.unl.pt/dispositivos-de-apoio/cdi/cdi/sector-de-publicacoes/revista/2010/pdf/volume-tematico-seguranca-do-doente/8-A%20magnitude%20financeira%20dos%20eventos%20adversos%20em%20hospitais%20no%20Brasil.pdf, PwC analysis
5. Source: http://www.ensp.unl.pt/dispositivos-de-apoio/cdi/cdi/sector-de-publicacoes/revista/2010/pdf/volume-tematico-seguranca-do-doente/8-A%20magnitude%20financeira%20dos%20eventos%20adversos%20em%20hospitais%20no%20Brasil.pdf, PwC analysis

Integrating healthcare systems and enhancing access

mHealth solutions which enable easier creation of health records could in particular improve healthcare access to low income and rural people. Such solutions could enable healthcare providers to remotely create health records for population residing in areas that do not have a healthcare facility. Hence, more people can be registered with the universal healthcare systems. Data on a patient's health could be collected in real time to enable quicker analysis, improved coordination and swifter medical response. This in turn could enable improved decision-making and enhance the effectiveness of care. Further, standardised health records could enable improved integration of care, facilitate appropriate referrals and enhance the utilisation of healthcare resources.

Enhancing practitioner support

By 2017, mHealth solutions could allow doctors to save 8.9 million days in Brazil and 5 million days in Mexico.

0.4 mn

9%

8.9 mn

0.2 mn

of total doctors' time can be saved using mHealth

- *Practitioners spend 30% of their time gathering and analysing patient records and information on medical practices*
- *30% of this time could be saved using mHealth solutions that make this data available on mobile devices*

Doctors
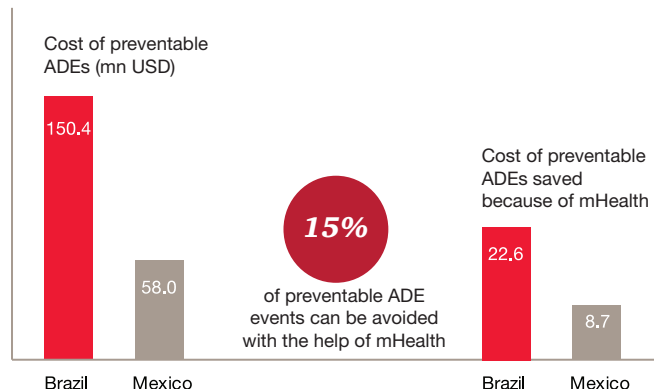
4.94 mn

Doctor days saved

2017 figures mentioned
Source: Stockholms läns landsting Sweden, WHO 2012, PwC analysis

mHealth solutions could equip doctors with the most relevant information on their mobile devices and, thereby, save their time as they can access and analyse information on the move. By using such mHealth solutions, practitioners and medical staff could lower the time they spend to access and update medical information and medical records by 30%[6]. Since doctors spend 30% of their time at work on accessing such information, 9% of their time could be saved. If each doctor in Brazil works for 250 days per year, one could save 22.5 days. Taking into account the estimated number of doctors in Brazil and Mexico in 2017, 8.9 million and 4.9 million working days for doctors could be saved in these countries respectively. Doctors could utilise this time saved to attend to additional patients or spend more time with critical patients, making care more efficient and effective.

Preventing ADEs

Cost of preventable ADEs (mn USD)

150.4

58.0

15%

of preventable ADE events can be avoided with the help of mHealth

Brazil   Mexico

Cost of preventable ADEs saved because of mHealth

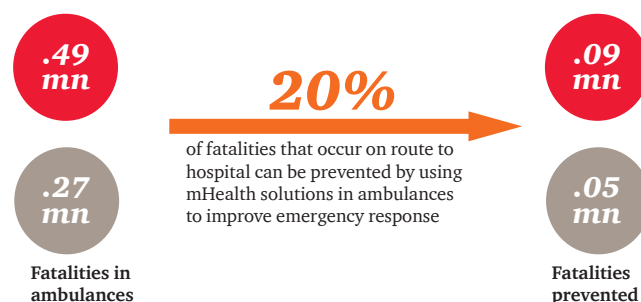22.6

8.7

Brazil   Mexico

2017 figures mentioned
Source: Rightdiagnosis, Enspl.unl, PwC analysis, Banco de Saude

By 2017, mHealth could improve clinical decision making of healthcare providers and allow them to avoid 15% of preventable ADEs, saving 31 million USD in associated healthcare costs.

Doctors could also use mHealth solutions to access the latest medical research, and this could reduce the extent of prescription of conflicting drugs. While writing prescriptions, doctors could check for potential conflict amongst drugs using mHealth solutions and, thereby, avoid preventable adverse drug events (ADEs). By allowing doctors to validate their prescriptions real time, mHealth could help avoid 15% of such preventable ADEs, saving 22.5 million USD in associated costs in Brazil and another 8.7 million USD of the same in Mexico.

Improving emergency response

.49 mn

20%

.09 mn

.27 mn

of fatalities that occur on route to hospital can be prevented by using mHealth solutions in ambulances to improve emergency response

Fatalities in ambulances

.05 mn

Fatalities prevented

2017 figures mentioned
Source: Banco de Saude, PwC analysis

Accounting for the number of ambulances in Brazil and Mexico, 90,000 lives in Brazil and 50,000 lives in Mexico could be saved in 2017 by using mHealth to improve emergency response.

According to healthcare experts, 20 people die en route to hospitals per year, per ambulance in Mexico. If the paramedics in the ambulance can communicate with primary or emergency care, the number of deaths could be reduced. mHealth solutions can connect the ambulance with the hospital, allowing healthcare staff stationed at the hospital to monitor the patient being brought in and direct paramedics to administer basic emergency care en route. By doing so, we estimate that at least 20% of these fatalities can be prevented, which would translate to 90,000 lives saved in Brazil and 50,000 lives saved in Mexico in 2017.

6. Source: Stockholms läns landsting Sweden

2.2.2. Limiting disease incidence

"While the diet habits of Mexicans is one of biggest health challenges, many people are not also aware of the consequences of their condition."

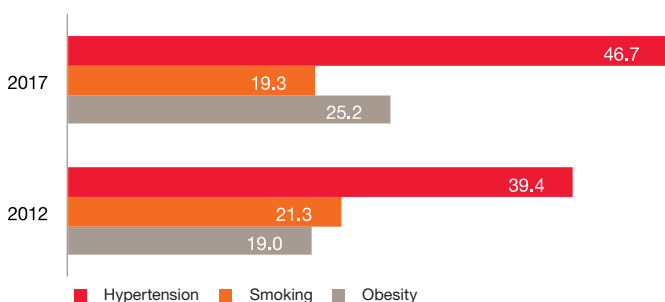**Dr. Angelica Arredondo, Hospital Ángeles del Pedregal**

"I believe that a major part of the problem is people being unaware of the importance of prevention measures and timely care. The lack of health promotion initiatives to educate pregnant women on the importance of visiting the doctor early exposes them to multiple avoidable risks."

Dr. Arturo Ramírez, CENETEC

Unhealthy lifestyles and lack of awareness

At least 74 million[8] people in Brazil and Mexico currently suffer from lifestyle disorders such as obesity, hypertension and smoking. Due to these lifestyle disorders, at least 19.7[9] million are at significant risk of developing chronic diseases such as T2DM, COPD and CVD. It is estimated that due to the growing risk of chronic diseases, the total number of patients suffering from these diseases in Brazil and Mexico can rise from at least 69 million in 2012 to at least 76 million in 2017. Besides increasing the risk of chronic disease, unhealthy lifestyles can increase their severity by escalating the chances of developing complications, which could aggravate the healthcare and economic burden these diseases pose. Therefore, improving lifestyles to limit the incidence of these chronic diseases and reduce their severity is critical.

Importance of wellness and prevention and challenges in encouraging it

Wellness measures can effectively help manage lifestyles which will not only overcome disorders such as obesity but also limit the risk of developing chronic diseases. However, educating patients on the importance of wellness and preventive care and motivating them to improve their lifestyles is challenging. The cultural acceptance of obesity in Mexico reflects in the fact that about 50% of their total population is either overweight or obese. Whilst in Brazil, around 50% of the men in urban centers of Brazil are overweight which demonstrates a lack of awareness on the risks that lifestyle disorders pose. Lack of awareness also extends to maternal and child care. Brazil and Mexico have made significant efforts to educate expecting mothers on ways to manage pregnancy and child birth better, but despite that 30%[9] of expecting mothers do not comply with the schedule for doctor visits, elevating the risk of pre-term and still births.
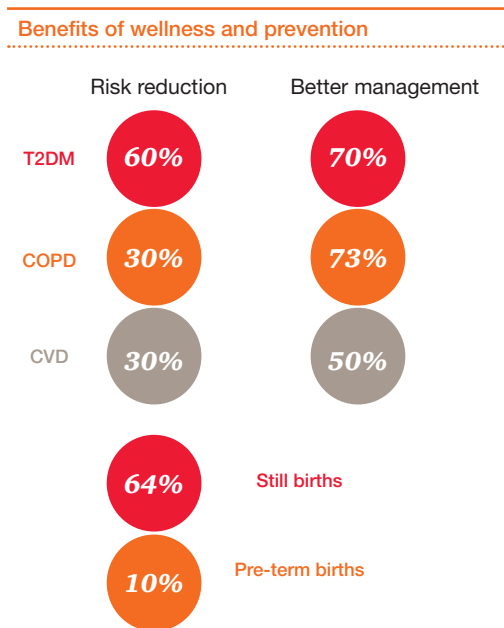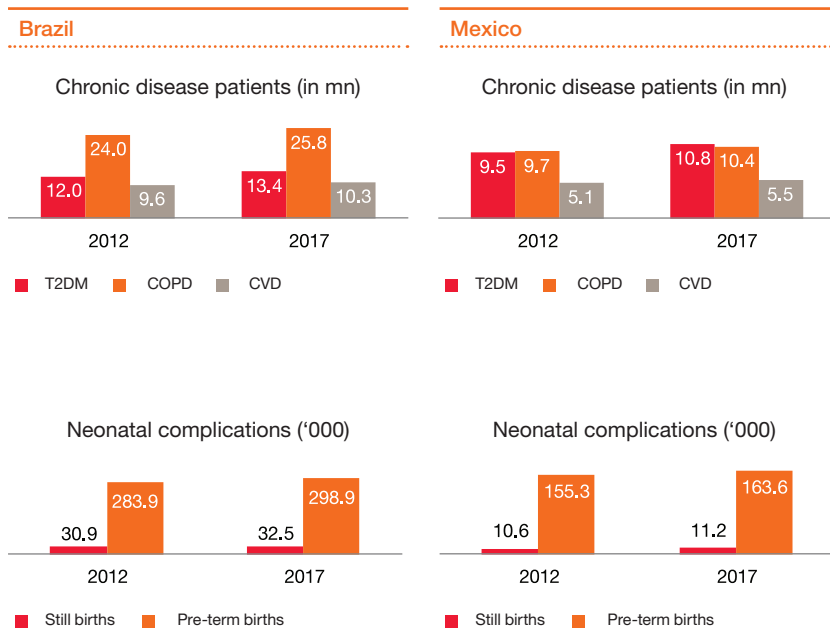
Furthermore, the lack of healthcare resource poses a challenge to spreading health awareness in Brazil and Mexico. For example, in Brazil, the family healthcare teams deployed by SUS to promote good health and provide care cover only 50% of the population[10]. The limited healthcare resources need to be equipped with tools that can allow them to efficiently reach more people at a greater frequency in order to overcome the cultural barriers that limit health awareness, which could in turn make the awareness initiatives more effective.

