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Are Smartphones Ubiquitous?

An in-depth survey of smartphone adoption by seniors.

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SUBSTANTIAL ONGOING RESEARCH NOW USES SMARTPHONES AS A RESEARCH PLATFORM for various studies and interventions. With the aging population becoming a frequent focus of research, an increasing number of studies and projects attempt to develop technological interventions for the elderly population. The extent to which the elderly population (i.e., *seniors*) adopts and uses smartphones is not clear. Many studies acknowledge that today's seniors are not particularly keen on using smartphones, but in the near future we can expect this trend to change.

In this article, we present an in-depth survey of statistics on smartphone adoption within the elder population, including the popularity and type of use that smartphones enjoy among seniors. We show that, far from being ubiquitous, smartphones are still overshadowed by phones with traditional features. We also show that substantial geographical differences exist between countries. Furthermore, those seniors who do adopt smartphones tend to use them as feature phones and do not adopt services that are popular among younger users. Our survey provides an

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assessment on the ubiquity of smartphones among seniors, which can be used to inform the assumptions of our research community.

THE SPREAD OF SMARTPHONES

Smartphone adoption by the general population has increased rapidly in recent years, including within the elderly population. A pronounced age divide still exists, however, and a number of studies now claim that older adults (i.e., above 50 years old) remain reluctant in adopting smartphones [1], especially due to financial limitations, vision impairment, and lack of interest or know-how [2].

Researchers often make the assumption that smartphones will eventually become ubiquitous across the whole population. Here, we present a systematic, in-depth survey to quantify and validate this assumption. To ground our work, we systematically compiled statistics from multiple sources to measure the adoption rate of mobile phones and smartphones among seniors internationally, and we determined the rate at which smartphone penetration is growing within this population segment. Data on mobile phone and smartphone penetration are provided to help us forecast the extent of smartphone proliferation among senior users in the future.

RESEARCH ON SENIORS AND SMARTPHONES

The challenges that our aging societies face have triggered an increasing number of funding agencies to promote a research agenda that calls for using seniors to take advantage of the capabilities of smartphones. Enhanced mobility is an important potential benefit, in that use of a smartphone can help older people navigate cities on public transportation [3], provide itinerary management and local assistance when "on the move" [4], and promote active and healthy aging by targeting early risk detection of cognitive impairment, frailty, and social exclusion [5].

The potential value of smartphones for elderly citizens is also increasingly reflected in governmental measures aimed at social inclusion for seniors through mobile technology. Governments have begun to formulate strategic plans considering information and communications technologies (ICTs) for seniors [6] to increase intergenerational bonding through the use of smartphones.

Some businesses have begun developing apps aimed at seniors. One purpose that apps can serve is to enhance real-time communication while promoting independent living. One example is the Silverline app for older adults, which replaces a smartphone's advanced functionality with an elder-friendly interface so that older adults can connect more easily with their families and caregivers [7]. Similarly, the HeartWise Blood Pressure Tracker app allows seniors to record blood pressure, heart rate, and weight on a daily basis and over time, while the Pillboxie app allows them to be reminded of when and which medication to take. Other relevant apps include the EyeReader app, which allows the phone's camera to function as a magnifying glass with a light to assist with reading. Entertainment apps such as Clevermind or Lumosity provide quizzes and games that may help improve memory and attention, among other cognitive skills, and could help fight the progression of diseases like Alzheimer's [8].

Despite the potential impact smartphones can have on the everyday lives of seniors, no systematic review exists on how popular smartphones are among this population internationally. In this article, we aim to shed light on the assumptions that we make as researchers regarding the ubiquity of smartphones and their usage among seniors.

Our systematic survey was conducted in two stages. First, relevant sources of information were identified and coded on the basis of the geographic region they reference and the age groups they include. Second, relevant sources were grouped together, cross referenced, and combined into the summary charts that we have generated in this review. We also note that, due to the diversity and inconsistency of the raw data coding, we were not able to include all sources in the diagrams, although we do reference them in the text.

TRENDS IN ADOPTION OF SMARTPHONES BY SENIORS

The worldwide population is aging at a fast pace. Citizens over the age of 55 now represent 25% of Europe's population, and the 65+ age group is expected to nearly double by 2060, reaching 151 million [9]. Outside of Europe, both the United States and Japan are among the top ten countries on the Global AgeWatch index overall ranking, while among Brazil, Russia, India, China, and South Africa, China maintains the fastest aging rate [9]. At the same time, smartphone adoption is rapidly increasing in developed markets, with predictions pointing to 2.9 billion smartphone connections by 2020 [10]. Considering the drastic demographic changes worldwide and the growing adoption of smartphones by older segments of the population, it is of crucial importance to look specifically at the historical and ongoing tendencies regarding smartphone adoption by the elderly to reflect on possible future trends.

