

AN EMPIRICAL REVIEW OF THE TOP 500 MEDICAL APPS IN A EUROPEAN ANDROID MARKET

Dr Vivian Obiodu MD^{1,2}, Emeka Obiodu MSc³

¹East and North Hertfordshire NHS Trust, England, UK, ²Institute of Orthopaedics and Musculoskeletal Science, University College London, UK, ³Warwick Business School, Coventry, UK

Corresponding Author: obiodu@doctors.org.uk

Background/Aims: Mobile phone apps are increasingly playing a role in healthcare delivery and the training of healthcare professionals. According to Research2guidance, the market for such medical apps reached US\$718 million in 2011. The market for mobile applications for Apple and Google dominate the app scene, as they contain over 500,000 apps each. This research reviews the 500 top medical apps in a specific Android market as it seeks to explore the availability, popularity, and prices of apps designed for different medical specialties and uses.

Methods: The Android market was chosen because it provides better download statistics and its unregulated nature is a good indicator for good and bad apps. The Italian Android market was chosen as it approximates a closed healthcare market.

Results: The results show that apps designed for public education, to be used as health diaries, or for healthcare practitioners to make calculations were the most popular. While mean number of downloads for the 500 apps was 74,471, the median is closer to 3,000 downloads per app, reflecting how a few popular apps have skewed the mean. The median number of reviews for each app was 16, the median rating was 4.1/5 and the data shows most apps (77%) are free.

Conclusion: This review of the top, consecutive 500 'medical' apps in the Italian Android market shows that a majority of the apps are designed for healthcare professionals. On the average, a typical medical app will be downloaded 3,000 times, reviewed 16 times, rated 4.1/5 and given away for free. While there are many benefits to society from medical apps, there are also concerns so as not to endanger healthcare delivery or jeopardize public health and safety.

Journal MTM 1:4:22-37, 2012

DOI: 10.7309/jmtm.74

www.journalmtm.com

Introduction

The growing adoption of smartphones and the proliferation of mobile phone apps, especially since Apple's launch of its Appstore in 2008, have created new opportunities for healthcare delivery and medical education¹. As healthcare practitioners and policy makers explore how apps can play a role in healthcare delivery or training, developers are pushing an ever growing number of apps to the market. Research2guidance reported that the market for apps designed for the healthcare market

increased by a factor of 7 to reach US\$718 million in 2011². Apple's appstore and Google's Android market are the two most dominant app marketplaces, although there are other markets for applications such as Microsoft's Windows marketplace and independent ones such as GetJar³.

A growing number of papers or reports have reviewed specific apps^{4,7}, apps for specific healthcare disciplines⁸⁻¹³ or the general market/trend for healthcare apps¹⁴⁻¹⁷. These demonstrate the pervasiveness of apps, and how different healthcare

disciplines are finding niche uses for mobile phone apps.

This paper seeks to further that research and is designed to investigate healthcare apps from a multidisciplinary perspective. It empirically reviews the top, consecutive 500 medical apps as displayed on the Italian Android market. It then uses the resulting metrics to determine how popular the apps are, their quality, their uses and potential concerns about them. These metrics are then used to engage in a broader discussion on the trajectory of medical apps and the opportunities and challenges that lie ahead.

Methods

Choice of application market

While both Apple's appstore and Google's Android market have substantial number of apps dedicated to the healthcare sector, the Android market was selected for the following reasons.

1. Unlike Apple's appstore, the Android market is more open about sharing download metrics. As such, this gives an immediate and exact idea how many times an app has been downloaded.
2. The Android market offers a better medium to appraise concerns about the unregulated nature of the apps market and the, often unverified, claims made about healthcare apps. While Apple's curated appstore offers a semblance of control, providing a presumed check on the quality of apps that are available, the Android market offers no check on the apps that are submitted, potentially making it vulnerable to hackers¹⁸.
3. Given the prevalence of English apps, the Italian Android market was selected as it offered an opportunity to appraise a standalone market that was big and wealthy enough to support own-language apps instead of being inundated with English apps that can be used across all English-speaking countries.