Prevalence of lifestyle disorders in Brazil (in mn)

Prevalence of lifestyle disorders in Mexico (in mn)

Source: Ripsa (Brazil government), WHO, OECD 2011, PubMed, PwC analysis

7. Source: Axa Insurance Mexico
8. Source: PwC Analysis
9. Source: http://www.scielosp.org/pdf/bwho/v85n10/a10v8510.pdf
10. Source: www.thelancet.com, The Brazilian health system: history, advances, and challenges

Brazil

Chronic disease patients (in mn)

	2012	2017
T2DM	12.0	13.4
COPD	24.0	25.8
CVD	9.6	10.3

■ T2DM ■ COPD ■ CVD

Neonatal complications ('000)

	2012	2017
Still births	30.9	32.5
Pre-term births	283.9	298.9

■ Still births ■ Pre-term births

Mexico

Chronic disease patients (in mn)

	2012	2017
T2DM	9.5	10.8
COPD	9.7	10.4
CVD	5.1	5.5

■ T2DM ■ COPD ■ CVD

Neonatal complications ('000)

	2012	2017
Still births	10.6	11.2
Pre-term births	155.3	163.6

■ Still births ■ Pre-term births

Benefits of wellness and prevention

	Risk reduction	Better management
T2DM	60%	70%
COPD	30%	73%
CVD	30%	50%

64%	Still births
10%	Pre-term births

Source: The World Bank, IDF, Atsjournals, Scielo, WHO, PubMed, Sbpt,OECD 2012, Medtronic, Silverchain,PubMed, Marchofdimes, PwC analysis

Leveraging mHealth to enhance wellness and prevention

mHealth solutions could help public and private healthcare providers to connect more efficiently with patients, especially in rural areas, even if healthcare workers cannot reach out to them. Having established the connection, healthcare providers could work with service providers (such as telecom operators) to provide information that convinces patients to use educational mHealth services. Using these services, patients could receive general and personalised health tips through short message service (SMS), calls and emails, which make them more aware of the importance of healthy lifestyles and preventive measures.

Even with increased awareness, the lack of self-motivation and adherence to wellness regimes may continue to inhibit patients from managing their lifestyles better. mHealth can play a key role in motivating patients to sustain lifestyle improvement initiatives through interactive solutions that encourage a game-like attitude to attaining wellness goals. Patients can use these solutions to manage information about diet, exercise regimes and medication. The resulting reports and trends can be put on web-based communities and patients can be rewarded for achieving their fitness objectives. Furthermore, doctors could use these reports and trends to customise healthcare and thereby increase its effectiveness. Hence, healthcare providers could use mHealth to empower patients to improve their lifestyles, avoid diseases and reduce their severity.

Potential for population to use mHealth for lifestyle conditions

Condition	Disease type	Brazil			Mexico		
		Prevalence	mHealth users	Users benefitted	Prevalence	mHealth users	Users benefitted
Population at risk	Obesity	90.2	34	11.5	58.6	13.1	4.5
	Smoking	17	6.4	0.5	10.1	2.3	0.2
	Hypertension	33.4	12.6	3.8	21.5	4.8	1.4
Population with condition	Obesity	25.2	9.5	3.2	28.5	6.4	2.2
	Smoking	19.3	7.3	0.6	11.7	2.6	0.2
	Hypertension	46.7	17.6	5.3	37.8	8.5	2.5

All figures are in mn units
2017 numbers have been reported
Numbers have been rounded

Source: Hospital Ángeles del Pedregal, Medtronic, PwC analysis

Potential for population to use mHealth for chronic diseases and prenatal care

Condition		Brazil			Mexico		
	Disease type	Prevalence	mHealth users	Users benefitted	Prevalence	mHealth users	Users benefitted
Population at risk	T2DM	5.6	2.1	1.5	5.7	1.3	0.9
	COPD	3	1.1	0.8	1.4	0.3	0.2
	CVD	3.8	1.4	0.7	2.6	0.6	0.3
Population with condition	T2DM	13.4	5	3.5	10.8	2.4	1.7
	COPD	25.8	9.7	7.1	10.4	2.3	1.7
	CVD	10.3	3.9	1.9	5.5	1.2	0.6
	Prenatal care	3.2	0.5	0.1	2.2	0.2	0.07

All figures are in mn units
2017 numbers have been reported

Source: Hospital Ángeles del Pedregal, Medtronic, PwC analysis

Impact of mHealth enabled wellness and prevention

PwC estimates that, by 2017, more than 100 million patients suffering from or at the risk of developing lifestyle disorders and chronic diseases across Brazil and Mexico could use mHealth regularly for managing their lifestyles.

Of the 3 million Brazilians and 1.5 million Mexicans who manage the risk of developing chronic conditions by using mHealth solutions, 1.2 million Brazilians and at least 0.7 million Mexicans would no longer be at risk of developing chronic diseases due to significant improvement in their lifestyles. Some of the findings are as follows:

- Of these, 0.2 million Brazilians and 0.1 million Mexicans could surely avoid developing chronic diseases in 2017.

- By 2017, 12.6 million chronic patients in Brazil and four million chronic patients in Mexico could manage their disease better by using mHealth to adopt healthier lifestyles and take preventive measures.

Additionally, of the 900,000 expecting mothers using mHealth for prevention across the two countries[11], 160,000 women in Brazil and 70,000 women in Mexico would be able to significantly improve their prenatal condition, avoiding a potential 17,000 pre-term and still births in all.

Benefits of mHealth

Condition		Brazil			Mexico		
Limiting the burden of diseases		Risk reduction	Incidence prevented	Patients benefited	Risk reduction	Incidence prevented	Patients benefited
Lifestyle disorders	Obesity	11.6	0.2	3.2	4.5	0.3	2.2
	Smoking	0.5	NA*	0.6	0.2	0.1	0.2
	Hypertension	3.8	0.4	5.3	1.4	0.2	2.5
Chronic diseases	T2DM	0.8	0.1	3.5	0.53	0.06	1.7
	COPD	0.2	0.07	7.1	0.07	0.02	1.7
	CVD	0.2	0.02	1.9	0.09	0.006	0.6
	Prenatal care	NA	NA	0.1	NA	NA	0.07

*Since the prevalence of smoking is reducing in Brazil exact incidence prevented because of mHealth could not be estimated
All figures are in mn units
2017 numbers have been reported
Number have been rounded

Source: Hospital Ángeles del Pedregal, Medtronic, PwC analysis

- A total of 25.1 million Brazilians and 11.0 million Mexicans could successfully improve their lifestyle enough to reduce the risk of developing lifestyle disorders or overcome them.

- As a result, 0.6 million Brazilians and 0.6 million Mexicans could avoid developing lifestyle disorders in 2017.

- A total of three million Brazilians and 1.5 million Mexicans at risk of developing chronic conditions could use mHealth to improve their lifestyles and take preventive measures.

11. Source: WHO, PwC Analysis

Optimising use of healthcare resources

The combined impact of these wellness oriented measures on improved prevention and management of disease could relieve the burden on healthcare facilities by limiting incidence and severity of lifestyle disorders and chronic diseases. The following result will then be observed:
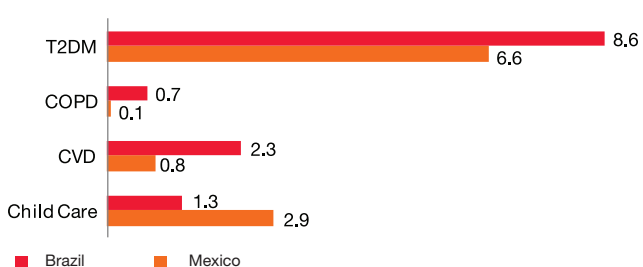
- A total of 15.4 billion USD could be saved in healthcare costs across Brazil and Mexico in the year 2017.
- Patients in Brazil and Mexico could avoid 88,000 and 32,700 hospitalisations respectively.

The hospital beds made available and money saved could be used to treat additional patients, providing patients easier access to care.