EUROPE

Data from 2013 [11] indicate that smartphone adoption for users aged 55+ varies widely among countries, with Norway leading the statistics (43%), followed by Sweden (31.9%) and the United Kingdom (30%). In contrast, southern European countries have a low penetration, e.g., Greece (8.8%) and Portugal (10.6%). Smartphone penetration across the other age groups is higher but follows a similar tendency when analyzed by country. Overall, the five biggest markets (Germany, France, Italy, Spain, and the United Kingdom) had a smartphone audience of 136.2 million users [12]. Regarding the age composition of the smartphone audience, 17% of those aged 45–54 were smartphone users, while 20% of those 55+ used a smartphone [12].

Indicatively, traditional mobile phones are far more popular among the 55–65 (79%) and 65+ (62%) demographics [13]. Among older age groups (55–74), male users are stronger adopters of smartphones than females (75 versus 69%),

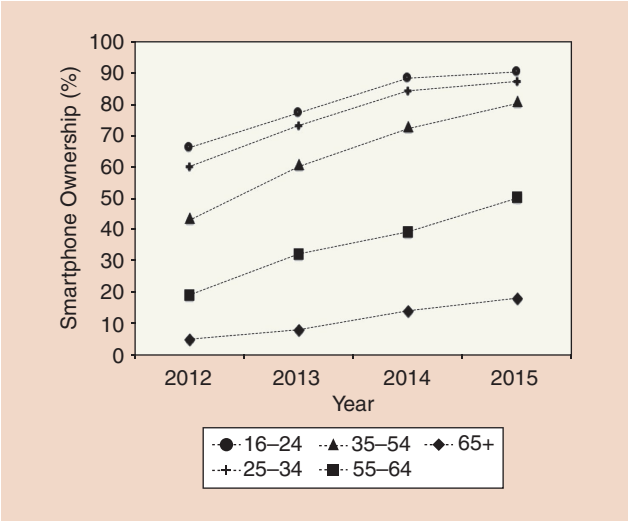

FIGURE 1. Smartphone ownership (%) by age group in the United Kingdom between 2012 and 2015 [15].

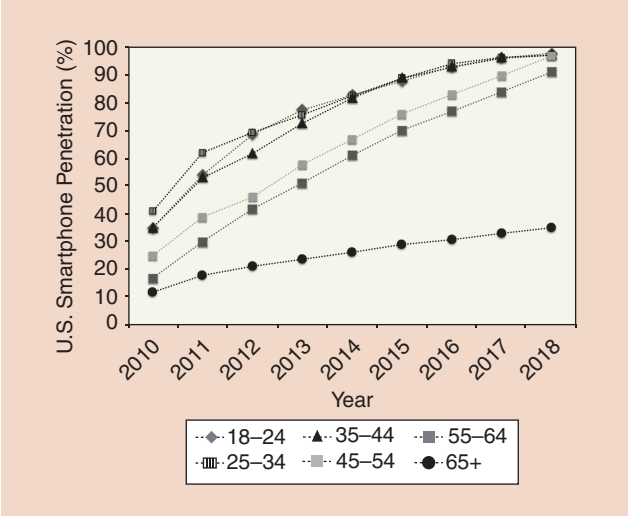

FIGURE 2. U.S. smartphone user penetration (%) by age cohort from 2010 to 2018 [15], [16], [18], [19].

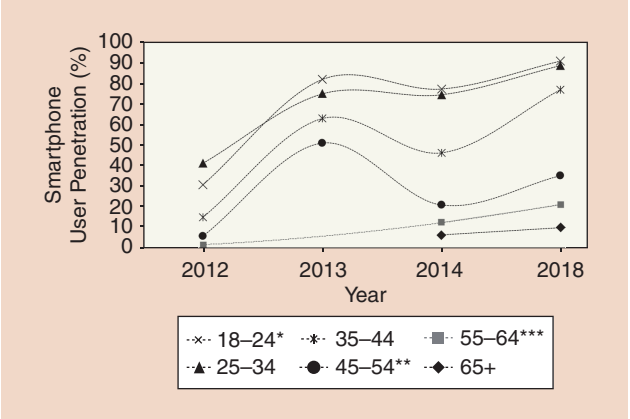

FIGURE 3. Smartphone user penetration in China (%) by age cohort between 2012 and 2018 [15], [21], [22]. (For 18–24*, except for 2013, data refer to 16–24; for 45–54**, except for 2012, data refer to 45–55, and for 2013, data refer to 45–64; for 55–64***, except for 2012, data refer to 55+.)

and a higher level of education is linked to higher percentages of adopters: 63, 77, and 87%, respectively, for low, medium, and higher education [13]. We expect that education may have a similar effect on smartphone adoption, although this cannot be confirmed with any of the available statistics.