Populating the database

Having selected the Android market, a search of the website of the Italian Android market was done on 16 March 2012. Details of the first 500 apps displayed were then entered into an MS Excel

database. This approach was used as any app outside the top 500 as viewed on the Android market website is unlikely to show up in the much smaller smartphone screen.

Download statistics

Although Android gives an idea how many apps have been downloaded, it only provides this information in distinct intervals of an upper and lower limit. Accordingly, the midpoint of each interval is selected as the approximate number of downloads for the app. This is then used to estimate the volume of downloads for all the 500 apps in the database. Table 1 is a conversion table from Android intervals to number of downloads.

App Categories

Each of the 500 apps was individually reviewed by two graders to determine the healthcare discipline it is most suited for, or the primary use of it for the general population. In many cases, this was straightforward. But there were several apps that transverse specific discipline or that did not easily fit into any of the broad categories. These outlier apps were grouped into special categories as shown in table 2.

Table 1: Android download intervals and their approximate conversion

| Android interval | Approximate no of downloads |
|--------------------|-----------------------------|
| 1 - 5 | 3 |
| 5 - 10 | 8 |
| 10 - 50 | 30 |
| 50 - 100 | 75 |
| 100 - 500 | 300 |
| 500 - 1000 | 750 |
| 1000 - 5000 | 3,000 |
| 5000 - 10000 | 7,500 |
| 10000 - 50000 | 30,000 |
| 50000 - 100000 | 75,000 |
| 100000 - 500000 | 300,000 |
| 500000 - 1000000 | 750,000 |
| 1000000 - 5000000 | 3,000,000 |
| 5000000 - 10000000 | 7,500,000 |

Table 2: Special categories for apps

| Category | Description | App examples |
|-------------------|--|----------------|
| Emergency | Representing apps that purport to help | ICE, First Aid |
| Assistance | users in an emergency | |
| Education | Apps whose main purpose seems to be | Handbook of |

| | | |
|--------------------------|--|--|
| | about boosting knowledge of healthcare among the general population | diseases, Bones |
| Health | Apps that help users to track any part of | Medication Alarm |
| Diary | their medical history, including drug schedules | Clock, Headache Diary Pro |
| Medical Tools | Encompassing all apps that help healthcare professionals to calculate medical values and formulas. | Lab Values, Acid Base Balance |
| Pharmacy Services | Apps that are aimed at providing direction, enquiry services or reservations services for pharmacies | Cerca Farmacia, Farmacia |
| Reference | Apps that provide a reference manual for healthcare professionals | Pubmed+, Epilepsia Journal |
| Therapy | Apps that purport to provide some type of therapy to the general public, especially to enhance sleeping | Are you fear of heights?, Astral Serenity Brain Massage |
| Women's Health | Apps designed specifically for women, especially to help with their reproductive cycles. A few apps on unisex sex are also included. | Contraceptive Patch, Pregnancy Stages |

Results

The results of the statistical analysis are shown in tables 3, 4, 5 and 6.

Table 3: Volume of apps downloaded

| | No of apps | Mean | SD | Median |
|-----------------------------|------------|---------|---------|--------|
| All | 500 | 71,471 | | 3,000 |
| | | | 314,213 | |
| Animals | 7 | 2,187 | 1,288 | 3,000 |
| <i>Animals</i> | 7 | 2,187 | 1,288 | 3,000 |
| Personal Health | 227 | 99,184 | | 7,500 |
| | | | 365,353 | |
| <i>Baby's Health</i> | 7 | 53,721 | | 7,500 |
| | | | 101,215 | |
| <i>Body Care</i> | 18 | 113,000 | | 30,000 |
| | | | 185,644 | |
| <i>Education</i> | 68 | 108,741 | | 7,500 |
| | | | 394,511 | |
| <i>Emergency Assistance</i> | 9 | 349,868 | | 7,500 |
| | | | 937,244 | |
| <i>Health Diary</i> | 58 | 58,505 | | 3,000 |
| | | | 150,729 | |
| <i>Pharmacy Services</i> | 16 | 13,066 | 24,454 | 3,000 |
| <i>Therapy</i> | 21 | 33,157 | 63,485 | 7,500 |
| <i>Women's Health</i> | 30 | 175,431 | | 30,000 |
| | | | 536,564 | |
| Professional | 266 | 49,644 | | 3,000 |