Reduced hospitalisation in 2017 due to mHealth enabled wellness and prevention ('000)

	Brazil	Mexico
T2DM	29.5	16.3
COPD	36.2	8.7
CVD	7.7	2.7
Child Care	14.7	5.0
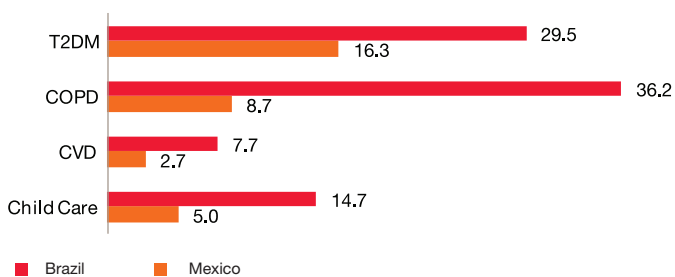
Life years saved in 2017 due to mHealth enabled wellness and prevention ('000)

	Brazil	Mexico
T2DM	8.6	6.6
COPD	0.7	0.1
CVD	2.3	0.8
Child Care	1.3	2.9

Source: Hospital Ángeles del Pedregal, Medtronic, PwC analysis

Cost savings across various disease conditions due to mHealth enabled wellness and prevention (in bn USD)

Total healthcare cost saving (in bn USD)

Brazil

12.3

Mexico

3.1

	Condition	Disease type	Brazil	Mexico
	Population at risk	T2DM	1.2	0.5
		COPD	0.6	0.1
		CVD	0.8	0.2
		Obesity	1.2	0.3
		Smoking	0.2	0.05
		Hypertension	0.9	0.2
	Population with condition	T2DM	1	0.3
		COPD	4.3	0.9
		CVD	2	0.4
		Prenatal Care	0.08	0.02

All figures are in USD bn
2017 numbers have been reported
Source: Hospital Ángeles del Pedregal, Medtronic, PwC analysis

2.2.3. Expediting diagnosis to improve effectiveness of care

"Remote diagnosis can help in overcoming access related challenges. Mobile health can help improve the access to tertiary (specialised) care. It can also be used to get a secondary opinion."

Luiz Tizatto, Unit Care Saude

"Early diagnosis of any disease provides early treatment, better surveillance and fewer complications, benefiting the patient."

Dr. Arturo Ramírez, CENETEC / IMSS

"The diagnosis in Mexico is not well organised as the facilities of treatment are not accessible for those in the interiors."

Dr. Andrés Hernández, INER

Reasons and impact of delayed diagnosis

The latent nature of chronic diseases and a lack of awareness of their causes and symptoms often means that would-be patients do not proactively undergo preventive health checkups in advance. Most chronic diseases get diagnosed when complications appear[12]. On average, 40% of T2DM patients are not aware of their condition until seven to eight years after the disease has developed. Early diagnosis can help trigger timely interventions and, thereby, avoid such complications and reduce healthcare costs.

In Brazil and Mexico, an insufficient presence of healthcare facilities or staff also delays diagnosis, particularly for the low income population residing in rural areas. In some rural areas in Mexico, people have to travel for around an hour for a simple blood test and reaching a hospital might take half a day due to the shortage of healthcare facilities[13]. Meanwhile, in Brazil, private players own most of the diagnostic facilities, which may not be affordable for low income groups.

12. Source: IDF Atlas, 2012, PwC analysis
13. Source: http://www.pih.org/blog/rebuilding-a-primary-health-care-system-in-rural-mexico

Extending access to diagnosis and expediting it

Benefits of early diagnosis

Average reduction of treatment cost

T2DM 30% **COPD** 35% **CVD** 35%

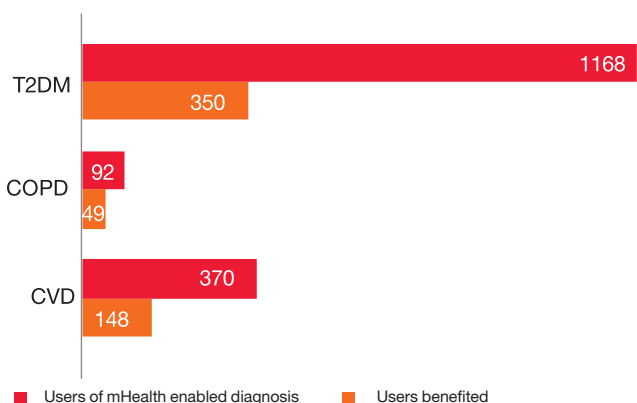*Source: Telemedicine benefits used as indicators for potential mobile health benefits, Source: NYY-NHS Telehealth study, California healthcare foundation*

Due to funding and people constraints, healthcare providers in Brazil and Mexico are forced to rely on innovative ways of detecting diseases that can help overcome these infrastructural gaps. mHealth solutions could address these gaps by encouraging self-assessment of symptoms and enabling remote diagnosis. For example, an mHealth solution supporting remote diagnosis for cardiac patients enables sharing of electrocardiograms (ECG) through mobile devices. Cardiac patients can share their results with their physicians, who can view the report on their mobile device and make faster, more informed diagnosis and treatment decisions.

Population using mHealth enabled diagnosis in Brazil in 2017 ('000)

T2DM	2946
	589
COPD	789
	421
CVD	1164
	465

■ Users of mHealth enabled diagnosis ■ Users benefited
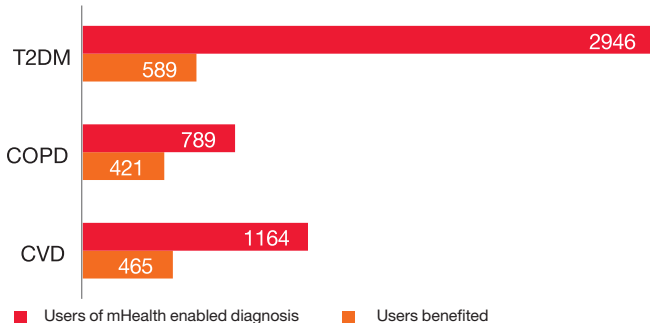
Population using mHealth enabled diagnosis in Mexico in 2017 ('000)

T2DM	1168
	350
COPD	92
	49
CVD	370
	148

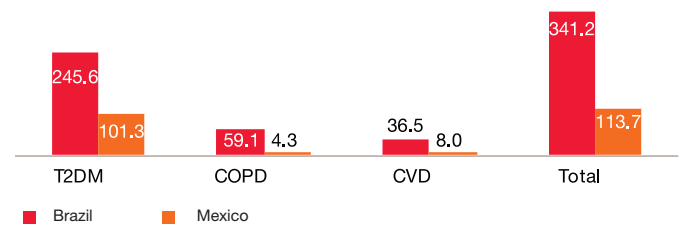■ Users of mHealth enabled diagnosis ■ Users benefited

Additionally, through interactive, algorithmic mHealth solutions, patients could check the existence of symptoms and determine the need of medical attention, which can help them initiate medical interventions earlier. Furthermore, by enabling patients to self assess symptoms, avoidable consultations could be omitted.

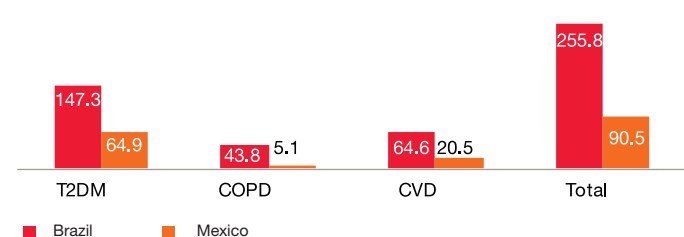## Increasing effectiveness and efficiency of care

PwC estimates that, by 2017, healthcare providers in Brazil and Mexico could be using mHealth to achieve the following:

- Provide 4.9 million people in Brazil and 1.6 million people in Mexico with access to diagnosis.
- Reach 1.5 million people in Brazil at risk of developing chronic diseases to diagnose their symptoms early, meaning that 680,000 could detect their chronic disease earlier.
- Reach out to 0.5 million people in Mexico at risk of developing chronic diseases to diagnose their symptoms early, meaning that 360,000 could detect their chronic disease earlier.

Treatment cost savings in 2017 (in mn USD)

	T2DM	COPD	CVD	Total
Brazil	245.6	59.1	36.5	341.2
Mexico	101.3	4.3	8.0	113.7

■ Brazil ■ Mexico

Doctor days saved in 2017 ('000)

	T2DM	COPD	CVD	Total
Brazil	147.3	43.8	64.6	255.8
Mexico	64.9	5.1	20.5	90.5

■ Brazil ■ Mexico

Source: PwC analysis

Such timely interventions could help patients avoid complications and reduce the need for hospitalisation, lowering treatment costs. Due to the reduced healthcare burden, doctors and paramedic staff could save on working days, which could be used to treat additional patients.

- In 2017, 454.8 million USD could be saved in healthcare costs due to early diagnosis of disease.
- An estimated 340,200 working days could be saved for doctors in these two countries.
- Assuming that only half of these days are used for additional patient visits and a doctor consults 18 patients per day, about 3 million additional consultations could be conducted.
- If a patient visits a healthcare provider three times a year, one million additional patients could be treated without having to add a single extra doctor.

2.2.4. Enhancing quality of care

> *"Remote monitoring and compliance would help to make care more patient-centric. The patient need not come to the hospital. Sending the information about their health condition as relevant pathological readings would be sufficient for analysis by the doctor."*
>
> *Adrian Pacheco, CENETEC*

> *"Remote monitoring would help in tracking vital signs in a continuous manner."*
>
> *Luiz Tizatto, Unit Care Saude*

> *"Mobile health could be used to continuously provide details of the medical condition of a patient. This would help insurance companies in providing a more effective level of healthcare coverage."*
>
> *Hector Rode Haza, AXA Insurance*