Since statistics at the European Union level are scarce and unreliable, we consider the United Kingdom as a case study for systematically studying adoption trends. We find that 61% of U.K. adults claim to own a smartphone [14]. Ownership in the United Kingdom has gradually grown for every age group, and 18% in the 65+ age group now own a smartphone (Figure 1). Indicatively, 72% own a traditional mobile phone in the same group [15].

We observed that smartphones are overall far from ubiquitous in the United Kingdom, both across the whole population (61%) and considering senior citizens (14%) [14]. In fact, despite the trends of our aging society, smartphone adoption among seniors has not risen as fast as in other age groups, and traditional mobile phones are still the de facto technology for this age group (72%) [15].

UNITED STATES

Regarding the share of adults in the United States who own a smartphone, statistics show that a gradual increase in ownership has occurred over time for every demographic group [15]–[19]. Unlike the European Union, ownership is most prominent in those aged 25–34 years, and in the United States, the share of 65+ using smartphones is 29% (Figure 2), a rate that is lower than that in Nordic countries but higher than what is seen in most other European countries. For the United States, we were able to find more granular statistics regarding the adoption rate of smartphones among those aged 65+ [17]. The data indicate that smartphone ownership gradually decreases to 21% for the 70–74 age group, to 10% for the 75–79 age group, and to just 5% for those aged 80+.

ASIA

According to a 2013 report [20], ownership of either a mobile phone or a smartphone is at least 90% in 14 major Asian cities. Gender-wise, both males and females in their 20s drive smartphone ownership in Asia. In cities with high smartphone ownership (e.g., Seoul, Hong Kong, Singapore, and Taipei), the television (TV), computer, and smartphone have become the "big three" media. Smartphone ownership among male and female users 50–54 years old is highest in Seoul (78 and 52%, respectively) [20].

For China, a 2012 report [15] notes that the 25–34 age group is the largest smartphone user group (41.2%). Among the 55+ age group in China, only 1.5% were smartphone users (Figure 3). It is predicted that 9.8% of the 65+ age group in China will use a smartphone by 2018 [21]. However, the penetration among people 45–64 years old in 2012 was 51% [22]. In Japan, smartphone ownership is at 58.1%, and, unlike in the European Union and the United States, the leading demographic is females (62.4%) [23]. Smartphone penetration among people 45–54 years old has grown to 21.4%,

while for those aged 55+ it gradually increased to 10.6% in 2013 (Figure 4) [11]. According to a 2014 report, smartphone ownership among the 50–59 age group reached 39.4% in April. For seniors 60+, the numbers are lower at 22.5% [23].

SENIORS' SMARTPHONE USAGE HABITS

Ownership of a smartphone does not necessarily indicate that the full capabilities of a smartphone have been adopted. For example, do seniors use their smartphones just to make phone calls, or do they also access information on them? For this reason, in addition to examining smartphone ownership among seniors, it is also important to investigate adoption patterns and appropriation.

The literature points out that nonadoption and misappropriation of smartphones by older adults is common [24]. A number of studies show that older adults show substantial barriers to the use of smartphones [25], such as 1) subjective barriers, 2) technological barriers, and 3) situational barriers. Subjective barriers are related to individuals' attitudes and ability, such as the lack of know-how on how to use the smartphone, which may be related to a decline in both mental and physical ability due to old age: e.g., poor eyesight and shaky hands may prevent seniors from seeing the keyboard properly or taking a picture. Technological barriers are mainly related to interface and usability concerns. Situational barriers include economic costs, which are also a great obstacle to the adoption of smartphones [25].

Before the rise of smartphones, studies in 2006 showed that the 60+ age group made limited use of mobile phones, utilizing them mainly for emergencies [26]. Seniors also tended to avoid short message services and other communication features simply because the devices were deemed as not user-friendly: the displays and buttons were small and difficult to see. More broadly, Ofcom had claimed that the older generation was significantly less likely than other Internet users to engage in a range of online activities such as banking and watching or downloading TV programs or films [27]. These trends continue to some extent in modern smartphone usage.