| | | | 265,354 | |
|-----------------------------|----|--------|---------|--------|
| <i>Alternative Medicine</i> | 3 | 12,600 | 12,650 | 7,500 |
| <i>Anatomy</i> | 9 | 50,950 | 90,818 | 7,500 |
| <i>Anesthesia</i> | 11 | 14,741 | 28,426 | 750 |
| <i>Cardiology</i> | 24 | 23,269 | 59,012 | 5,250 |
| <i>Dentistry</i> | 6 | 15,510 | 14,524 | 16,500 |
| <i>Dermatology</i> | 1 | 3,000 | - | 3,000 |
| <i>Emergency Medicine</i> | 15 | 24,462 | 73,982 | 3,000 |
| <i>Endocrinology</i> | 1 | 300 | - | 300 |
| <i>Family Medicine</i> | 4 | 413 | 195 | 300 |
| <i>Genetics</i> | 1 | 3,000 | - | 3,000 |
| <i>Hematology</i> | 1 | 30,000 | - | 30,000 |
| <i>Histology</i> | 2 | 18,750 | 11,250 | 18,750 |
| <i>Infectious Disease</i> | 2 | 1,875 | 1,125 | 1,875 |
| <i>Medical Tools</i> | 62 | 21,532 | 54,405 | 3,000 |
| <i>Nephrology</i> | 4 | 15,077 | 14,923 | 15,150 |
| <i>Neurology</i> | 1 | 30,000 | - | 30,000 |
| <i>Nursing</i> | 10 | 71,580 | | 3,000 |
| | | | 116,326 | |
| <i>O&G</i> | 1 | 30,000 | - | 30,000 |
| <i>Oncology</i> | 4 | 2,888 | 2,853 | 1,875 |
| <i>Ophthalmology</i> | 2 | 16,500 | 13,500 | 16,500 |
| <i>Pathology</i> | 1 | 3,000 | - | 3,000 |
| <i>Pediatrics</i> | 8 | 11,573 | 24,077 | 3,000 |

| | | | | |
|-----------------------------|----|---------|---------|--------|
| <i>Pharmacy</i> | 16 | 51,652 | 96,966 | 3,000 |
| <i>Physiotherapy</i> | 10 | 8,018 | 11,179 | 3,000 |
| <i>Psychiatry</i> | 4 | 10,313 | 11,623 | 5,250 |
| <i>Radiology</i> | 22 | 6,250 | 9,640 | 3,000 |
| <i>Reference</i> | 34 | 235,530 | | 30,000 |
| | | | 698,489 | |
| <i>Respiratory Medicine</i> | 1 | 7,500 | - | 7,500 |
| <i>Surgery</i> | 4 | 8,445 | 12,493 | 1,875 |
| <i>Urology</i> | 2 | 1,650 | 1,350 | 1,650 |

Table 4: No of reviews per app

| | No of apps | Mean | SD | Median |
|-----------------------------|------------|-------|-------|--------|
| All | 500 | 232 | 1,150 | 16 |
| Animals | 7 | 5 | 3 | 5 |
| <i>Animals</i> | 7 | 5 | 3 | 5 |
| Personal Health | 227 | 327 | 1,283 | 24 |
| <i>Baby's Health</i> | 7 | 162 | 342 | 31 |
| <i>Body Care</i> | 18 | 296 | 550 | 25 |
| <i>Education</i> | 68 | 332 | 1,636 | 17 |
| <i>Emergency Assistance</i> | 9 | 1,166 | 2,699 | 13 |
| <i>Health Diary</i> | 58 | 225 | 572 | 24 |