A shift in healthcare needs from acute care to continuous care

Chronic diseases and medical conditions such as child birth, require continuous care or constant, real-time management. The treatment relies on patients and general practitioners, and the intervention of specialist doctors is required only when complications develop. When patients are involved in managing their own care and ensuring dietary and treatment compliance, this can be tiring and burdensome. Additionally, chronic patients often mistake temporary relief for significant improvement and discontinue treatment or take recourse to lower medication levels.
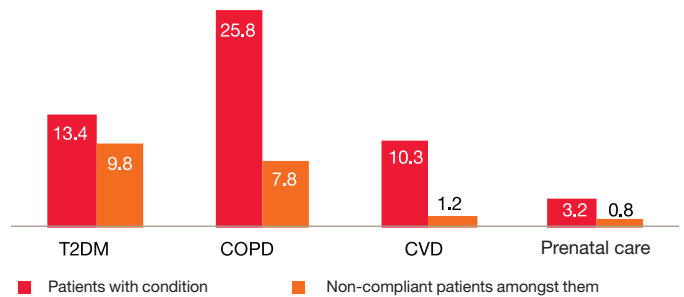
These behaviours can lead to sub-optimal clinical outcomes and non-compliance. Complications can develop and hospital readmissions may be required, thereby creating a significant burden for healthcare systems. To avoid such situations, patients need to be continuously monitored in the hospital and outside it so that compliance levels are maintained and any medical interventions required can be made promptly.
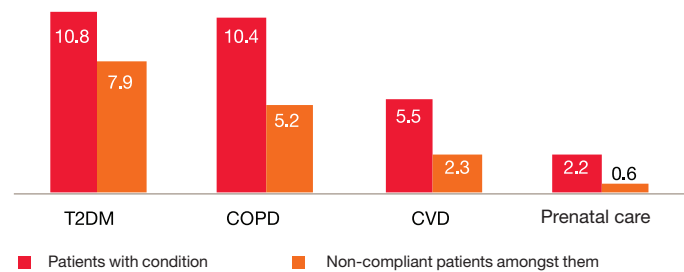
	T2DM	COPD	CVD	Prenatal care
Non-compliance rate	73%	30-50%	12-41%	20-30%
ALOS per year	8	12	4	28*
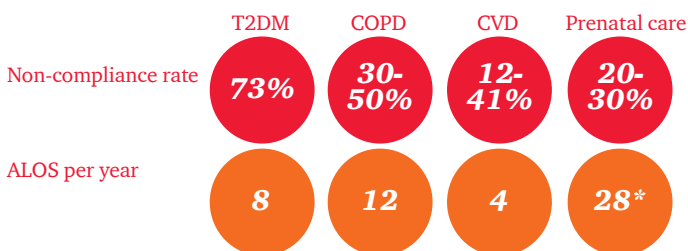
Note: *ALOS for a pre-term child, ALOS – Average length of stay

Source: Scielo, Folha.uol, Ncbi, CENETEC, Diabetic innovations, Incubi, PwC analysis

Non-compliant patients in Brazil in 2017 (in mn)

	T2DM	COPD	CVD	Prenatal care
Patients with condition	13.4	25.8	10.3	3.2
Non-compliant patients amongst them	9.8	7.8	1.2	0.8

Non-compliant patients in Mexico in 2017 (in mn)

	T2DM	COPD	CVD	Prenatal care
Patients with condition	10.8	10.4	5.5	2.2
Non-compliant patients amongst them	7.9	5.2	2.3	0.6

The demand for continuous care will continue to rise in Brazil and Mexico. By 2017, around 39.2 million of the 76 million chronic patients and expecting mothers will need monitoring. With a greater presence of specialists than general practitioners, the healthcare delivery systems in Brazil and Mexico have always been more suited for acute care than continuous care. To limit the imminent healthcare burden of chronic conditions, these healthcare systems need fast and cost effective ways to develop capabilities required to deliver continuous care.

Addressing the shift by enabling continuous care outside hospitals

Brazil and Mexico can use mHealth solutions that enable remote monitoring and promote treatment compliance to shift continuous care outside hospitals for 8.2 million patients from amongst the 39.2 million patients that require monitoring. These patients could avoid significant days of hospitalisation by using these solutions to stay connected with healthcare providers from their homes.

These solutions can also help increase dietary and treatment compliance through reminders sent through SMS, calls and email reminders and motivate them to improve their lifestyle. By recording the patterns of various health parameters being monitored, these solutions can build a medical history of these patients. The healthcare providers can analyse these health patterns of patients being monitored by using cloud-based solutions to initiate timely medical interventions, thereby optimising and personalising their care.
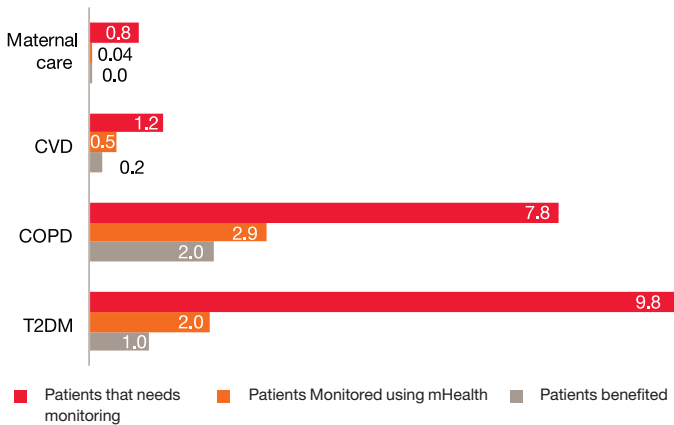
Since the patients would have their medical histories on their mobile devices, they can become more independent in managing their care, and feel empowered to sustain the effectiveness of their treatment even if they move locations or change doctors.
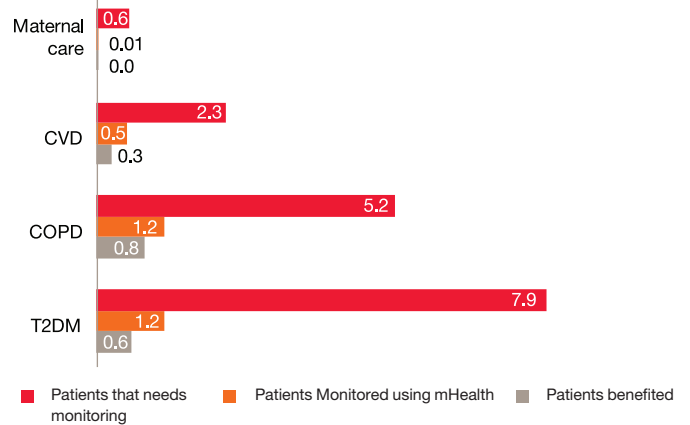
Improving clinical outcomes

mHealth-enabled remote monitoring can increase compliance amongst 4.9 million chronic patients and 5,600 pregnant women.

Population benefited by mHealth enabled Treatment and Monitoring (T&M) in Brazil (in mn)
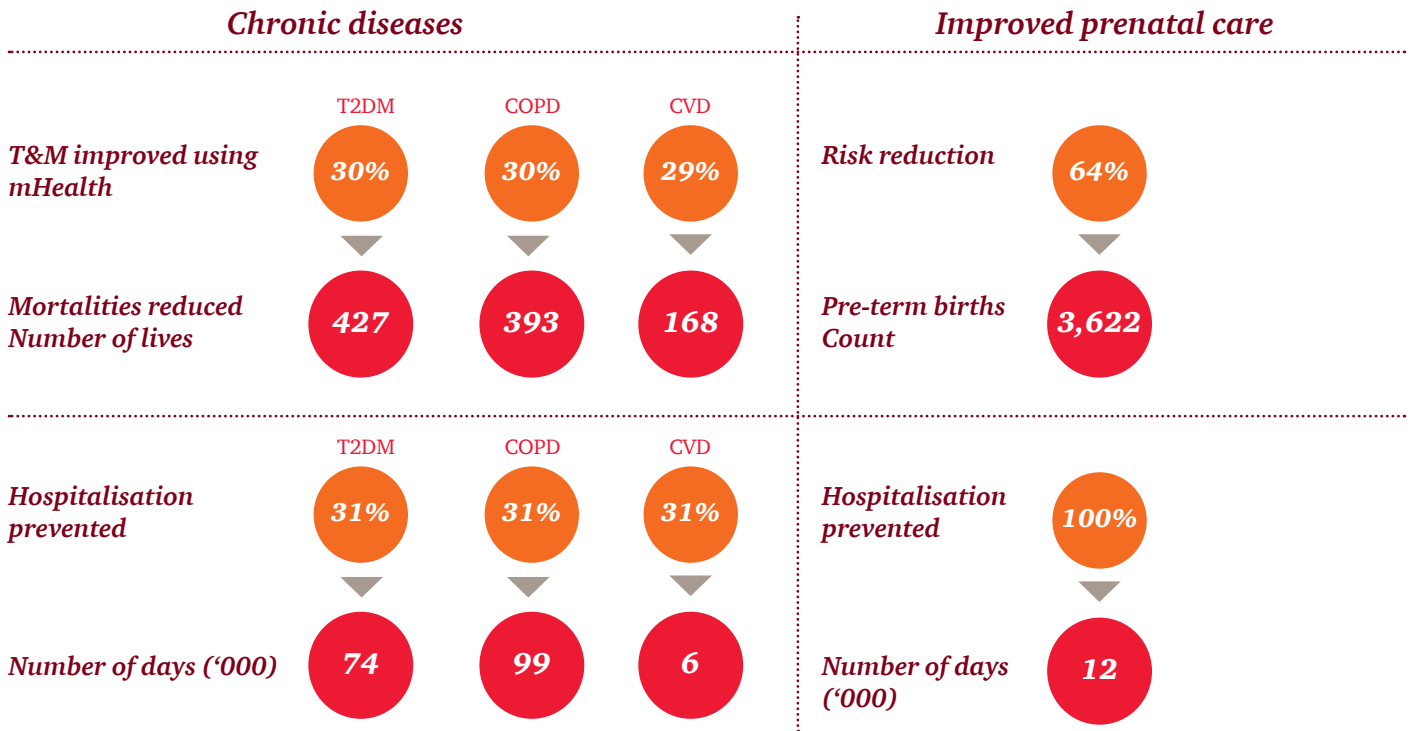
Category	Patients that needs monitoring	Patients Monitored using mHealth	Patients benefited
Maternal care	0.8	0.04	0.0
CVD	1.2	0.5	0.2
COPD	7.8	2.9	2.0
T2DM	9.8	2.0	1.0

■ Patients that needs monitoring ■ Patients Monitored using mHealth ■ Patients benefited

Population benefited by mHealth enabled Treatment and Monitoring (T&M) in Mexico (in mn)

Category	Patients that needs monitoring	Patients Monitored using mHealth	Patients benefited
Maternal care	0.6	0.01	0.0
CVD	2.3	0.5	0.3
COPD	5.2	1.2	0.8
T2DM	7.9	1.2	0.6

■ Patients that needs monitoring ■ Patients Monitored using mHealth ■ Patients benefited

2017 data has been reported
Source: PwC analysis

Improved effectiveness of care in Mexico and Brazil

Chronic diseases

	T2DM	COPD	CVD
T&M improved using mHealth	30%	30%	29%
Mortalities reduced Number of lives	427	393	168

	T2DM	COPD	CVD
Hospitalisation prevented	31%	31%	31%
Number of days ('000)	74	99	6

Improved prenatal care

Risk reduction	64%
Pre-term births Count	3,622

Hospitalisation prevented	100%
Number of days ('000)	12

2017 data has been reported
Source: Medtronic, Hospital Ángeles del Pedregal, CENETEC, PwC analysis

Condition	Average duration of stay in a hospital in a year (in days)	Estimates of mHealth-led reduction in hospital duration (%)	Average reduction in days of stay in the hospital (in days)
Diabetes	8	31%	2.48
COPD	12	31%	3.72
CVD	4	31%	1.24
Prenatal care*	28	92%	26

*Duration of stay mentioned is for a pre-term birth child

The improved adherence and continuous remote treatment can help avoid severe complications associated with chronic diseases, thereby reducing their severity and lowering the need of hospitalisation. Some of the findings are as follows:

- By 2017, of the 8.2 million people in Brazil and Mexico being treated and monitored using mHealth, 4.9 million chronic patients could avoid 179,000 days of hospitalisation.