In general, age plays an important role in smartphone use. This age gap is more pronounced in the use of social networking services: in 2013, data from 11 developed countries (Belgium, Finland, France, Germany, Japan, The Netherlands, Singapore, South Korea, Spain, the United Kingdom, and the United States) showed that just below a third of those over 55 use a smartphone for social networking, unlike younger age groups [28]. Similar differences are found in the use of mobile instant messaging. Finally, 25% of smartphone owners aged 55+ have never downloaded an app to their mobile device [28].

More detailed statistics are available for the United States, where today we find that the most popular services for smartphone users aged 50+ are calls (94%), closely followed by text messaging (92%), e-mail (87%), and Internet use (80%). There is still a considerable age gap in social networking services: 91% of people 18–29 years old use this feature versus only 55% of users who are 50+ years old. Watching videos and listening to music/podcasts are the least popular features among

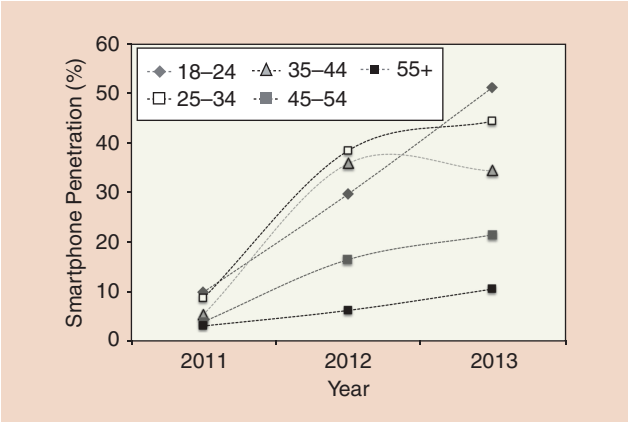

FIGURE 4. Smartphone penetration in Japan (%) from 2011 to 2013 by age cohort [11], [23].

those 50+ (31% and 21%, respectively) (Figure 5) [29]. In Japan, however, users in the 55–59 and 60+ age groups were active video viewers, with 77 and 66.1% respectively [23].

Regarding the use of the smartphone to look up job openings, educational content, and health information, the 18–29 age group is the most active, while for those 50+ searching for a job or submitting a job application only accounts for 17% and 4%, respectively, in contrast with a much higher percentage among younger age groups. Searching for educational content only accounts for 14% among seniors (versus 44% among those 18–29 years old), while 39% of people 50+ searched for information about a health condition versus 77% of those 18–29 years old (Figure 5) [29].

Similar age-related trends are observed for new and emerging services. For instance, unlike young adults (18–29 years old), who are likely to use their smartphones for turn-by-turn navigation (80%), the percentage of users in the 50+ age group that uses this service is only 44.5% (±10.61). This drops to 12.5% (±4.95) when dealing with public transit information and to 6% (±1.41) for reserving taxis or a car service [29]. Some services are surprisingly popular with senior users over 50, however, such as sharing information about local events 56% ± 5.66, following breaking news 51.5% ± 13.44, and learning about community events 40% ± 7.07, [29].

SMARTPHONES ARE NOT UBIQUITOUS

Smartphones are far from ubiquitous today. This is unlikely to change unless ubicomp researchers make this part of the research agenda. Today, the highest penetration rates among seniors are observed in Nordic countries (Figure 6), but in general, traditional feature phones still reign supreme among seniors.

It has been speculated that since feature phones will be increasingly harder to acquire as smartphones become cheaper, the overall difference in smartphone penetration by age will disappear and even become negligible as soon as 2020 [34]. Furthermore, traditional wisdom has been that the seniors of tomorrow are the middle-aged of today [35], and therefore today's smartphone adoption by younger age