| | | | | |
|-----------------------------|-----|-----|-------|----|
| <i>Pharmacy Services</i> | 16 | 53 | 96 | 10 |
| <i>Therapy</i> | 21 | 51 | 51 | 32 |
| <i>Women's Health</i> | 30 | 653 | 1,743 | 49 |
| Professional | 266 | 155 | 1,030 | 12 |
| <i>Alternative Medicine</i> | 3 | 60 | 28 | 51 |
| <i>Anatomy</i> | 9 | 130 | 154 | 65 |
| <i>Anesthesia</i> | 11 | 29 | 47 | 5 |
| <i>Cardiology</i> | 24 | 23 | 28 | 14 |
| <i>Dentistry</i> | 6 | 8 | 4 | 10 |
| <i>Dermatology</i> | 1 | 8 | - | 8 |
| <i>Emergency Medicine</i> | 15 | 67 | 103 | 12 |
| <i>Endocrinology</i> | 1 | | | |
| <i>Family Medicine</i> | 4 | 6 | 3 | 7 |
| <i>Genetics</i> | 1 | 21 | - | 21 |
| <i>Hematology</i> | 1 | 73 | - | 73 |
| <i>Histology</i> | 2 | 23 | 11 | 23 |
| <i>Infectious Disease</i> | 2 | 37 | 31 | 37 |
| <i>Medical Tools</i> | 62 | 49 | 137 | 11 |
| <i>Nephrology</i> | 4 | 10 | 11 | 5 |
| <i>Neurology</i> | 1 | 36 | - | 36 |
| <i>Nursing</i> | 10 | 221 | 518 | 23 |
| <i>O&G</i> | 1 | 10 | - | 10 |
| <i>Oncology</i> | 4 | 9 | 9 | 5 |
| <i>Ophthalmology</i> | 2 | 50 | 48 | 50 |

| | | | | |
|-----------------------------|----|-----|-------|----|
| <i>Pathology</i> | 1 | 17 | - | 17 |
| <i>Pediatrics</i> | 8 | 16 | 18 | 4 |
| <i>Pharmacy</i> | 16 | 84 | 101 | 43 |
| <i>Physiotherapy</i> | 10 | 17 | 21 | 9 |
| <i>Psychiatry</i> | 4 | 14 | 6 | 15 |
| <i>Radiology</i> | 22 | 10 | 12 | 6 |
| <i>Reference</i> | 34 | 872 | 2,719 | 32 |
| <i>Respiratory Medicine</i> | 1 | 14 | - | 14 |
| <i>Surgery</i> | 4 | 57 | 55 | 57 |
| <i>Urology</i> | 2 | 3 | 1 | 3 |

Table 5: Ratings of apps (5 is the maximum)

| | No of apps | Mean | SD | Median |
|-----------------------------|-------------------|-------------|-----------|---------------|
| All | 500 | 3.9 | 0.8 | 4.1 |
| Animals | 7 | 4.3 | 0.7 | 4.4 |
| <i>Animals</i> | 7 | 4.3 | 0.7 | 4.4 |
| Personal Health | 227 | 3.9 | 0.8 | 4.0 |
| <i>Baby's Health</i> | 7 | 3.8 | 0.6 | 4.0 |
| <i>Body Care</i> | 18 | 3.6 | 0.8 | 3.7 |
| <i>Education</i> | 68 | 3.8 | 0.9 | 3.9 |
| <i>Emergency Assistance</i> | 9 | 4.4 | 0.6 | 4.5 |

| | | | | |
|-----------------------------|-----|-----|-----|-----|
| <i>Health Diary</i> | 58 | 3.9 | 0.8 | 4.1 |
| <i>Pharmacy Services</i> | 16 | 3.8 | 0.9 | 3.9 |
| <i>Therapy</i> | 21 | 4.0 | 0.7 | 4.1 |
| <i>Women's Health</i> | 30 | 4.0 | 0.7 | 4.0 |
| Professional | 266 | 4.0 | 0.8 | 4.2 |
| <i>Alternative Medicine</i> | 3 | 4.0 | 0.6 | 4.3 |
| <i>Anatomy</i> | 9 | 3.7 | 0.8 | 4.0 |
| <i>Anesthesia</i> | 11 | 4.2 | 0.8 | 4.4 |
| <i>Cardiology</i> | 24 | 3.6 | 0.8 | 3.7 |
| <i>Dentistry</i> | 6 | 4.3 | 0.5 | 4.5 |
| <i>Dermatology</i> | 1 | 4.5 | 0.0 | 4.5 |
| <i>Emergency Medicine</i> | 15 | 4.3 | 0.5 | 4.4 |
| <i>Endocrinology</i> | 1 | | | |
| <i>Family Medicine</i> | 4 | 4.4 | 0.5 | 4.5 |
| <i>Genetics</i> | 1 | 4.7 | 0.0 | 4.7 |
| <i>Hematology</i> | 1 | 4.5 | 0.0 | 4.5 |
| <i>Histology</i> | 2 | 3.5 | 0.7 | 3.5 |
| <i>Infectious Disease</i> | 2 | 4.8 | 0.0 | 4.8 |
| <i>Medical Tools</i> | 62 | 4.1 | 0.7 | 4.3 |
| <i>Nephrology</i> | 4 | 3.4 | 2.0 | 4.3 |
| <i>Neurology</i> | 1 | 4.1 | 0.0 | 4.1 |
| <i>Nursing</i> | 10 | 4.2 | 0.6 | 4.3 |
| <i>O&G</i> | 1 | 4.1 | 0.0 | 4.1 |
| <i>Oncology</i> | 4 | 4.0 | 1.1 | 4.3 |