- Expectant mothers across these countries could prevent around 3,600 pre-term births by improving compliance and, hence, avoiding prenatal complications. As a result, they would have to stay 12,000 days fewer in hospitals.

These improvements could allow healthcare systems in Brazil and Mexico to use the hospital beds made available to treat additional patients, making the healthcare delivery more efficient.

Enhancing efficiency while limiting spend

mHealth enabled remote treatment and monitoring could reduce the treatment costs for chronic diseases by 35%.

Reduction in cost of treatment due to mHealth	Before use of mHealth (in USD)		% reduction#	Savings after use of mHealth (in USD)	
Condition	Brazil*	Mexico*		Brazil	Mexico
Diabetes	1,390	964	35%	486	337
COPD	2,540	2,124	35%	889	743
CVD	3,553	2,463^	35%	1,243	862

*The latest available figures have been taken from secondary sources for chronic condition and have been inflation adjusted to reach at 2017 figures
^Figures estimated based on CVD treatment cost in Brazil
#Numbers arrived based on secondary research and primary interviews
Source: IDF, Mediagrpahic, Scielo, Scieosp, CENTEC, Medtronic, Hospital Ángeles del Pedregal, PwC analysis

Cost savings in Brazil due to mHealth enabled T&M (in mn USD)
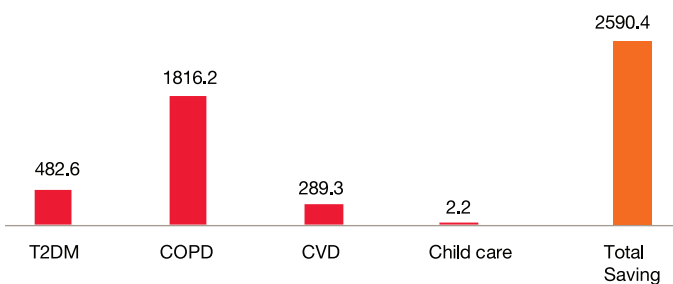
Cost savings in Mexico due to mHealth enabled T&M (in mn USD)
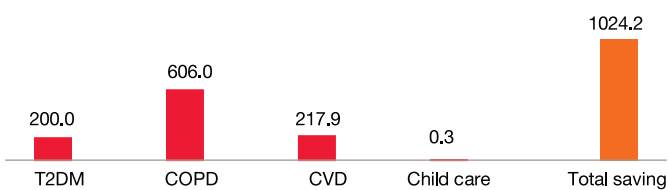
2017 data has been reported
Source: Medtronic, Hospital Ángeles del Pedregal, CENETEC, PwC analysis

Doctor days saved due to mHealth enabled T&M ('000)
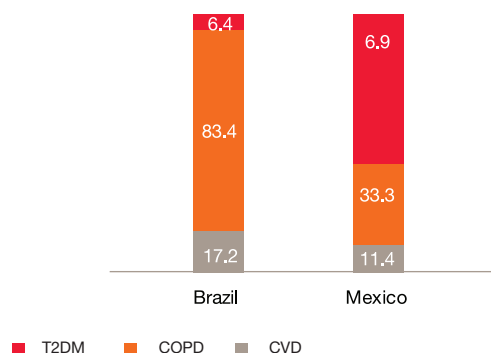
2017 data has been reported
Source: Medtronic, Hospital Ángeles del Pedregal, CENETEC, PwC analysis

Improved outcomes, fewer hospitalisations and avoidance of associated outpatient doctor consultations can reduce the cost of care. In particular, the cost of care for chronic diseases can be reduced by 35% through the effective use of mHealth-enabled treatment and monitoring solutions. The findings are as follows:

- By 2017, the annual per capita cost of care for T2DM can be reduced by 486 USD for one million patients in Brazil and by 337 USD for 0.6 million patients in Mexico.

- These 1.6 million T2DM patients could save 682 million USD in annual healthcare costs.

- The annual per capita cost of care for COPD can be reduced by 889 USD for two million patients in Brazil and by 743 USD 330 for 0.8 million patients in Mexico.

- In 2017, the total annual cost of care for these 2.8 million patients could be lowered by 2.4 billion USD

- By 2017, the annual per capita cost of care for CVD can be reduced by 1,243 USD for 0.2 million patients in Brazil and by 862 USD for 0.3 million patients in Mexico.

- These 0.5 million patients could save 507 million USD in annual care costs in 2017.

Due to the reduced complications and need for hospitalisation, doctors could prioritise patients to consult and reduce consultations, helping them save 158,000 working days across chronic conditions and 1,500 doctor days across child care in 2017 across Brazil and Mexico. According to PwC estimates, around 0.5 million additional patients could be attended to without having to add any more doctors to the system, reducing the physician gap in these countries.

2.3. Creating value using mHealth

Enabling healthcare systems to empower patients

Through the various benefits of mHealth, the healthcare systems in Brazil and Mexico could improve their readiness to deal with chronic conditions and become more capable in improving the quality of life of the patients. By connecting with patients outside hospitals, healthcare systems can help them take greater control of their lifestyles and diseases. Using mHealth to foster healthier lifestyles and make wellness and prevention more effective, the healthcare systems could benefit around 4.4 million patients at the risk of developing chronic diseases in 2017. In this manner, 276,000 incidences of these diseases can be prevented in 2017.

Incidences of chronic disease prevented in Brazil and Mexico by 2017 (in mn)
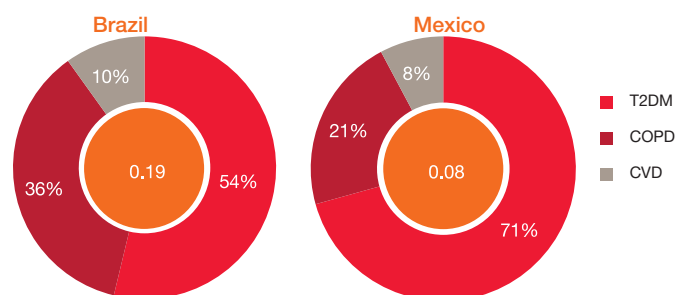
2017 data has been reported
Source: PwC analysis

While the healthcare systems will be able to optimise the allocation of resources due to the improved self-management and reduction in disease incidence, the empowered patients could create a further 30,000 years of healthy living.

Utilising resources better to limit spend and increase access

By 2017, mHealth could lower the total annual per capita healthcare spend for patients benefitting from mHealth solutions by 20% in Brazil and by 25% in Mexico

Healthcare systems can use mHealth to improve the quality and access to care by expediting diagnosis and enabling remote monitoring. The increased compliance levels and avoidance of disease can improve clinical outcomes and reduce the need for hospitalisation and visiting doctors, thereby reducing treatment costs. Some of the findings are as follows:
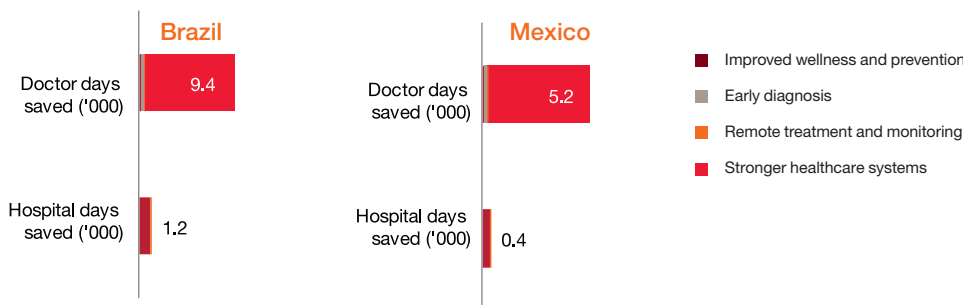
- Around 1.64 million days of hospitalisation could be prevented across Brazil and Mexico by 2017.
- 14.6 million days for doctors could be created through enhanced practitioner support.
- mHealth could allow doctors to treat 43 million additional patients in the time saved.

Accounting for the funds required to sustain the 200,000 jobs needed to support mHealth deployments by 2017, Brazil and Mexico will be able to save 17.9 billion USD in annual healthcare costs across around 64 million patients in Brazil and Mexico. Some of the findings are as follows:

- Public and private healthcare providers could use mHealth to save 14.1 billion USD in annual healthcare costs in Brazil and 3.8 billion USD in Mexico.
- 45.7 million patients, which is equivalent to 27.9% of the adult population in Brazil, could benefit from mHealth in 2017.
- Similarly, 18.7 million patients, or 27.8% of the adult population in Mexico, could benefit from mHealth in 2017.
- The annual per capita healthcare costs could be lowered by 20%, or 309 USD, in Brazil and 25%, or 204 USD, in Mexico.
- As a result, private spending could be reduced significantly. Every patient benefitting from mHealth in Brazil could avoid 96 USD in annual out-of-pocket healthcare expenses in 2017. The comparable amount in Mexico would be 95 USD.
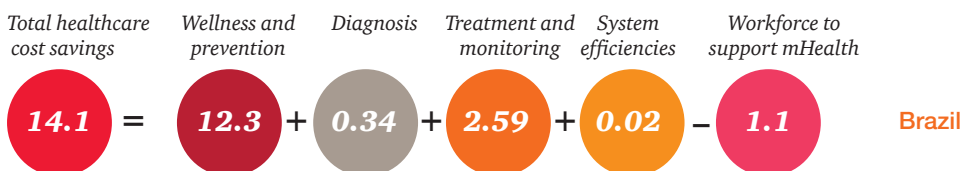
The resulting savings of USD 14.1 billion in Brazil and USD 3.9 billion in Mexico could allow public and private players to accommodate the treatment for a further 4.26 million and 2.3 million more patients in each respective country if only 15% of the doctor days were made available and used to treat additional patients.
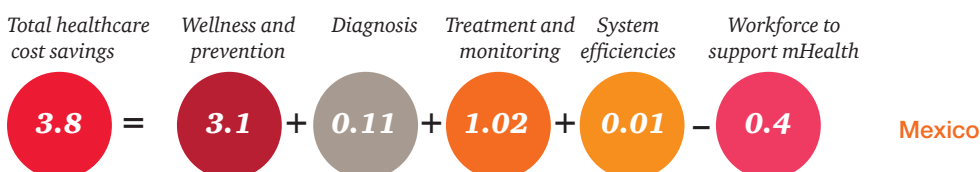
Reduced burden on healthcare resources