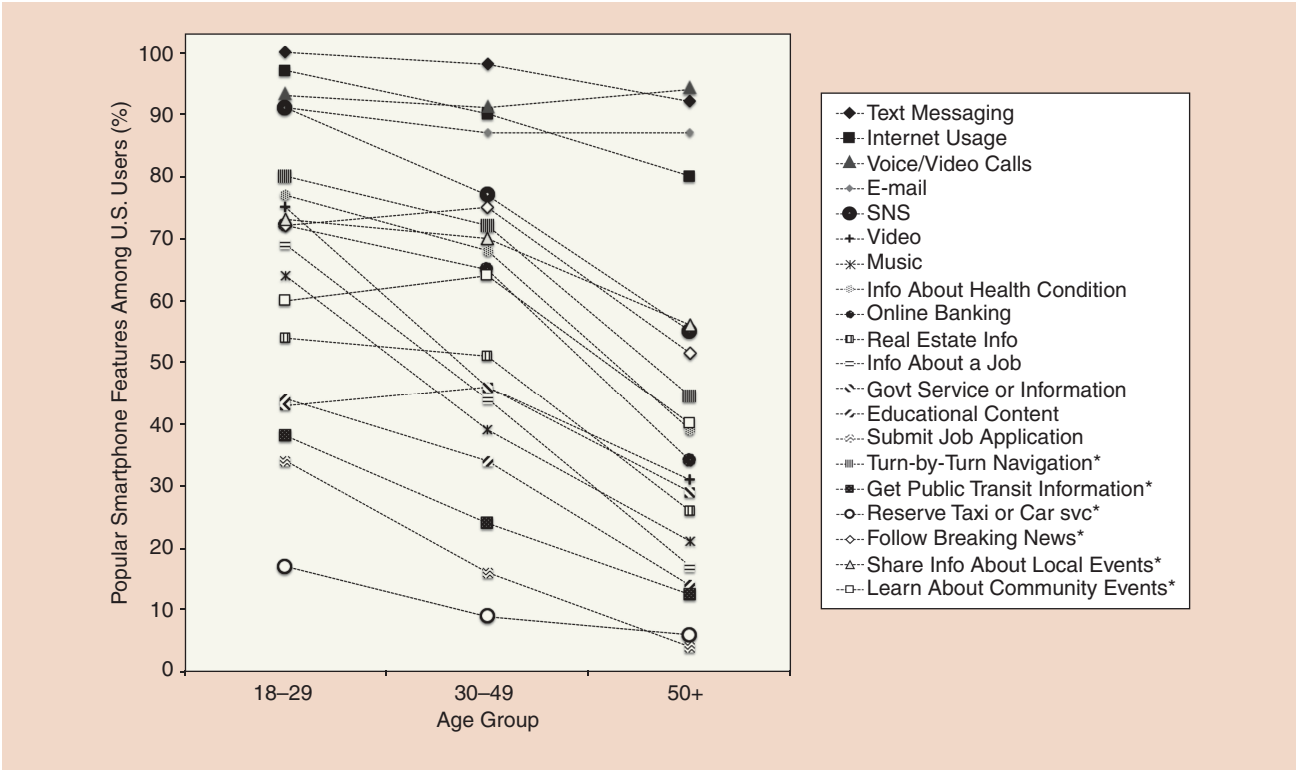

FIGURE 5. Popular smartphone features (%) among U.S. smartphone owners, and phone use for job seeking, educational content, health information, and other services (%) by age cohort in 2014. For categories marked with *, the 50+ age group includes the mean between the 50–64 and 65+ categories. Standard deviations vary between 1.41 and 13.44 [29].

groups is a strong predictor of smartphone adoption by seniors in the years to come.

These assumptions that serve as a basis for motivating much of the ongoing research on smartphone and ubicomp technologies for seniors, however, ignore the data on adoption practices. Even if we concede that smartphones will find their way into more seniors' hands, ownership does not translate to the use of advanced and new services. When considering the totality of smartphone users (including seniors), we observe a significant age divide in the types of services being used. It is unclear whether this trend is likely to shift in the future. Smartphones are mostly used as feature phones by seniors, and many of the popular services are relatively underutilized by seniors.

There are two possible explanations that can account for age-related differences in smartphone usage. First, the inevitable physical and cognitive decline among seniors is likely to remain a persistent barrier in the adoption of more advanced services. Second, existing technologies and services do not target the major lifestyle changes that seniors experience (changes to job/career, family, health) and the associated changes in their needs and interests. Thus, it is likely that seniors do not adopt today's popular services simply because they are not designed for seniors.

Recent advances suggest that smartphones have the potential to serve both as valuable research platforms and breakthrough intervention technologies in targeting various societal needs. While smartphones are not yet ubiquitous, the common assumption in our research community has been that this will change over time. Our in-depth analysis of multiple statistical sources suggests that both ownership and use practices are closely linked to age differences. Even if smartphones find their way into seniors' hands, there still exists a lack of services geared toward them, and therefore smartphones are likely to be used as feature phones, with users never downloading apps to customize the functionality of their device.