| | | | | |
|-----------------------------|----|-----|-----|-----|
| <i>Ophthalmology</i> | 2 | 3.6 | 0.6 | 3.6 |
| <i>Pathology</i> | 1 | 4.5 | 0.0 | 4.5 |
| <i>Pediatrics</i> | 8 | 3.8 | 1.5 | 4.3 |
| <i>Pharmacy</i> | 16 | 3.8 | 1.0 | 4.1 |
| <i>Physiotherapy</i> | 10 | 4.0 | 0.5 | 3.9 |
| <i>Psychiatry</i> | 4 | 4.2 | 0.4 | 4.2 |
| <i>Radiology</i> | 22 | 3.7 | 0.7 | 3.8 |
| <i>Reference</i> | 34 | 4.0 | 0.6 | 4.1 |
| <i>Respiratory Medicine</i> | 1 | 3.6 | 0.0 | 3.6 |
| <i>Surgery</i> | 4 | 4.9 | 0.1 | 4.9 |
| <i>Urology</i> | 2 | 3.6 | 0.1 | 3.6 |

Table 6: Price of apps

| | No of apps | Mean | SD | Median |
|------------------------|------------|--------|--------|--------|
| All | 500 | € 1.01 | € 4.91 | € - |
| Animals | 7 | € 0.40 | € 0.63 | € - |
| <i>Animals</i> | 7 | € 0.40 | € 0.63 | € - |
| Personal Health | 227 | € 0.51 | € 2.11 | € - |
| <i>Baby's Health</i> | 7 | € 0.22 | € 0.53 | € - |
| <i>Body Care</i> | 18 | € - | € - | € - |
| <i>Education</i> | 68 | € 0.76 | € 3.57 | € - |

| | | | | |
|-----------------------------|-----|---------|--------|--------|
| <i>Emergency Assistance</i> | 9 | € 0.44 | € 0.95 | € - |
| <i>Health Diary</i> | 58 | € 0.42 | € 0.92 | € - |
| <i>Pharmacy Services</i> | 16 | € 0.32 | € 0.57 | € - |
| <i>Therapy</i> | 21 | € 1.09 | € 1.52 | € - |
| <i>Women's Health</i> | 30 | € 0.22 | € 0.59 | € - |
| Professional | 266 | € 1.46 | € 6.41 | € - |
| <i>Alternative Medicine</i> | 3 | € 3.05 | € 4.31 | € - |
| <i>Anatomy</i> | 9 | € 1.94 | € 2.31 | € 1.95 |
| <i>Anesthesia</i> | 11 | € 0.76 | € 1.12 | € - |
| <i>Cardiology</i> | 24 | € 0.82 | € 1.27 | € - |
| <i>Dentistry</i> | 6 | € 0.22 | € 0.48 | € - |
| <i>Dermatology</i> | 1 | € - | € - | € - |
| <i>Emergency Medicine</i> | 15 | | € | |
| | | € 6.55 | 19.72 | € - |
| <i>Endocrinology</i> | 1 | € - | € - | € - |
| <i>Family Medicine</i> | 4 | € 1.75 | € 3.03 | € - |
| <i>Genetics</i> | 1 | € - | € - | € - |
| <i>Hematology</i> | 1 | € - | € - | € - |
| <i>Histology</i> | 2 | € - | € - | € - |
| <i>Infectious Disease</i> | 2 | | | € |
| | | € 11.68 | € 9.61 | 11.68 |
| <i>Medical Tools</i> | 62 | € 0.74 | € 1.83 | € - |
| <i>Nephrology</i> | 4 | € 0.13 | € 0.22 | € - |
| <i>Neurology</i> | 1 | € - | € - | € - |