	Brazil		Mexico	
Doctor days saved ('000)	9.4	Doctor days saved ('000)	5.2	
Hospital days saved ('000)	1.2	Hospital days saved ('000)	0.4	

- Improved wellness and prevention
- Early diagnosis
- Remote treatment and monitoring
- Stronger healthcare systems

2017 data has been reported
Source: PwC analysis

Care costs saved in Brazil and Mexico by 2017 (in bn USD)

Total healthcare cost savings		Wellness and prevention		Diagnosis		Treatment and monitoring		System efficiencies		Workforce to support mHealth	
14.1	=	**12.3**	+	**0.34**	+	**2.59**	+	**0.02**	–	**1.1**	Brazil

All figures are in bn USD
2017 data has been reported

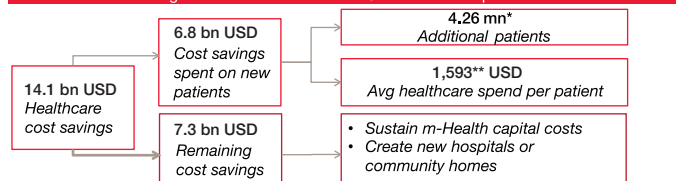| Total healthcare cost savings		Wellness and prevention		Diagnosis		Treatment and monitoring		System efficiencies		Workforce to support mHealth	
3.8	=	**3.1**	+	**0.11**	+	**1.02**	+	**0.01**	–	**0.4**	Mexico

2017 data reported
Source: PwC analysis

Even after accommodating the additional patients mentioned above, significant savings will still be available to sustain capital costs on mHealth and invest in new hospitals and community homes. The capacity created across these resources and savings available could equip the healthcare providers to extend the access to areas by reallocating human resources and infrastructure investments. The public healthcare systems could, therefore, accelerate the expansion of universal coverage and increase the equity of care. Over the longer term, the gradual lowering of costs could allow public and private payers to reduce insurance premiums, making healthcare more affordable.

m-Health can help alleviate human capital crisis in Brazil

Country	m-Health users that benefit (mn)	Number of doctor days saved (mn)	Extra of doctor consultations feasible (mn)	Extra patient capacity created* (mn)
Brazil	45.7	9.4	85.3	28.4

Healthcare cost savings alone sustain around 4.26 mn additional patients

14.1 bn USD Healthcare cost savings →
- 6.8 bn USD Cost savings spent on new patients →
  - 4.26 mn* Additional patients
  - 1,593** USD Avg healthcare spend per patient
- 7.3 bn USD Remaining cost savings →
  - • Sustain m-Health capital costs
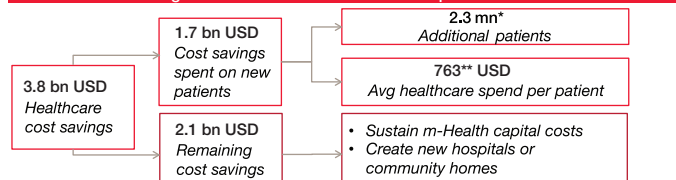 - • Create new hospitals or community homes

*Note: *Assuming only 15% of additional patients are to be treated out of money saved and 3 consultations are needed per patient **Estimated per capita healthcare cost in 2017 2017 data has been reported*

Source: PwC analysis

m-Health can help create extra capacity supporting doctors

Country	m-Health users that benefit (mn)	Number of doctor days saved (mn)	Extra of doctor consultations feasible (mn)	Extra patient capacity created* (mn)
Mexico	18.7	5.2	46.7	15.5

Healthcare cost savings sustain around 2.3 mn additional patients in Mexico

3.8 bn USD Healthcare cost savings →
- 1.7 bn USD Cost savings spent on new patients →
  - 2.3 mn* Additional patients
  - 763** USD Avg healthcare spend per patient
- 2.1 bn USD Remaining cost savings →
  - • Sustain m-Health capital costs
  - • Create new hospitals or community homes

*Note: *Assuming only 15% of additional patients are to be treated out of money saved and three consultations are needed per patient **Estimated per capita healthcare cost in 2017 2017 data has been reported*

Source: PwC analysis

Added individual earnings and economic growth

Healthier patients could add to their earnings by extending their professional lives. By reducing the severity of their disease through the regular use of mHealth solutions, chronic patients could avoid premature retirement, which is otherwise a common occurrence amongst them. Similarly, patients at a significant risk of developing chronic disease could reduce occurrences of unpaid absenteeism. The increased productivity of these healthier employees could allow them to work longer, earn more and enhance their contribution to the economy. Some of the findings are as follows:
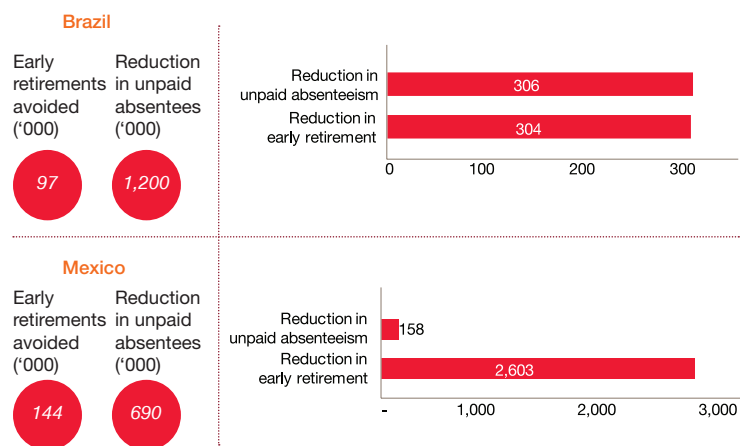
- In 2017, 97,000 chronic patients in Brazil and 144,000 chronic patients in Mexico could avoid premature retirement.
- Chronic patients that would have successfully avoided premature retirement up to 2017 could add 304 million work hours in Brazil and 2,603 million work hours in Mexico in

2017. The fact that Mexicans work till the age of about 69 years on average as compared to Brazilians, who retire at around 53 years of age, results in much higher addition of work hours in Mexico.

- In 2017, 1.2 million Brazilians and 0.7 million Mexicans who are at a high risk of developing chronic diseases could save 255 work hours and 225 work hours, respectively, in unpaid absenteeism.
- This would add 306 million annual work hours of paid work in Brazil and 158 million annual work hours in Mexico in 2017.
- The 610 million hours of work created in Brazil could add 3.1 billion USD in disposable wages, on which the government could collect 1.5 billion USD in taxes and social security contributions. Hence, a further 4.6 billion USD could be added to the GDP.
- Similarly, the 2,761 million work house created in Mexico could add 6 billion USD in disposable wages, on which the government could collect 2.4 billion USD in taxes and social security contributions. As a result, a further 8.4 billion USD could be added to the Mexican GDP.

Thus, the positive influence of mHealth can spread beyond clinical benefits to create a material impact on the quality of lives and productivity levels of the patients, providing them significant economic benefits. The incremental GDP could make universal healthcare delivery more sustainable through the enhanced social security contributions from these patients.
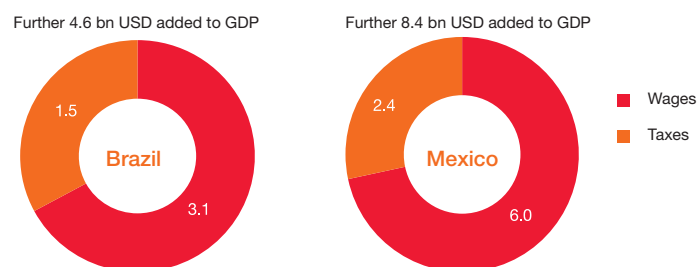
Extending professional lives for citizens by adding work hours (in mn)

Brazil

Early retirements avoided ('000): 97
Reduction in unpaid absentees ('000): 1,200

Reduction in unpaid absenteeism	306
Reduction in early retirement	304

(axis: 0, 100, 200, 300)

Mexico

Early retirements avoided ('000): 144
Reduction in unpaid absentees ('000): 690

Reduction in unpaid absenteeism	158
Reduction in early retirement	2,603

(axis: -, 1,000, 2,000, 3,000)

2017 data has been reported
Source: Sciencedirect, University of Michigan, London School of Economics,Abep,Educationforhealth, PMC-US National Library of Medicine, Bmj, RAND Health Research, Ncbi, PwC analysis

Additional GDP created in Brazil and Mexico in 2017 (in bn USD)

Further 4.6 bn USD added to GDP

Brazil
- 1.5
- 3.1

Further 8.4 bn USD added to GDP

Mexico
- 2.4
- 6.0

Legend:
- ■ Wages
- ■ Taxes

2017 data has been reported
Source: Taxrates.com, PwC analysis

Overcoming the barriers to adoption

"The lack of a performance-based healthcare system with low accountability of resource usage is a significant barrier. There is an urgent need for performance based funding of hospitals."

Dr Miguel Angel, Health Advisor PwC Mexico

"The lack of visibility on how hospital would earn in the new ecosystem resulting from mobile health creates a reluctance to adopt mHealth. Currently, there is no business model in place."

Adrian Pacheco, CENETEC

"Data security and interoperability with IT systems within and outside the hospital are areas of challenge for mHealth."

Dr. Miguel Angel, Health Advisor PwC Mexico

"Definite regulations for mobile application need to be in place for Mexico."