Thus, it is important for ubicomp research to consider whether seniors' needs are addressed to ensure that meaningful penetration continues to grow in that age group. More appropriate interfaces that account for physical and mental decline, including less complex configuration requirements, while also maintaining the sensing capabilities and connectivity options of modern smartphones is likely a winning strategy.

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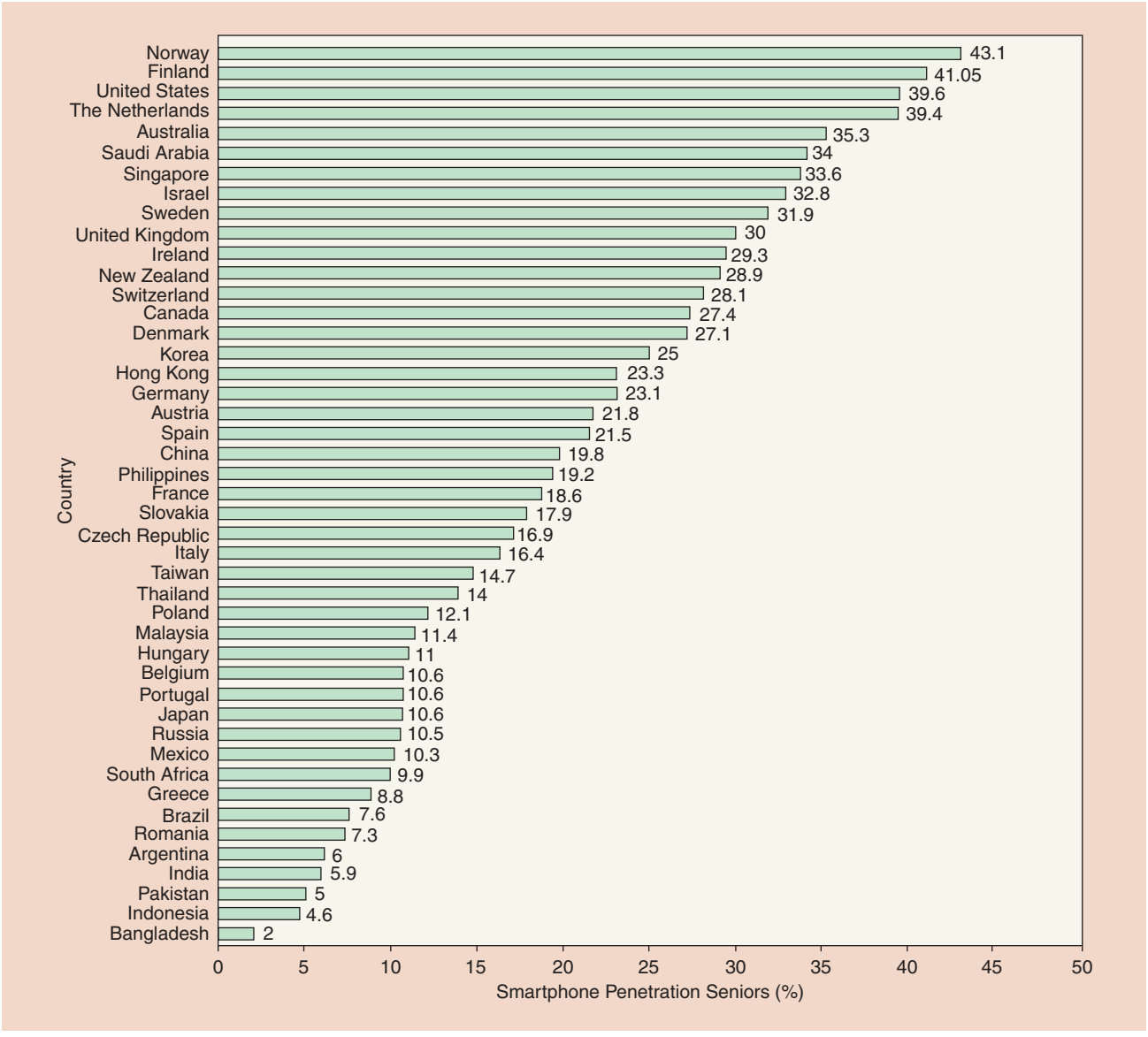

FIGURE 6. Smartphone penetration worldwide by country for age group 55+, from 2013 to 2015 [11], [19], [30]–[33].

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