| | | | | |
|-----------------------------|----|--------|--------|--------|
| <i>Nursing</i> | 10 | € 1.67 | € 3.27 | € - |
| <i>O&G</i> | 1 | € - | € - | € - |
| <i>Oncology</i> | 4 | € - | € - | € - |
| <i>Ophthalmology</i> | 2 | € - | € - | € - |
| <i>Pathology</i> | 1 | € - | € - | € - |
| <i>Pediatrics</i> | 8 | € 1.53 | € 1.97 | € 0.75 |
| <i>Pharmacy</i> | 16 | | € | |
| | | € 5.65 | 13.78 | € - |
| <i>Physiotherapy</i> | 10 | € 0.85 | € 2.21 | € - |
| <i>Psychiatry</i> | 4 | € - | € - | € - |
| <i>Radiology</i> | 22 | € 0.87 | € 2.93 | € - |
| <i>Reference</i> | 34 | € 0.30 | € 0.78 | € - |
| <i>Respiratory Medicine</i> | 1 | € - | € - | € - |
| <i>Surgery</i> | 4 | € - | € - | € - |

Discussion and Analysis

Prevalence of apps

The bulk of medical apps (53%) were mainly designed for healthcare professionals. Within the professional category, it is not a surprise that 'medical tools' (12%) and reference (7%) were the most common category of apps in the market. But the prevalence of cardiology (5%) and radiology (4%) apps is interesting. For the former, there are a sizeable number of apps focused on the Echocardiogram while for the latter; it is all about viewing DiCom (Digital Imaging and Communications in Medicine) images on the mobile phone. Pharmacy apps for professionals (3%) focus mostly on helping doctors in understanding and prescribing drugs.

Apps designed for personal health (45%) were grouped into fewer categories. Many of them can be described as educational resources (14%) that seek to tap into the public's obsession with bodily welfare¹⁹. There were 58 apps (12%) that provide a sort of diary for users to track various aspects of their health. About 6% of the apps are for women affairs, trying to help women manage their fertility and pregnancy records. There were a surprisingly high number of apps that claim to help people to sleep. These were the main components of the 'therapy' category (4% of total). Also, 3% of the apps are pharmacy services, reflecting the attraction of Italians to services that can enable them to locate or interact with their nearest pharmacy.

Seven apps were aimed at animal owners, offering them assistance on how to take care of their animals or providing veterinary services

Popularity of apps

There are no surprises in the app categories that have achieved the most downloads. The mean values show this to be Emergency Assistance, Women's Health and Reference, each with over a mean 175,000 number of downloads.

But as the median values show, the reality is slightly different. The presence of blockbuster apps with millions of downloads have skewed the mean value for most of these categories. Accordingly, the median values show that no category achieves

download volumes of over 30,000 (an interval of 10,000 – 50,000 on the Android market).

Using the median values, the most popular apps are those for Body Care, Women's Health and Reference.

Ratings of apps

If rating is used as a proxy for quality, it is commendable that the average ratings of the apps were 3.9/5 (mean) and 4.1/5 (median). The lowest median rating of 3.5 was recorded for Histology although the sample size for it is too small to make any reasonable conclusion. Accordingly, it is plausible to regard Body Care (median rating of 3.7 and mean rating of 3.6), as the lowest rated category with a decent sample size.

User engagement with apps

Expectedly, the number of reviews matches closely the volume of downloads for each app category. Using the mean data, Emergency Assistance, Women's Health and Reference apps received the most number of reviews. The median data says otherwise although it mostly skews the data to give a better performance for categories with small samples.