Guadalupe Aparicio, IMSS

Impact of limited adoption

The healthcare systems in Brazil and Mexico can realise significant benefits from mHealth to enhance the quality of care and address some of most pressing challenges these systems face due to the mismatch in resources and changing healthcare needs. Leveraging mHealth could impact patients positively by making their lives healthier and more productive. However, the broad socio-economic impact that mHealth can potentially create for the various beneficiaries including the healthcare systems by 2017 depends on how many healthcare providers and patients adopt it and use it regularly.
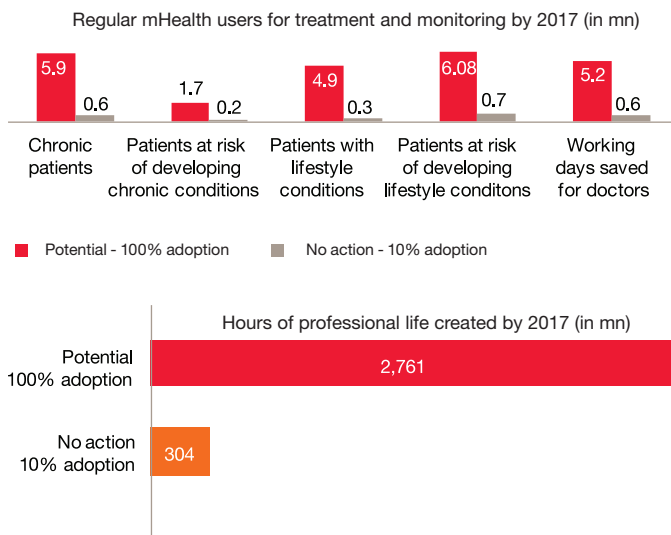
Even though the healthcare regulators, policy makers and providers in Brazil and Mexico have been enthusiastic about the potential of mHealth, multiple barriers are still preventing mHealth solutions from being adopted formally and achieving scale. There is a significant possibility that, even if telecom penetration do not rise too significantly in these countries, only 10% of the patients and healthcare providers which can potentially adopt mHealth will do so by 2017. The potential that mHealth holds for Brazil and Mexico may be left significantly underutilised and its impact could remain localised.

Impact of limited adoption in Brazil

Regular mHealth users for treatment and monitoring by 2017 (in mn)

Category	Potential - 100% adoption	No action - 10% adoption
Chronic patients	16.3	1.8
Patients at risk of developing chronic conditions	4.0	0.4
Patients with lifestyle conditions	9.2	1.0
Patients at risk of developing lifestyle conditons	15.9	1.7
Working days saved for doctors	9.4	1.0

■ Potential - 100% adoption   ■ No action - 10% adoption

Hours of professional life created by 2017 (in mn)

Potential 100% adoption	610
No action 10% adoption	67

28.4 mn	Additional patients treated in 2017 →	**3 mn**
14.1 bn	Total healthcare cost savings in 2017 →	**1.5 bn**
4.5 bn	Total GDP addition in 2017 →	**0.5 bn**

Source: PwC analysis

Regular mHealth users for treatment and monitoring by 2017 (in mn)

	Chronic patients	Patients at risk of developing chronic conditions	Patients with lifestyle conditions	Patients at risk of developing lifestyle conditons	Working days saved for doctors
Potential - 100% adoption	5.9	1.7	4.9	6.08	5.2
No action - 10% adoption	0.6	0.2	0.3	0.7	0.6

■ Potential - 100% adoption   ■ No action - 10% adoption

Hours of professional life created by 2017 (in mn)

Potential 100% adoption	2,761
No action 10% adoption	304

Source: PwC analysis

15.5 mn →	Additional patients treated in 2017	**1.7 mn**
3.8 bn →	Total healthcare cost savings in 2017	**0.4 bn**
8.4 bn →	Total GDP addition in 2017	**0.9 bn**

To fully harness the potential of mHealth, various stakeholders in the mHealth ecosystem need to collaborate and take initiatives to facilitate adoption.

The four key barriers to adoption

Multiple stakeholders involved in the delivery of healthcare, including public healthcare providers and private insurance companies, are already making efforts to deploy mHealth in Brazil and Mexico but mHealth has not yet reached scale. The overall socio-economic impact is promising but there are four sets of active barriers that are limiting its adoption:

- **Regulatory:** There is a need for clear regulation in area of mHealth. The absence of regulation on some fundamental areas is slowing the adoption of mHealth. Some of the challenges created due to the absence of regulation are as follows:
  - Current regulation restricts the practice of medicine to facility-based protocols only. A doctor cannot diagnose, treat or prescribe outside a healthcare facility. Even a simple phone call from the doctor's home to the patient is illegal, creating significant limitations for mHealth.
  - Technological standards need to be established and interoperability promoted to enable scale and ease of use of innovation in mHealth product development.
  - Clarity needs to be provided on how medical device regulations apply to mHealth, providing a clear pathway for certification, while ensuring patient safety and trust.
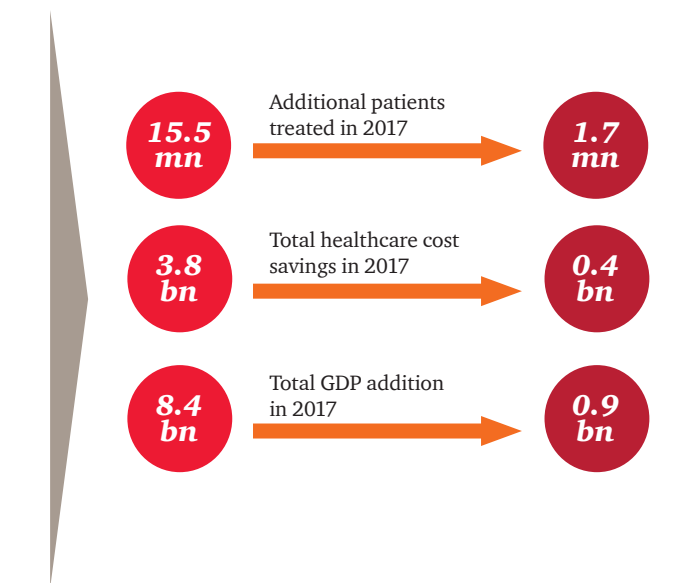
- **Economic:** Currently, economic incentives that could facilitate the commercialisation of mHealth and efficient realisation of its benefits are not available. Some of the constraints are as follows:
  - The evidence base of mHealth benefits needs to be strengthened to easily convince healthcare providers and regulators of the value mHealth can create.
  - Performance and financial incentives that encourage healthcare providers to focus on transactions rather than quality of clinical outcomes prevent them from considering or evaluating technologies such as mHealth which can shift care outside of hospitals.
  - Lack of insurance coverage or reimbursement mechanisms for the use of mHealth makes mHealth solutions and devices unaffordable for patients, especially in the low-income groups.
  - Limited healthcare budgets can restrict public investments in research and development of mHealth solutions, creating a burden for the private sector.
  - A lack of awareness of the benefits of mHealth amongst healthcare providers keeps them from encouraging patients to use mHealth solutions.
  - Furthermore, this lack of awareness creates a reluctance to invest in addressing the change management needs associated with deployment of mHealth.

- **Structural:** Even though electronic medical records are being implemented in Brazil and Mexico, their fragmented healthcare systems limit the sharing of information and alignment of processes. Hospitals today do not share electronic medical records among their departments, much less between enterprises. Even at the most sophisticated hospitals, the emergency room and clinical records are not integrated into the hospital records. Since there is no incentive for hospitals to exchange data, government intervention and policy setting will be required. This poses a risk of localisation of mHealth systems and can keep mHealth from scaling up. We have seen good indications from MOH's DATASUS regarding the agency plans for health information exchanges which is encouraging, but these must be combined with regulatory policies to encourage commitment from hospitals to embrace the data exchange requirements. Furthermore, absence of performance-based incentives for public healthcare providers limits their competitiveness, which could restrict their need to leverage mHealth in making their resources more efficient.

- **Technological:** Even though telecom networks exist and sufficient mobile coverage is present, the lack of interoperability of solutions and devices and common data standards prevent mHealth solutions from achieving scale. However, these barriers are relatively easy to address provided there is a sufficient support of healthcare regulators and the relevant telecommunications regulators to promote adoption of mHealth solutions amongst healthcare solution providers.

Call for immediate action

Many mHealth benefits are system oriented and may be visible over the longer term. To ensure that these benefits can be attained in the longer term, the four main areas such as regulatory, economic, structural and technological, need to be acted upon immediately.

The regulators and payers need to design frameworks and incentives that can encourage adoption now in order to maximise benefits of mHealth as soon as stronger evidence is established.

Flow of information	Regulatory		Economic	Structural	Technological
Healthcare provider			Need for further evidence Conflicting incentives Change mgmt	Low cohesion across levels and regions Low competition	Mismatch between current workflows and mHealth solutions
Solution vendor	Restricted scope of practice		Inadequate funding Hindrances to scalability	Hindrances to scalability	Interoperability
Mobile service provider	Lack of clarity on mHealth certification		Lack of reimbursement mechanisms		Standardisation Interoperability
Medical device vendor	Lack of interoperability standards		Ensure affordability for low income groups		Standardisation Interoperability
Doctors / Patients			Lack of awareness of mHealth benefits Lack of affordability for low income groups		Significant training needs

Source: PwC analysis

Actions needed to drive adoption

Policy and regulatory decisions that formalise the mHealth ecosystem can help address regulatory concerns and overcome structural barriers. Regulators and payers can also devise economic incentives and technology standards that can encourage the adoption and use of mHealth.

"There is a need to involve doctors in early stages of product development. Products categories which could help to simplify the activities of the doctor like payment claims, information processing could find more traction with doctors."

Hector Rode Haza, AXA Insurance

"Innovative pricing models such as a low base price plus service based pricing mechanism could be used for mHealth."

Act. José Antonio Barreiro, General de Salud

"Mobile health would be creating a new workflow for the doctors which would increase their work pressure. There is a need to understand the current way doctors work and use mobile health in a way which supplements their existing work flow."

Luiz Tizatto, Unit Care Saude

"There is a need to create a supporting regulatory structure. For example, there is a need to make the electronic records have a legal bearing."