Price of apps

Contrary to popular opinion about how much money apps make, the reality is that most apps would need to be given away for free – 77% in this case. While the mean data gives an idea of how prices vary, the median data shows that on average, apps in only three categories (Anatomy, Infectious Disease, Pediatrics) can be expected to be sold for money.

Concerns about medical apps

While some of the papers cited above refer to how healthcare practitioners use apps, there is a wider question of whether these apps offer good value to professionals at their place of work. Are these apps necessary, and are they simply replicating existing data? For the general public, many of the apps purport to provide information that is already available online. It thus begs the question whether these apps even necessary.

But the much bigger problem occurs when apps make medical claims, which can pose serious public health safety issue as well. For example, while several of these apps suggest they can be used for activities that would have required medical training and supervision, they do not have any official approval. Although some developers try to circumvent this concern by incorporating disclaimers, there is growing research, especially at John Hopkins University, and official interest, led by the US FDA, into medical apps²⁰⁻²².

However, any official clampdown may struggle to achieve its aims without stifling innovation. Mobile apps are intangible, software products and will thus prove difficult to police, just like websites. The alternative of leaning on app market owners such as Apple or Google to vet medical claims is feasible, but risks a consumer backlash. A middle way might be for authorities to provide evidence-based/best-practice approach to app development for the healthcare sector. The public will then be encouraged to always evaluate any healthcare app based on the guidelines.

Future studies

Apps only debuted in the market in its current format in 2008 and so research into mobile apps in general, and healthcare apps in particular, are just starting. Future research should seek to include Apple's appstore (because of its preeminence) and other emerging app markets such as Microsoft's. Greater proliferation and use of smartphones and apps means there are many opportunities to look at how healthcare practitioners, in different healthcare systems, are using apps. Likewise, concerns about public safety will present fertile grounds for future research on mobile apps.

Conclusion

Apps are playing an increasing role in healthcare delivery and also for the training of healthcare practitioners. This review of the top, consecutive 500 'medical' apps in the Italian Android market shows that a majority of the apps are designed for healthcare professionals. On the average, a typical medical app will be downloaded 3,000 times, reviewed 16 times, rated 4.1/5 and given away for free. While there are many benefits to society from medical apps, there are also concerns so as not to endanger healthcare delivery or jeopardize public health and safety.

References

1. Trelease R.B. Diffusion of innovations: smartphones and wireless anatomy learning resources. *Anatomical sciences education* [Internet]. [cited 2012 Aug 25];1(6):233–9. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/19109851>
2. Jahns R.G. The market for mHealth application reached \$US 718m in 2011 [Internet]. 2012 [cited 2012 Aug 25]. Available from: <http://www.research2guidance.com/the-market-for-mhealth-application-reached-us-718-million-in-2011/>
3. Sullivan D. Does an app store's size matter if content is the killer app? [Internet]. *CNET News*. 2012 [cited 2012 Aug 20]. Available from: http://news.cnet.com/8301-33620_3-57471636-278/does-an-app-stores-size-matter-if-content-is-the-killer-app/
4. Boulos M, Wheeler S, Tavares C, Jones R. How smartphones are changing the face of mobile and participatory healthcare: an overview, with example from eCAALYX. *Biomedical engineering online* [Internet]. 2011 Jan [cited 2012 Jul 20];10:24. Available from: <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=3080339&tool=pmcentrez&rendertype=abstract>
5. Symbionix. Symbionix Introduces their First Mobile App for Surgical Education «Symbionix [Internet]. Press release. 2010 [cited 2012 Aug 25]. Available from: <http://symbionix.com/2010/04/14/symbionix-introduces-their-first-mobile-app-for-surgical-education/>
6. iMedicalApps. Educating patients on knee surgery with a medical app [Internet]. *iMedicalApps*. 2011 [cited 2012 Aug 25]. Available from: <http://www.imedicalapps.com/2011/08/knee-unhinged/>
7. Ovum. Kaiser's patient-centric mobile app opens many doors [Internet]. 2012 [cited 2012 Aug 27]. Available from: <http://ovum.com/2012/02/22/kaisers-patient-centric-mobile-app-opens-many-doors/>
8. Franko O.I. Smartphone apps for orthopaedic surgeons. *Clinical orthopaedics and related research* [Internet]. 2011 Jul [cited 2012 Jul