Hector Rode Haza, AXA Insurance

"Mobile health would be creating a new workflow for the doctors which would increase their work pressure. There is a need to understand the current way doctors work and use mobile health in a way which supplements their existing work flow."

Adrian Pacheco, CENETEC

Source: PwC analysis

Create a facilitative regulatory environment

The policy makers and regulators can play a primary role in establishing policies and regulations that can help formalise the mHealth ecosystem through the following steps:

- Create policies that integrate mHealth with the nationwide healthcare strategy, which can help align the development of mHealth with the priorities of the healthcare sector.

- Harmonise the gap between regulations around delivery of healthcare services and mobile health services, e.g. modify the healthcare regulations to facilitate the use of technology that enables administration of care outside hospitals.

- Establish clear medical device certification for mHealth to ensure accountability of stakeholders.

- Establish technology and data standards to ensure development and deployment of interoperable solutions, which could enable mHealth solutions to achieve scale.

- Encourage coordination amongst healthcare providers by mandating them to use interoperable solutions.

Establish beneficial compensation and funding mechanisms

Payers, with the support of regulators, can create compensation mechanisms that ensure that gains from mHealth get fairly distributed across the stakeholders. Establishing funding mechanisms that ensure direct mHealth investments as per needs of the healthcare systems can help ensure efficient usage of these investments. To attain these objectives, the payers could adopt the following:

- Create compensation mechanisms for patients and healthcare providers that could cover the cost of mHealth solutions for the patients and reimburse the healthcare providers.

- Create favourable pricing models of mHealth for the low income population to ensure that they get equitable access to mHealth services.

- Reward healthcare providers for attaining positive health outcomes and efficiency improvements by using mHealth solutions, promoting healthy competition and encouraging mHealth adoption.

- Establish public private partnerships and collaborate with NGOs and global health organisations to fund mHealth solutions that address the most important needs of the healthcare systems

Enable the ecosystem to adopt and use mHealth

The regulators and payers need to work together to promote the awareness of mHealth benefits and support the efficient development of mHealth solutions by taking steps that help in the following:

- Continue building the evidence base of mHealth to clearly establish the value that mHealth can create.

- Drive clinical leadership to establish pioneers of mHealth implementation such that change management needs are lowered progressively and a set of best practices for mHealth implementation can be established.

- Changing the culture of professionals in their use of technology and connectivity is needed to enable adoption of mHealth.

- Encourage clinical engagement earlier in the development of mHealth solutions to work towards the refinement of exact needs for these solutions.

- Incentivise healthcare providers to promote the awareness of mHealth benefits amongst patients and associated healthcare staff.

- Establish education systems across all healthcare professionals to train them on how to use mHealth solutions.

- Centralise the procurement of mHealth solutions to ensure their standardization, interoperability and scalability.

- Ensure the availability of solutions in local languages.

These recommended steps are relatively straightforward when reviewed individually. However, collaborative action amongst various stakeholders is necessary to ensure that these recommendations are implemented efficiently and consistently to coincide with each other. Clearly, policy makers, regulators and payers have a significant role to play in guiding the formalisation of the mHealth ecosystem through these steps. Hence, an urgency on their part in conceiving the frameworks and policies and implementing them is critical to ensure that the potential that mHealth holds is maximised and the benefits are not pushed out to far into the horizon.

Appendix A: Assumptions

Areas of assumption	Assumptions
Health conditions	**Chronic conditions:** T2DM, CVD and COPD are the conditions considered for assessment. **Lifestyle conditions:** Obesity, smoking and hypertension have been analysed as these lead to chronic conditions. **Prenatal care:** Although Brazil and Mexico have achieved more than 90% of immunisation coverage for children under five years, these countries still have high rates of neonatal mortality. Hence, prenatal care, still birth and pre-term birth have been studied for Brazil and Mexico.
Criteria for disease selection	Chronic and lifestyle conditions have been selected based on factors such as prevalence, Disability Adjusted Life Years (DALY) loss and mortality contribution in Brazil and Mexico. Maternal care was selected for assessment because Brazil and Mexico still have high rates of neonatal mortality. Our study omitted certain diseases such as cancer and asthma because our healthcare experts opined that mHealth will not be able to create any significant clinical improvement in the short term.
Areas of mHealth intervention	The following two broad areas have been considered for impact of mHealth interventions: • **Solutions across patient pathways:** Areas considered include wellness, prevention, diagnosis, treatment and remote monitoring. • **Solutions to strengthen healthcare systems:** Areas considered include are healthcare practitioner support, healthcare administration and emergency response.
Relevant population	**Wellness and prevention:** Population at risk of developing conditions and population with conditions being assessed. **Diagnosis:** Population at risk who do not have access to diagnosis and population with conditions who are not diagnosed. **Treatment and monitoring:** Population with conditions who are non-compliant to treatment. The above population has been further segmented according to rural and urban areas. The impact of mHealth will vary across these two user bases.
Adoption factors	Telecom penetration rate is used to arrive at the population that can be reached by mHealth. Adoption rate reflects the percentage of the relevant population who will adopt such mHealth solutions. Two scenarios have been considered here which are as follows: • Adoption rate would be 10% in 2017 if no action is taken to encourage it. • Potential adoption rate in 2017 is taken to be 100%, assuming that full adoption will be realised once the mHealth framework, policies and business models will be put in place. Adoption rates have been arrived at through primary interviews with healthcare experts. Repeat usage rate has been accounted for, based on the assumption that the mHealth solutions will take 6 to 12 months in order to have a meaningful healthcare impact. It has been validated by healthcare experts in relevant geographies. The repeat usage rate has been considered differently for urban and rural areas.
mHealth benefits	The following areas have been used as representative to quantify mHealth related benefits: • Pilot mHealth projects and their benefits. • Tele-health projects and their benefits. • e-Health project and their benefits. Final numbers obtained from these findings were further validated and modulated through primary interviews in the relevant geographies. **Aggregation of population:** Benefitted population has been calculated across wellness, prevention, diagnosis, treatment compliance and remote monitoring categories and overall population has been aggregated. **Lifestyle conditions:** Total population suffering with just lifestyle conditions and not chronic diseases has been calculated by adding obese, smokers and hypertensive population together. **Chronic conditions:** For patients suffering from chronic conditions or at risk of developing them, the overlap for various lifestyle disorders has been accounted for.
Age group for health conditions	**Lifestyle conditions:** Relevant age groups have been considered for each disease. For example, 15 plus years for smoking, hypertension and obesity. **Chronic conditions:** The age group of 20 to 79 years has been considered for diabetes, whereas for COPD and CVD, 15 years and above have been considered. **Prenatal care:** No particular age group has been considered. Reported rate of child birth has been used to arrive at the population of expecting mothers who will need prenatal care.
Treatment cost	Historical treatment costs have been inflation adjusted in order to arrive at current costs where required.

Productivity loss	Due to absenteeism, productivity loss has been computed over unpaid sick days beyond entitled sick leaves.
	Due to early retirement, productivity loss has been computed on the years by which a chronic patient retires early.
	Daily wages and tax rates of each country have been taken into account to calculate productivity loss and loss on government taxes due to absenteeism and early retirement.
Hospitalisation days	**Percentage of hospitalisation and ALOS have been captured from secondary sources. This is further validated by primary interviews from healthcare experts in relevant geographies**
Job creation	Jobs will be created for paramedics, trainers and technical support staff, with each mHealth deployment in hospitals.
Adverse drug events	Preventable adverse drug events cause a major cost burden on the healthcare system. This can be reduced by effective mHealth deployments across hospitals.

Appendix B: Methodology

Understanding and quantifying region-specific healthcare challenges

To arrive at the socio-economic impact of mHealth, we started with the view that for mHealth to be effective, it has to address the challenges and needs of Brazil and Mexico. We gathered data points on relevant challenges such as disease incidence, prevalence, disease- related mortalities and the number of people at risk. These healthcare challenges and data points were further validated by primary interviews with healthcare experts in the regions.

Further to identify the socio-economic impact of the disease we looked into parameters like treatment costs of each disease in each region, and the cost burden of early retirement and absenteeism caused by those diseases. We also looked into disease-specific hospitalisation frequency and hospitalisation days in order to quantify the socio-economic challenge.

Identifying the scope of mHealth and capturing benefit data

The relevance of mHealth was established against these challenges. We identified two broad areas of interventions such as solutions across the patient pathway and the healthcare system strengthening. These two broad categories were further sub-divided into six areas of intervention– solutions across the patient pathways (wellness and prevention, diagnosis, treatment and monitoring) and healthcare systems (emergency response, healthcare practitioner support and healthcare systems strengthening).

The following key steps were taken to arrive at the quantified healthcare benefits of mHealth:

- A relevant population base was selected for each condition being assessed.
- The smartphone and basic user phone penetration was applied to this population to arrive at the total potential users of mHealth solutions.
- Since mHealth solutions benefit only if used regularly, the percentage of total potential users who would regularly use such mHealth applications was determined to arrive at the relevant number of mHealth users.
- Further, the percentage of regular mHealth users that could benefit was computed for each solution type and condition.
- The potential benefits estimated for each solution type and condition were then applied to arrive at the overall benefit.

Each area and type of benefits of mHealth were estimated based on existing studies, pilots and expert opinion.

Arriving at socio-economic estimates

In order to analyse the benefits across Brazil and Mexico, an economic model was developed to quantify healthcare challenge and mHealth induced socio-economic benefit in these countries.

Approach to quantify socio-economic benefits					
	Quantify major healthcare challenges in the country	Identify the scope of mHealth	Analyse the potential benefits of mHealth	Translate healthcare benefits to socio-economic benefits	Scenario analysis
Areas covered	• Data analysis to profile healthcare challenges of the country • Translation of these challenges to socio-economic challenges	• Identify relevant areas for mHealth interventions on the basis of healthcare challenges of each country • Prioritisation of these areas based on the goals of multiple players in the mHealth ecosystem of the country	• Analyse case studies and pilot projects in order to arrive at estimates of benefits • Conduct primary interviews to verify the estimates	• Convert these healthcare benefits to socio-economic benefits through econometric modeling	• Parameters varied to under analyse socio-economic impact of various scenarios of mHealth adoption
Source of data	• Primary interviews • Secondary sources	• PwC analysis • Primary interviews	• Primary interviews • Secondary sources	• PwC analysis	• PwC analysis

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