19];469(7):2042–8. Available from: <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=3111786&tool=pmcentrez&rendertype=abstract>

9. O’Neill S, Brady R. Colorectal smartphone apps: opportunities and risks. *Colorectal disease : the official journal of the Association of Coloproctology of Great Britain and Ireland* [Internet]. 2012 Sep [cited 2012 Aug 25];14(9):e530–4. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/22646729>

10. Franko O.I, Tirrell T.F. Smartphone App Use Among Medical Providers in ACGME Training Programs. *Journal of medical systems* [Internet]. 2011 Nov 4 [cited 2012 Aug 3]; Available from: <http://www.ncbi.nlm.nih.gov/pubmed/22052129>

11. Dala-Ali B.M, Lloyd M.A, Al-Abed Y. The uses of the iPhone for surgeons. *The surgeon : journal of the Royal Colleges of Surgeons of Edinburgh and Ireland* [Internet]. 2011 Feb [cited 2012 Jul 19];9(1):44–8. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/21195331>

12. Stanzel B.V, Meyer C.H. [Smartphones in ophthalmology : Relief or toys for physicians?]. *Der Ophthalmologe : Zeitschrift der Deutschen Ophthalmologischen Gesellschaft* [Internet]. 2012 Jan [cited 2012 Aug 25];109(1):8–20. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/22274293>

13. Rosser B.A, Eccleston C. Smartphone applications for pain management. *Journal of telemedicine and telecare* [Internet]. 2011 Jan [cited 2012 Aug 25];17(6):308–12. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/21844177>

14. Klasnja P, Pratt W. Healthcare in the pocket: mapping the space of mobile-phone health interventions. *Journal of biomedical informatics* [Internet]. 2012 Feb [cited 2012 Jul 14];45(1):184–98. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/21925288>

15. Medical Mobile Apps on the Rise [Internet]. *The publication of surgical residents and fellows in training*. 2012 [cited 2012 Aug 25]. Available from: http://www.intrainingsurgery.com/ViewArticle.aspx?d=In+Technology&d_id=467&i=July2011&i_id=742&a_id=17429

16. Newell Derek. 5 Ways Mobile Apps Will Transform Healthcare [Internet]. *Forbes*. 2012 [cited

2012 Aug 25]. Available from: <http://www.forbes.com/sites/ciocentral/2012/06/04/5-ways-mobile-apps-will-transform-healthcare/>

17. Ovum. Mobile app challenges in the US aim to enhance innovation in healthcare » *Ovum* [Internet]. 2012 [cited 2012 Aug 27]. Available from: <http://ovum.com/2012/04/11/mobile-app-challenges-in-the-us-aim-to-enhance-innovation-in-healthcare/>

18. Storm Darlene. Killer Android app allows the clueless to hack, pwn like a pen tester | *Computerworld Blogs* [Internet]. ComputerWorld. 2012 [cited 2012 Aug 25]. Available from: http://blogs.computerworld.com/18755/killer_android_app_allows_the_clueless_to_hack_pwn_like_a_pen_tester

19. McLuhan M. *Understanding Media: The Extensions of Man*. Toronto, Canada: McGraw-Hill; 1964.

20. Cerrato P. Mobile Medical Apps Gold Rush Needs Scrutiny - Healthcare - Mobile & Wireless - *Informationweek* [Internet]. Information Week. 2012 [cited 2012 Aug 25]. Available from: <http://www.informationweek.com/healthcare/mobile-wireless/mobile-medical-apps-gold-rush-needs-scru/240000464>

21. Cohn M. Tens of thousands of health apps available, but which ones work? - *baltimoresun.com* [Internet]. *Baltimore Sun*. 2012 [cited 2012 Aug 27]. Available from: <http://www.baltimoresun.com/health/bs-hs-mobile-health-apps-20120314,0,2590424.story?track=rss>

22. Gold J. FDA regulators face daunting task as health apps multiply [Internet]. *USA Today*. 2012 [cited 2012 Aug 27]. Available from: <http://www.usatoday.com/news/health/story/2012-06-22/health-apps-regulation/55766260/1>